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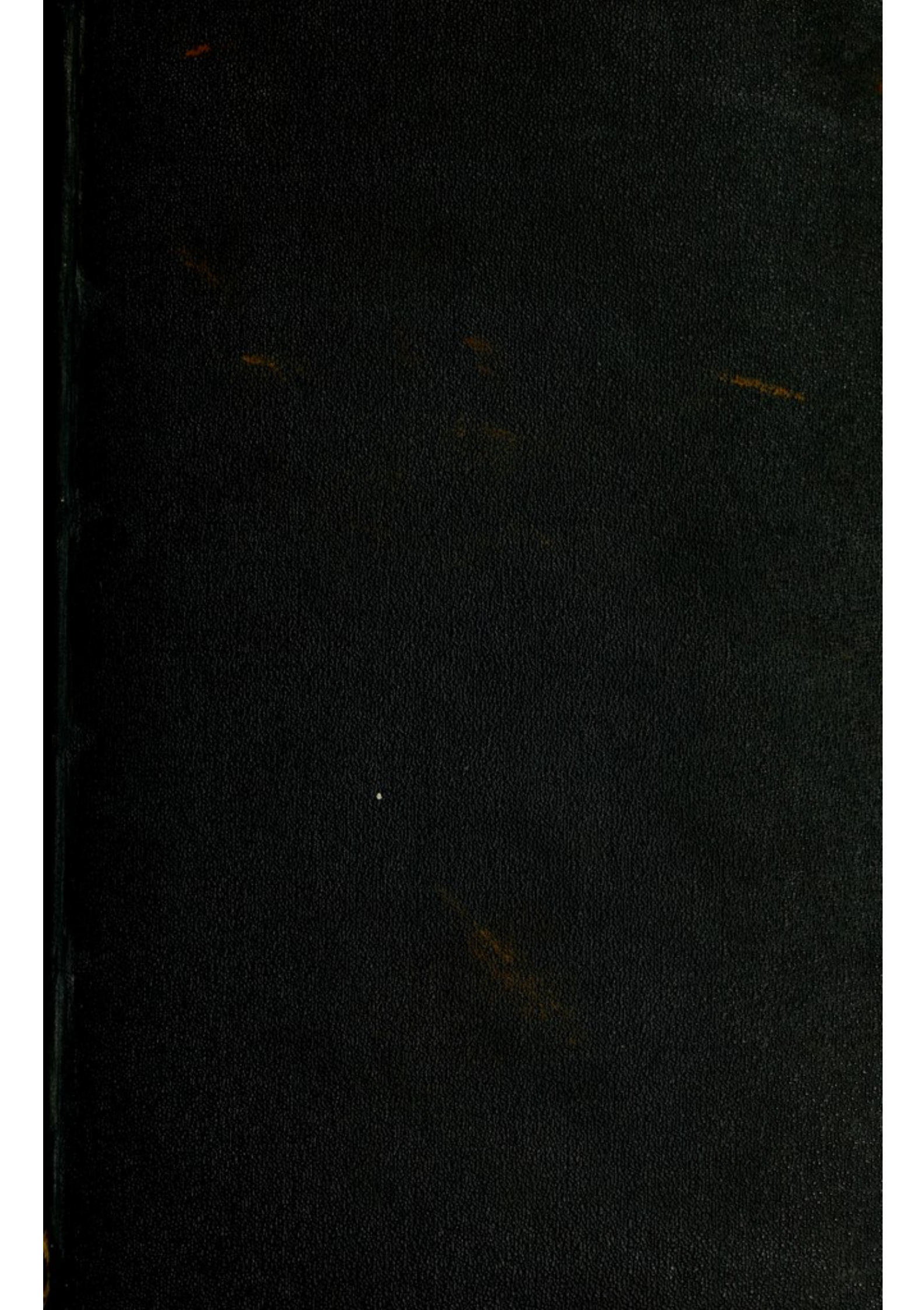
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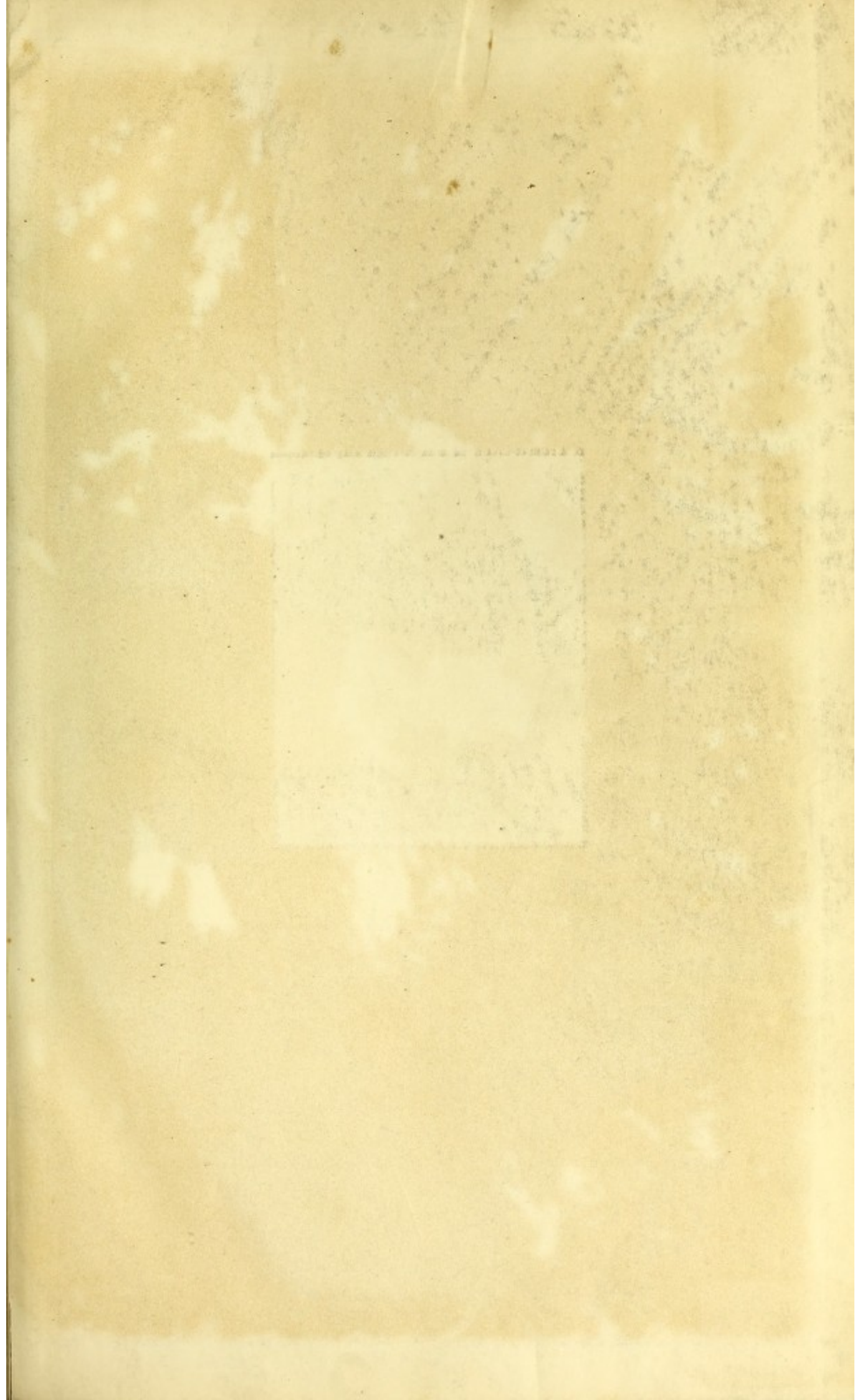
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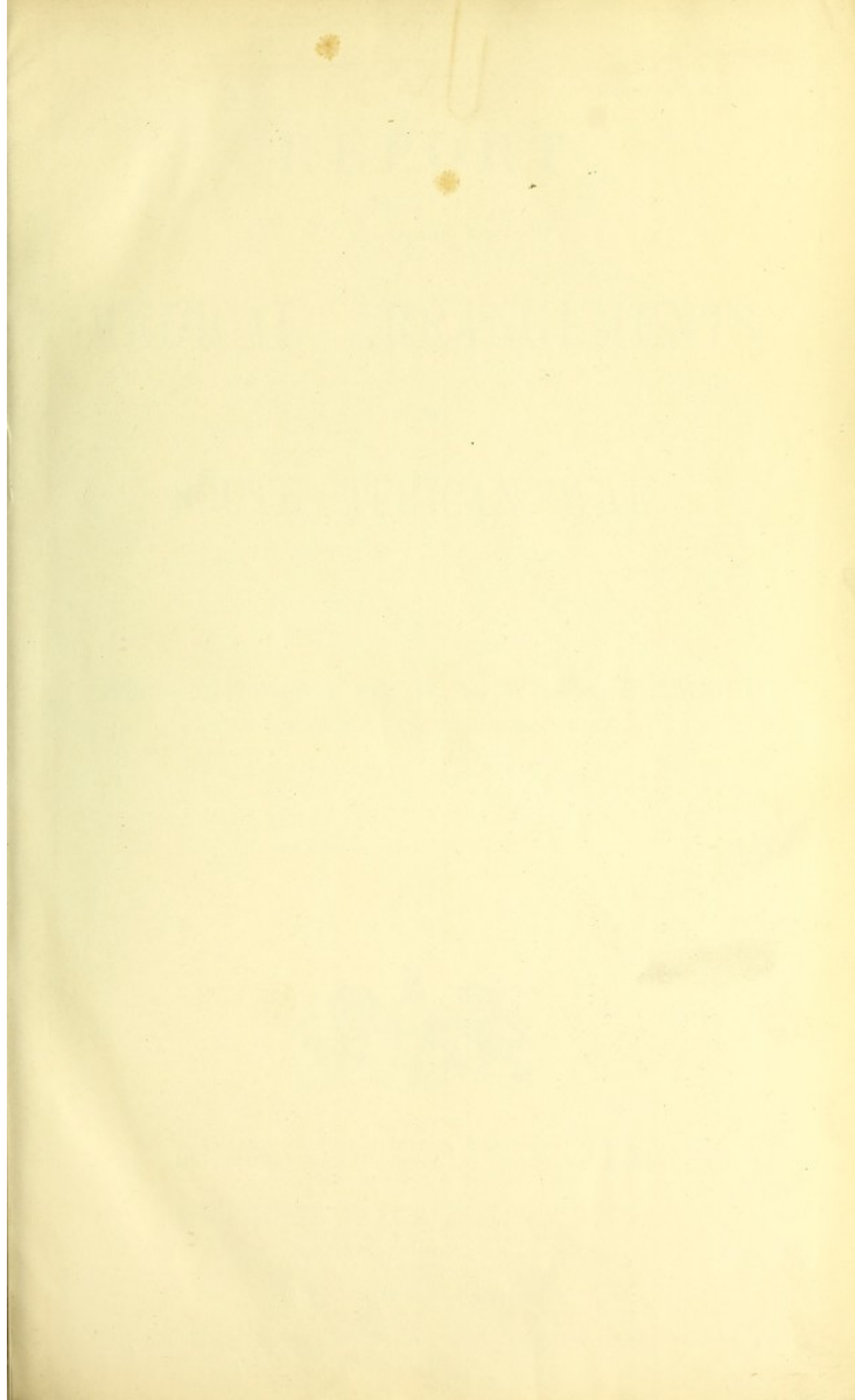
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REPORT
ON THE
MEDICAL ARRANGEMENTS
IN THE
SOUTH AFRICAN WAR.

BY
SURGEON-GENERAL SIR W. D. WILSON, K.C.M.G.
(Late Principal Medical Officer, South African Field Force).



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REPORT

OF THE

MEDICAL ARRANGEMENTS

OF THE

SOUTH AFRICAN WAR.

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From

SURGEON-GENERAL SIR W. D. WILSON, K.C.M.G.,
*Late Principal Medical Officer,
South African Field Force.*

To

THE DIRECTOR-GENERAL,
Army Medical Service.

LONDON,

December 18th, 1903.

SIR,

I HAVE the honour to forward herewith my Report on the Medical Arrangements in the South African War.

2. In doing so, I am glad to have the opportunity of expressing my thanks to the Officers, Consulting Surgeons, Civil Surgeons, Sisters, Warrant and N.C. Officers and men of the various branches of the Medical Service who were under my command during the Campaign, for the excellent work which they performed. It was only through their untiring energy and devotion that it was possible to carry out a task which far exceeded any anticipation, both in magnitude and duration. It will not, I think, be invidious to distinguish for special recognition in this place that nucleus of all ranks of the Royal Army Medical Corps, and the comparatively small number of Sisters, both of the Army Nursing Service and Army Nursing Service Reserve, who served continuously throughout the whole Campaign.

3. My thanks are also due to the Red Cross Society, to the various voluntary organisations organised by, or in conjunction with, the Central British Red Cross Committee, to various independent societies, and many private individuals both in England and South Africa, who spared neither time nor labour in assistance.

4. I wish further to thank these Officers who have contributed to this Report, and whose names will be found associated with their special contributions, and more particularly Lieut.-Colonel R. J. S. Simpson, C.M.G., on whom, as my Secretary, much of the labour of collecting and arranging the materials, and of the actual preparation of the Report, has fallen.

I have the honour to be, Sir,

Your obedient servant,

W. D. WILSON,

Surgeon-General A.M.S.

Received of the Hon. W. L. Wilson, K.C.M.G.
the sum of £1000
for the purchase of the land

The Director-General

London, 18th Nov 1900

Dear Sir,

I HAVE the honor to forward herewith the report on the work
done in the South African War.

It is very good, and I am glad to hear the opportunity of expressing my
thanks to the Hon. Director-General, Mr. Wilson, for the excellent work
done by him and his staff in the various branches of the Medical Service
and in the various other departments during the war. The report is very
well written and contains much valuable information. It is very
interesting to read of the work done by the various departments and
of the success which has attended their efforts. I am sure that the
report will be of great value to the Government and to the public.
I am, Sir, very respectfully,
Your obedient servant,
The Director-General

I have the honor to acknowledge the receipt of the report on the work
done in the South African War, and to thank you for the information
which it contains. I am sure that the report will be of great value
to the Government and to the public.

I am, Sir, very respectfully,
Your obedient servant,
The Director-General

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to the Government and to the public.

REPORT ON THE MEDICAL ARRANGEMENTS IN THE SOUTH AFRICAN WAR.

PART I.

GENERAL ACCOUNT OF THE MEDICAL ARRANGEMENTS.

A.—PREPARATIONS IN SOUTH AFRICA.

IN May, 1899, the strength of the garrison of South Africa was 8,628, of whom 4,150 were in Cape Colony, and 4,478 in Natal. In Cape Colony the greater part of the garrison was concentrated in the Cape Peninsula itself, in Wynberg, and Cape Town, while there were smaller garrisons in King Williamstown and Grahamstown. In Natal the garrison was practically divided between Maritzburg and Ladysmith.

The Principal Medical Officer, Colonel F. J. Supple, R.A.M.C., was in administrative charge of both colonies, the Cape and Natal; while the Senior Medical Officer of Natal, Lieut.-Colonel P. H. Johnston, was in charge of the hospital in Maritzburg.

In May, 1899, there were, in addition to the Principal Medical Officer, 28 Officers of the Royal Army Medical Corps employed in South Africa, with three sisters of the Army Nursing Service, and 132 Warrant and N.C. Officers and men of the Royal Army Medical Corps. In Cape Colony there were also six Officers and 140 N.C. Officers and men of the Cape Medical Staff Corps, an integral part of the Colonial Forces; there were also the Regimental Medical Officers of the Colonial Volunteers and the Cape Mounted Rifles, which had a small personnel of other ranks. In Natal the Volunteer Corps had their Regimental Medical Officers and some trained stretcher-bearers also.

The permanent hospitals were only sufficient for the garrison. In Cape Town there was the old station hospital at Woodstock, in Wynberg the hospital was in very good huts, while in King Williamstown and Grahamstown the hospitals formed part of the old barracks. In Natal there was a good hospital in Fort Napier, Maritzburg, accommodating some 90 sick in good buildings, while the accommodation was increased in case of necessity by the temporary reappropriation of adjacent barrack rooms. In Ladysmith there was a hutted hospital in the camp.

There was also a medical store at Cape Town, which supplied the whole of the stations in Cape Colony and Natal. A small reserve of field equipment was maintained in Cape Town and Maritzburg for emergencies, which in June, 1899, was completed to equip three field hospitals and three bearer companies.

After the Conference in Bloemfontein in May, 1899, the situation seemed critical. Small bodies of troops arrived during June and July (Army Service Corps and Engineers), followed in August by two battalions of infantry.

Although the issue of the negotiations between the Governments remained doubtful, it was evident that, in the not improbable occurrence of hostilities, the first brunt would fall on Natal; further, that whatever the development of the campaign, the only possible ports in Cape Colony, viz., Cape Town, Port Elizabeth, and East London, with the trunk lines leading from them through De Aar, Middelburg, and Naauwpoort, and through Sterkstroom, Stormberg, and Burghersdorp, would most certainly be utilised for the landing and forwarding of troops and stores, and for concentration prior to an advance.

So far the lines on which the Principal Medical Officer, South Africa, had to act could be easily defined, but for the reasons which need not be discussed here any overt preparation at this time was deprecated. The stock of medical and surgical stores in Natal was quietly but steadily increased during the months following the Bloemfontein Conference, and as early as June a provisional scheme for the mobilisation of the available personnel in Natal was put forward.

But by the beginning of September it was possible to do more: it was determined to establish a general hospital at Wynberg, and the conversion of the hut barracks in Wynberg Camp, an ideal site, was begun. About the same time an Officer was detailed to proceed to De Aar, Sterkstroom, Stormberg, and other important points on the main lines from Port Elizabeth and East London, to ascertain what buildings could be made available for use as temporary hospitals and the alterations and additions necessary to fit them for this purpose, which were then put in hand. With the assistance of the Cape Government Railway, two hospital trains (Nos. 2 and 3) were prepared for the conveyance of sick and wounded from the front, and ambulance carriages for local use between the docks and the hospitals in Wynberg and Cape Town were also prepared. Medical stores of all kinds were sent up to De Aar, Kimberley, and Mafeking.

In Natal additional hospital equipment of all kinds, to bring the total accommodation up to 10 per cent. of the garrison, had been cabled for in September; this arrived in November in the form of the equipment of a general hospital, and proved of great service. The equipment of the field hospital and bearer company was drawn from store, and a small personnel detailed for these units, making them available for any urgent service, which in the event proved necessary.

In August the stores for an advanced dépôt of medical stores had been sent to Ladysmith, while a hospital train (No. 1) to carry 70 sick and wounded was prepared by the Natal Government Railway under instructions from the Senior Medical Officer, Natal, Lieut.-Colonel Johnston. This train made its first trip from Ladysmith before hostilities had actually commenced.

Provisional arrangements were also made with the Union Castle Company for the transport of so many invalids per week, should this be required.

A register of civilian practitioners and nurses who were willing to serve was also opened; these were employed later on, as their services were required.

In the third and fourth weeks in September small bodies of troops moved to De Aar (26.9.99), Kimberley (18.9.99), and Orange River (19.9.99), and small hospitals were opened at these stations for the accommodation of their sick, the personnel and equipment being provided from Cape Town.

During this month there was a small increase in the strength of the Royal Army Medical Corps in South Africa, and during the first week in October the Indian contingent arrived, bringing with them three and a half British field hospitals and one native field hospital, all of the Indian Establishment, together with an Officer of the Royal Army Medical Corps and an assistant-surgeon with each regiment. These arrived and disembarked in Natal, complete as regards personnel, according to the Indian Regulations.

The distribution of the garrison of South Africa on October 13th, 1899, was as follows:—

<i>Cape Colony.*</i>						Strength.
Royal Garrison Artillery (2 companies)	...	...	...	...	...	306
Royal Engineers (3 companies)	...	...	...	...	...	377
Infantry (4½ battalions)	...	...	...	...	...	4,137
Other corps	...	...	...	...	...	400
Total	...	...	...	...	...	5,220
Local Forces	...	...	...	...	...	4,594
Rhodesian Forces	...	...	...	...	...	1,448
Grand total	...	...	...	...	...	11,262

* Appendix No. 7, "Report of Royal Commission on the War in South Africa."

With the following medical personnel :—

Royal Army Medical Corps—

Officers	...	...	...	...	...	15
Quartermasters	...	...	...	...	...	2
Other ranks...	...	...	...	...	...	99

Cape Medical Staff Corps—

Officers	...	...	...	...	...	6
Other ranks...	...	...	...	...	...	140

*Natal.**

						Strength.
Cavalry regiments (4)	...	...	...	...	...	1,840
Royal Artillery (7 batteries)	...	...	...	...	...	1,326
Royal Engineers	...	...	...	...	...	198
Infantry (10 battalions)	...	...	...	...	...	9,445
Other corps	...	...	...	...	...	377
Staff	...	...	...	...	...	42
Total	...	...	...	...	...	13,228
Volunteers	...	...	...	...	...	2,464
Police	...	...	...	...	...	317
Grand total	...	...	...	...	...	16,009

With the following medical personnel :—

Royal Army Medical Corps—

Officers	...	...	...	...	...	39
Quartermaster	...	...	...	...	...	1
Other ranks...	...	...	...	...	...	99

Indian Medical Service—

Officers	...	...	...	...	...	2
And the personnel (excluding Officers) of 3½ British and 1 native field hospital.						

Natal Volunteer Medical Corps—

Officers	...	...	...	...	...	18
Other ranks...	...	...	...	...	...	60

Nursing sisters	3
-----------------	-----	-----	-----	-----	-----	---

B.—PREPARATIONS IN ENGLAND.

The force, detailed on October 5th, 1899, to proceed from England to South Africa, consisted of a cavalry division, one army corps, and troops for the lines of communication. The strength was as follows :—

One cavalry division	...	...	5,366 plus 282 left at base.
One army corps	...	...	34,375 „ 2,550 „ „
Lines of communication troops	...	...	9,385
or			
Field army	...	...	39,741
Base and lines of communications...	...	...	12,217
Total	...	...	51,958 †

The necessary hospital accommodation was calculated on a possible sick rate of 10 per cent. of the force, and the immediate provision for this consisted of the regulation number of field hospitals, four general (of 520 beds each) and two stationary hospitals (of 100 beds each), two hospital trains, and two hospital ships.

* Appendix No. 7, "Report of Royal Commission on the War in South Africa."

† Appendix to "Report of Royal Hospital Commission," p. 23 *et seq.*

At this time, in addition to the equipment of the field units, there was in possession of the Army Ordnance Department, only the equipment of one general and two stationary hospitals, nor, indeed, was it until October 4th that sanction was given for the preparation of the three remaining general and two stationary hospitals. But, in spite of this, by November 15th, the four general hospitals had embarked, while the four stationary had sailed by November 4th.

The requirements in personnel of the Royal Army Medical Corps for the field army and the medical units for the lines of communication detailed with it are, according to Regulation, as follows :—

Field army—

	Officers.	Other ranks.
One cavalry division	26	193
One army corps	122	729

Lines of communication and base—

Four stationary hospitals	20	160
Four general hospitals	84	580
Five depôts medical stores	7	29
Two hospital trains	6	52
Two hospital ships	12	80
Left at base	1	67

Total	278	1,890
--------------	-----	-------

2,168

The 278 Officers include 24 quartermasters, so that the nett number of Medical Officers required was 254. But this does not include staff for the base or line of communications, or Medical Officers for the regimental units on the line of communications.

At the beginning of the war, of the authorised establishment of the Royal Army Medical Corps, 2,106 Warrant and N.C. Officers and men were serving at home, with, in addition, 760 N.C. Officers and men of Sections A, B, and C of the Reserve, a total of 2,866. That is, after providing for the force originally detailed, there were remaining in England about 1,000 men to work the home hospitals, provide for wastage in the South African Force, and for a second army corps if it should be needed.

It was, therefore, evident that some method of increasing the authorised establishment must be found *. To this end, on September 26th, sanction was obtained to reopen recruiting for the Royal Army Medical Corps in all districts, and the extension of the formation of a "Special Service Section" to the Militia Medical Staff Corps was also asked for. A further request made on the same date for the embodiment of the Militia Medical Staff Corps for service at home was approved and the whole corps embodied at home on November 13th. On October 9th, Sections A, B, and C of the Reserve were mobilised (giving 760 of all ranks as noted above), and volunteering from Section D for the reservists of the Royal Army Medical Corps was sanctioned soon after. This completed the measures adopted up to November, which resulted in the provision of additional military personnel.

In October a proposal made in February by the heads of the St. John Ambulance Association, that a proportion of the members of their brigade might be utilised for the assistance of the medical services in time of war, was finally accepted; this resulted in a total of about 1,900 Superintending Officers and men of the brigade being employed at various times during the war.

One consideration which cannot be lost sight of in this connection is, that, excepting the N.C. Officers and men of the Royal Army Medical Corps Reserve (and, to a less degree, the recruits enlisted into the Royal Army Medical Corps who received a short course of training at the depôt), none of the personnel so obtained had any knowledge of work in military hospitals of any description, while in the case of the Militia Medical Staff Corps and St. John Ambulance Brigade, the technical training which they had received

* See also p. 172.

barely extended beyond "First Aid," and stretcher drill, and their N.C. Officers were by no means equivalent to those of the Royal Army Medical Corps.

This deficiency of good N.C. Officers was very greatly felt all through the campaign, in spite of a relaxation of the regulations regarding promotion, and even in July, 1900, the actual numbers present were 550 short of the authorised scale for the hospitals.

Anticipating later events a little, it is convenient to point out in this place that after the field medical personnel for the 6th Division had been provided, there was practically no trained personnel left in England for the 7th and 8th Divisions which were sent out, while for the 9th, 10th and 11th Divisions, Mounted Infantry, and Colonial divisions, personnel had to be found in South Africa.

The authorised establishment of the Royal Army Medical Corps could not, of course, supply the number of Officers required for this force, and this deficiency, which has been foreseen, was made up by the employment of civil surgeons. In this way the number of Medical Officers was sufficient at all times, but the proportion of the trained Officers of the corps fell below what was required to carry on satisfactorily the highly technical work of the military Medical Officer without throwing undue pressure on those who were present.

The numbers actually embarked, as distinct from the detail given above, were :—

Warrant and N.C. Officers and men only.	Cavalry	4,586
	Mounted infantry	1,163
	Artillery	4,917
	Infantry	31,386
	Royal Army Medical Corps	1,790
	Other corps	3,239
Total		<u>47,081 *</u>

of whom 6,433 infantry were for the line of communication.

The medical units provided accommodation for 3,680 sick and wounded, as follows :—

12 field hospitals at 100	1,200
4 stationary hospitals at 100	400
4 general hospitals at 520	2,080
	<u>3,680</u>

and there were, in addition, the existing hospitals in South Africa which provided some 500 beds, making a total accommodation for about 4,200 sick and wounded.

In addition to this force from England, the Imperial troops in South Africa (some 18,000), and the local forces required their share of accommodation in the stationary and general hospitals. The Indian Contingent had brought with them their field hospitals, but no hospitals for the lines of communications.

The actual accommodation provided, including the existing hospitals, was therefore short of the estimated requirements. Fortunately, this (apart from the consideration of the besieged towns) caused no insuperable difficulty during the earlier months of the war. At a later period, when the stress actually came, hospitals were in the country, and the difficulties that then existed were not due to their deficiency, but to the impossibility of conveying them to the points where they were needed.

C.—EMBARKATION.

The embarkation of the army corps began on October 20th, but prior to this, No. 12 Field Hospital and No. 1 Stationary Hospital, leaving England on September 30th, arrived in Natal on October 26th, while No. 1 General Hospital sailed on October 6th, arriving in Cape Town on October 27th,

* Appendix No. 8, "Report of the Royal Commission on the War in South Africa."

whence it proceeded at once to Wynberg to occupy the hut barracks there, which had been converted into a large hospital. The two hospital ships, the "Spartan" and "Trojan," arrived in South African waters on October 9th and 19th respectively.

The field units, with two exceptions, arrived with the troops of the brigades to which they belonged. Nos. 2, 3, and 4 General Hospitals had all embarked by November 15th, while No. 4 Stationary Hospital embarked on October 21st, and Nos. 2 and 3 embarked on November 2nd and 4th respectively.

The medical store depôts sent from England embarked before November 2nd, while the staffs of two hospital trains which were sent from home embarked on October 23rd, and took over the trains which had been prepared in South Africa.

In three instances a portion of the equipment of a field unit was embarked on vessels other than that on which the unit itself embarked, causing some confusion and delay on disembarkation in South Africa.* But with these exceptions the field units arrived in good order and up to time. The only serious deficiency was caused by the loss of the transport "Isomore," in which No. 11 Bearer Company was embarked. The whole of the equipment of this unit was lost, and had to be replaced by that of No. 17 Bearer Company (unallotted), which had arrived, but with only a skeleton personnel.

D.—ORGANISATION IN SOUTH AFRICA.

The troops in Natal (from India and the Mediterranean, with the previous garrison of Natal) were formed into the 4th Division, for which the three and a half field hospitals of the Indian Establishment provided the necessary medical units with something to spare.

General Sir Redvers Buller, V.C., arrived on October 31st, and within a few days what was believed to be a temporary diversion of a part of the army corps to Natal was decided on. The 2nd and 6th Brigades and the 1st Divisional Artillery were the first to go, followed in a few days by the 2nd Divisional Staff, the 4th Brigade, one battalion of infantry from the lines of communication troops, and two regiments of cavalry, the 2nd Divisional Artillery and the 5th Brigade, except the 2nd Royal Irish Rifles.

The 2nd Division was then reformed in Natal of the 2nd and 4th Brigades, which disembarked with their medical units complete, while the medical units of the 5th and 6th Brigades (afterwards forming the 10th Division) were completed when the 6th Brigade Bearer Company rejoined its brigade at Chieveley on December 12th, a week after landing at Durban. This was one of the two field medical units of the 1st Army Corps which had arrived later than the brigades to which they belonged. As the army corps was broken up the "Corps Troops" field hospital of the army corps was sent to Natal to form a divisional hospital for the 2nd Division.

The 2nd Brigade of the 1st Division was immediately replaced by a brigade (the 9th) formed in South Africa of battalions not previously brigaded, and for this field units had to be provided. This was done as follows:—The 1st Divisional Field Hospital became the 9th Brigade Field Hospital, and was replaced in its original capacity by the 3rd Brigade Field Hospital (No. 10) which arrived in Cape Town a week after the divisional hospital. The 3rd Brigade Bearer Company joined the 9th Brigade which was then complete.

These 3rd Brigade units were available owing to the fact that the brigade was left behind when the greater part of the 2nd Division went to Natal, and they had to be utilised as a matter of necessity pending the arrival of other units. But the 3rd Brigade joined Lord Methuen's force at Modder River in the first week in December, and the medical units taken from it had to be replaced, the field hospital by the 2nd Divisional Field Hospital (the one remaining unit of this division) and the bearer company by "A" Company, Cape Medical Staff Corps, then under command of Surgeon Lieut.-Colonel Hartley, V.C.

* These were 2nd Brigade Bearer Company, five ambulances embarked separately; 3rd Brigade Bearer Company, all the ambulances embarked separately; No. 10 Field Hospital water-carts separate.

General Gatacre with the remnant of the 3rd Division (and some additional troops) had sent to him the original 3rd Divisional Field Hospital, with half a field hospital of the permanent Cape establishment, and in place of the 1st Cavalry Brigade Bearer Company (originally detached temporarily for this division, but delayed by the wreck of the transport "Ismore" on which it was embarked), a bearer company formed by the Cape Medical Staff Corps ("C" Company).

The forces in the field in Cape Colony at this time consisted of (1) Lord Methuen's force (the reconstituted 1st Division), complete with its brigade units, and a divisional hospital; (2) General Gatacre's force, as described, and (3) a small force under General French operating from Naauwpoort and Arundel, which had some of the field units of the cavalry division.

But it will be seen that the diversion of so large a proportion of the Army Corps to Natal and its inevitable replacement by troops not previously brigaded and provided with medical units, introduced considerable confusion into the medical arrangements, owing to the unavoidable re-distribution of the existing field units, and the necessity of providing others from the resources of the country in addition to those sent from England, for at this time only the actual number of units allowed by scale for the field army had arrived.

E.—DEVELOPMENT.

Meanwhile the stationary and general hospitals were arriving and being opened. No. 1 General Hospital (Colonel A. H. Anthonisz) opened at Wynberg on October 30th, though the personnel was then deficient of 52 reservists who had not arrived, owing to the fact that this hospital embarked before the mobilisation of the reserve. This, however, was compensated for later when No. 4 Stationary Hospital (Major R. Kirkpatrick) arrived on November 20th, and was attached temporarily to No. 1 General Hospital pending its being required elsewhere.

Several warnings had been received that the well-water was likely to be poisoned with cyanide of potassium (used largely in the mines), and although this was not a probable occurrence, it was deemed advisable to issue small test cases (made up locally) to the Medical Officers of units for the purpose of examining any suspected water. In no case was any addition of the cyanide detected.

A large dépôt camp was formed at Greenpoint for the troops arriving, a small non-dieted hospital was opened there early in November, and a convalescent camp a little later.

A site was prepared for No. 2 General Hospital (Colonel A. W. Duke) on a level area in Wynberg Camp. Some doubts had been expressed as to its suitability on account of the strong south-easterly gales which prevail in the summer, but the event proved that these apprehensions were groundless, as no trouble was caused on this account. The necessary accessory buildings were planned and erected before the arrival of the hospital on November 22nd, to open on December 1st.

In the middle of November small hospitals of 50 beds each were opened at Port Elizabeth and East London for the accommodation of the sick of the troops landing there, and in addition the hospital ship "Trojan" (Major A. P. Hart) was sent to East London to lie in the river and act as a stationary hospital, her services as a hospital ship not being so satisfactory as to prevent her being used in this way.

No. 3 General Hospital (Lieut.-Colonel O. Wood, since dead) arrived on November 20th and 24th. The first party was sent on arrival to assist in the hospital at Orange River, pending the establishment of the hospital, for which an excellent site was offered at Rondebosch close to Cape Town. The accessory buildings were at once put in hand, and the hospital opened for the reception of sick early in January. It was joined by the Portland Hospital (the first of the civil hospitals to arrive), which opened about the same time.

No. 2 Hospital train under command of Captain C. C. Fleming, D.S.O. (prepared in South Africa, but for which a staff had been sent out from England), left for the front on November 22nd in time to bring down the wounded from Belmont. It was followed on the 25th by No. 3 train (Major

M. W. H. Russell), also prepared in South Africa, and for which a staff had been detailed from the personnel of No. 3 Stationary Hospital. This train went straight through to Orange River, bringing down the wounded from the battle of Modder River to Cape Town.

Natal at this time asking for more personnel, No. 4 Stationary Hospital was sent round with, in addition, one Officer and 30 men, and six nurses of No. 2 General Hospital, besides some reservists who had now arrived.

In addition to the field units with Lord Methuen's force, which were complete,* there were also hospitals at De Aar and Orange River, which had been opened in September. The hospital at De Aar was being enlarged by the erection of wood and iron huts with an operating and X-ray room, and sisters' quarters, and on November 23rd No. 3 Stationary Hospital (the late Major Perry Marsh) left Cape Town to take over the hospital from the provisional staff which had been in charge of it. By November 29th the accommodation had been increased by the erection of marquees and tents, while the sick and wounded who could be moved without risk had been sent down the line to Cape Town, so as to give ample accommodation for cases from the front.

De Aar is an important junction, and it was necessarily the point of concentration for all bodies of troops moving from the coast ports to the western line; hence its occupation was obligatory. But in all respects it is a most objectionable site: on account of the dryness of the climate and the nature of the soil its dustiness is extreme, while from the number of horses and transport animals continually passing through a plague of flies soon developed which continued to be a source of discomfort during the greater part of the period of its occupation. But the provision of adequate hospital accommodation had to be made; it was indeed proposed to establish a general hospital there, but a careful inspection of all possible sites showed that this was impracticable on account of the limited area available within the line of defence.

The temporary hospitals at Orange River were formed by the two half-field hospitals of the original Cape establishment under Majors Birch and Greenway, with a portion of the staffs of No. 2 Stationary and No. 3 General Hospitals temporarily detached for this duty.

F.—LORD METHUEN'S ADVANCE.

Lord Methuen's force concentrated at Orange River during the third week of November; the advance began on November 21st, and the division fought its first action at Belmont on November 23rd, commencing at dawn.

Belmont.

The Guards Brigade and 9th Brigade Bearer Companies removed all the wounded (22 Officers, 206 N.C. Officers and men, with 35 Boers) back to the three field hospitals at Belmont Farm and Station by 1 p.m. On the following day (24th) the slighter cases were removed at 1.30 p.m. by No. 2 Hospital Train to Orange River. This train returned by 8 p.m., and left for Cape Town at 11 p.m. with the remaining wounded.

Meanwhile the division had moved off taking with it the 9th Brigade Field Hospital; the remaining units were left behind entraining the wounded, and marched at 1 a.m. on the morning of the 25th to rejoin their brigades at 4.30 a.m., when they continued their march with the division to Graspan, coming into action there about 7 a.m. on the morning of the 25th.

Graspan.

Here the 9th Brigade Bearer Company, assisted by the Guards Brigade Bearer Company, formed a collecting station, whence the 9th Brigade Field Hospital, stationed at Graspan Siding, received the wounded (171 of the 9th and Naval Brigades only), all of whom, except 20, were in the field

* An additional water-cart was issued to each bearer company.

hospitals before dark. The remainder were accommodated in the operating tent of the bearer company at the collecting station, and taken on to the field hospital early the next day (the 26th), when 80 of the slighter cases were sent to Orange River by train, the remainder leaving for Cape Town by hospital train on the 27th.

On the 27th the division moved on towards Modder River with its medical units, except those of the 9th Brigade detained at Graspan Siding with the wounded. Of these, the bearer company rejoined its brigade at Enslin, the field hospital rejoined the division while the battle of Modder River was in progress.

Modder River.

The action at Modder River began about 7 a.m. on the 28th; both brigade bearer companies formed collecting stations behind their respective brigades (that of the 9th being unavoidably exposed to a heavy fire), with dressing stations about two miles from the river, while the Guards Brigade Field Hospital and No. 10 (1st Divisional) Field Hospital were established beside the railway line some three miles south of Modder River Bridge. The 9th Brigade Field Hospital arriving during the day assisted the other hospitals on the field.

All the wounded (389) were collected before night; the majority in the field hospitals, the remainder accommodated in dressing stations established later in the day (on account of the distance from the field hospitals) in houses near the river and on each side of the railway. These two dressing stations had two medical officers each, who were kept working all night. The following day (29th) the remaining wounded were brought in from these dressing stations to the field hospitals, and a convoy of 389, including some cases of sickness, was despatched to Orange River.

The units rejoined their brigades the following day. This concluded a heavy week's work for these units; over 800 wounded had passed through the three field hospitals (Divisional, Guards, and 9th Brigade), and had been dealt with under conditions involving much labour and loss of rest to a staff already fully employed during the day.

Magersfontein.

At Magersfontein on December 11th, collecting and dressing stations were established about 5 a.m., that of the Guards Brigade Bearer Company on the right, and that of the Highland Brigade on the left. The Guards Brigade Bearer Company was reinforced by the personnel of the Guards Field Hospital, while No. 10 Field Hospital assisted the Highland Brigade Bearer Company. As the 9th Brigade was not likely to be engaged, its field hospital was established at Modder River, while its wagons, with the 9th Brigade Bearer Company, went forward to assist in removing the wounded. Stretcher parties from the bearer companies and regimental bearers were busily employed all the morning in bringing in the wounded, and it was soon evident that the total number was greater than the ambulance wagons would suffice for, hence the field hospital transport wagons were emptied, partially filled with scrub or grass, and used for the conveyance of the less severe cases. In this way, in spite of the difficulties of the position, by 1 p.m. 250 of the worst cases had been removed to Modder River. But as an ambulance can carry at most two lying down and three sitting up, by this time most of the ambulances had made two journeys, or a distance of about 20 miles. Their mules required rest, and had to be fed and watered at the Riet River, all of which delayed the evacuation. The Guards, Highland Brigade, and Divisional Field Hospitals were therefore pitched in rear of the right flank to facilitate the feeding and dressing of the wounded, as it was not possible to move them to the rear for some time.

By nightfall all the wounded in rear of the line held by our troops had been brought in, and their transport (the slighter cases in transport wagons, the more severe in ambulances) to Modder River, for conveyance by hospital train to Orange River continued till the moon set about 2 a.m. Most of the ambulances and many of the transport wagons had again made two journeys.

On the morning of the 12th ambulance wagons were sent under a flag of truce to remove the wounded from the Boer lines, and by 9 a.m. only some 50 wounded remained in the field hospitals, the remainder having been sent down to Modder River. As the division was about to retire, fresh casualties were still occurring, and all the ambulances occupied, a party of 300 men was obtained, and carried the remaining cases (still under a hot fire) on stretchers to Modder River, the last arriving there by 2 p.m.

Forty-eight officers and 668 N.C. Officers and men were wounded. Of these, three officers and 18 N.C. Officers and men died in the field hospitals. All of the remainder, except some severe cases, were sent to Orange River and Cape Town by the hospital trains. From their arrival on December 11th, Nos. 2 and 3 Hospital Trains made journeys between Modder River and Orange River, before leaving for Cape Town on the 14th, while on the same date a special train took 151 cases to Orange River.

The Guards Brigade and Highland Brigade Field Hospitals and Bearer Companies, and No. 10 Divisional Field Hospital moved forward with the troops to the assault; the 9th Brigade units were held in reserve with the brigade.

The field medical arrangements for the advance of the troops from Orange River to the assault at Magersfontein were made by Colonel (now Surgeon-General) E. Townsend, C.B., C.M.G., P.M.O., of the 1st Division. As shown above, the wounded were removed as rapidly as possible, and transferred to the hospitals on the lines of communication, so that the advance was not hampered by the presence of sick and wounded.

These actions illustrate the difficulties which have to be encountered in the removal of wounded in modern warfare; first, the difficulty of reaching the wounded man on the field; and, secondly, the distance to which he must be conveyed, from the place where he fell to the field hospital. Both at Modder River and Magersfontein, the troops, in extended order, were compelled to remain practically motionless under a heavy fire for the greater part of a day, during which time casualties continued to occur in addition to those which happened at the opening of the engagement. The analogous question of the supply of ammunition to the firing line is stated by the highest military authority to be "one of the most difficult problems of modern warfare," and a suggested "improvement on the present method which is almost impossible to carry out under fire," is that a chain of men between the supports and the firing line should be formed by a portion of the supports gradually creeping forward so that the ammunition could be worked up by hand. Similarly it is possible for individual advances to be made by the Bearer Company Staff, but it appears to be practically impossible to carry out the method which has been previously recognised for the removal by stretcher parties from the firing line, or immediately behind it.

Fortunately a large proportion of those wounded by modern rifles do not require immediate attention, and in a certain number the chance of final recovery is increased by their being left for some hours before being removed.

Field hospitals must be as far as possible protected from fire. With modern rifles and artillery this involves an increase of the distance to which the wounded must be conveyed, and consequent delay in evacuation. When to this is added, as in the case of these operations along the western line, a scarcity of water (which is essential to the working of a field hospital), it follows that these hospitals may be several miles in rear of the fighting line.

Under these conditions the resulting strain on the personnel of the field units must be considered. The actions at Belmont, Graspan, Modder River, and Magersfontein were fought under the most favourable conditions as regards the removal of the wounded, that is, hospital trains were able to come practically on to the field. But the *résumé* of the work of the field units given above shows what has to be done by their personnel in modern warfare, and it cannot be expected that the actions of the future will invariably take place alongside a main line of rail. For these reasons a reserve of field hospitals at least must be available, and there should also be a reserve personnel to relieve or assist the field units of a division. Owing to the facilities for evacuation in this particular area the reserve hospitals were not needed, their place being taken by the temporary hospitals on the lines of communication, with the general hospitals at the base.

G.—STORMBERG.

General Gatacre's force moved out of Molteno on the night of December 9th. No wheeled transport was allowed to accompany the column, so that the medical units (No. 16 Field Hospital and a Cape Bearer Company) moved off, with some other details, about an hour and a half after the column itself. These units with the Principal Medical Officer (Lieut.-Colonel J. D. Edge) and Major Twiss, Royal Army Medical Corps, started on the direct road for Stormberg, and eventually overtaking a machine gun and some ammunition wagons, it was decided by the Divisional Signalling Officer, who was present, that the whole should halt and remain where they were till daylight. About daylight an orderly came from the column ordering up the guns and the ammunition; the mounted Medical Officers were sent forward at once with dressings, and the Bearer Company hurried forward, followed by the field hospital. But when the column was reached the retirement had commenced. Between 30 and 40 wounded were picked up and taken back to Molteno on wagons, traps, and gun limbers, under fire for a great portion of the way. Two of the hospital wagons stuck, and in remaining to look after them, Major Lilly, Lieutenant Humphrey, and nine men of the Royal Army Medical Corps were taken prisoners. Major Lilly and seven men were detained till the 12th, when they returned to Sterkstroom, bringing with them one ambulance with one wounded man. Lieutenant Nickerson, R.A.M.C., having been taken prisoner earlier in the day, remained some time with the Boers in Stormberg and Burghersdorp to look after our wounded prisoners in their hands. The remaining wagon was retained by the Boers.

At Molteno all of the wounded were dressed, and some were accommodated in the town hall temporarily fitted up; the remainder (as the force was about to retire) were put in railway carriages, which had been in waiting for this purpose, and taken to Queenstown instead of exposing them to the long journey to East London at that late hour.

In Queenstown they were accommodated in the Drill Hall and Frontier Hospital, and on the 12th the less severe cases were transferred by train to the hospital ship "Trojan" at East London, the others remaining in the Frontier Hospital.

H.—FURTHER DEVELOPMENT.

After Magersfontein Lord Methuen's force remained at Modder River, the advance to Kimberley remaining in abeyance for a time.

The occupation of Modder River Camp by the force under Lord Methuen was a military necessity, but all the local conditions were unfavourable to the maintenance of the health of the troops, which had up to that time been good. The hot season was now fairly advanced, and the rains had set in; both these conditions were known to be associated with the prevalence of enteric fever in South Africa. For these reasons representations were made to the military authorities, and additional warning was given to the Medical Officers with this force of the necessity for all possible precautions being taken against its occurrence. But the local conditions were extremely unsatisfactory; Modder River had been the scene of a battle on November 28th; the Boers held both rivers—the Riet and the Modder—above the camp, and polluted their waters. Further, like most African rivers, the water contained so much fine mud that it was not possible to use the Berkefeld filters for the provision of drinking water, nor, on account of the scarcity of fuel, could boiling be general. To obviate these difficulties it was arranged to sink wells on the river bank so as to obtain water which could be filtered. A well in the court-yard of the hotel used by the General Officer Commanding and Staff was found to be contaminated with organic matter, and had to be closed.

There was also great difficulty about the latrines, the thin layer of surface sand covered ground almost as hard as rock, and it was impossible to make satisfactory trenches, while the soil had no deodorising properties, so that the closed trenches remained offensive. Disinfectants were used, and all possible measures taken to remedy these defects.

Enteric fever appeared among the troops at Modder River towards the end of December. A small hospital was established in the school-house for the accommodation of cases, or suspected cases, and for this Sisters were sent up as soon as practicable.

At the Orange River there were four hospitals: two of the permanent Cape establishment (one of which was staffed by the Cape Medical Staff Corps, and the other mainly by the Royal Army Medical Corps), two formed by detachments from No. 3 General and No. 2 Stationary Hospitals. Huts of a portable type supplemented by marquees and bell tents gave accommodation for 550 patients by January 1st, and nursing Sisters were sent up as soon as accommodation for them could be arranged. The accommodation at De Aar was also further increased.

General Gatacre, with his base at Sterkstroom, continued to oppose the invading columns advancing through Bethulie and Stormberg, while General French, with a base at Arundel, held the second hostile force in check round Colesberg.

General Gatacre had with him the units already mentioned, and a small hospital was opened at Sterkstroom, to which Sisters were sent. In addition to the local accommodation, evacuation to the coast at East London was systematically carried out, where in addition to No. 2 Stationary Hospital, established early in December, the hospital ship "Trojan" was acting as a base hospital. A hospital train was also prepared to work on the line from East London.

General French received the whole of the units of the cavalry division by the beginning of January; these were sent forward to him as opportunity for their employment arose. The 2nd Cavalry Brigade Field Hospital had established a temporary hospital in a house at Naauwpoort; this was added to and developed into the Stationary Hospital, being at a later date merged in No. 6 General Hospital. Evacuation to De Aar and Cape Town was systematically carried out by Nos. 2 and 3 Hospital Trains.

At the base the enlistment and training of men for the Cape Medical Staff Corps continued; 100 men were obtained during the week ending December 18th. As the want of trained orderlies for hospital duties was already making itself felt, it was arranged in the end of December that 10 men of the Royal Army Medical Corps should be withdrawn from each bearer company for these duties, their places being taken by the men of the Cape Medical Staff Corps. A small detention hospital was established in Maitland Camp to replace the cavalry brigade units which had previously looked after the local sick.

About the middle of December Natal asked for more personnel, and it was arranged in response to this to send a draft of two Officers and 30 N.C. Officers and men from the staff of No. 4 General Hospital which had arrived on December 10th. At this date there was an objection to sending the whole hospital to Natal (for which indeed a site had been sought at De Aar without success), as it was stated that for military reasons it would probably have to be brought back again to the Cape side. But within a week Sir Redvers Buller asked that a general hospital should be sent to Natal, and the whole of No. 4 was then despatched, where it opened at Mooi River early in January, 1900, its accommodation being increased from 520 to 920 beds.

The 5th Division arriving in the end of December went on to Natal, where it disembarked with its field units complete by the beginning of January.

The 6th Division staff arrived on January 10th, the battalions and field units of the 12th Brigade having arrived a day or two before. The 13th Brigade with its field units and the divisional hospital arrived between January 14th and 20th. These dates are important, as the detail of personnel of the 6th Division practically exhausted the whole of the trained N.C. Officers and men of the Royal Army Medical Corps (including those of Section D of the Reserve), available for service in South Africa, and further reinforcements were either partially trained or untrained men. Indeed, of the 226 N.C. Officers and men with the 6th Division 80, or 35 per cent., had less than one year's service, while 10 were reservists.

I.—ARRIVAL OF LORD ROBERTS.

Lord Roberts landed at Cape Town on January 10th, and the re-organisation of the force began at once. A new division was formed (the 9th) from the Highland Brigade, and a brigade newly formed in South Africa (the 19th). The 6th Division had been sent to Naauwpoort to assist in General French's operations immediately on disembarkation, and when the greater part of this division was ordered round to the western line, the 12th Brigade was left behind at Naauwpoort, and its place in the division taken by a second new brigade, the 18th, also formed in South Africa.

Medical units had to be found for these two new brigades, the 18th and 19th, as time would not allow of their supply from England. Only the skeleton of one bearer company, the 17th, had arrived in addition to the field units detailed for the divisions formed in England, and its equipment had been used to replace that of No. 11 Bearer Company, which had been lost in the wreck of the transport "Isomore." Fortunately, there was no lack of equipment in the country, while the increase of the Cape Medical Staff Corps, which had been steadily maintained, provided some of the necessary personnel.

The 18th Brigade received No. 1 Section of the Cape Field Hospital to act as a bearer company, and the 19th Brigade was furnished with a similar unit formed by the Cape Medical Staff Corps. But the only way of meeting the demands for field hospitals was by taking the divisional hospitals of the 6th and 7th Divisions for the 18th and 19th Brigades respectively. The result of this, the only possible arrangement, was that the 6th, 7th, and 9th Divisions were without their divisional field hospitals, while, as will be seen, the utility of the units that were provided was considerably impaired by the unavoidable reduction of their transport.

While these new brigades and a new division were being formed, six new regiments of mounted infantry were also raised from the mounted infantry companies of various regiments in South Africa, and, with two which had landed with the Army Corps, were formed into two brigades. After Paardeberg, the number of the brigades of mounted infantry was increased to four. Medical Officers had to be found for these, while the first section of the New South Wales Ambulance (a light, well-formed unit combining the functions of a field hospital with those of a bearer company) was divided into two, and one half sent with each brigade. These, however, were only able to join their brigades after Paardeberg, and till then the casualties were dealt with by the various hospitals of the force.

A colonial division, under General Brabant, was formed from regiments of the colonial forces with, in addition, various newly-raised corps of South Africa and oversea colonials. Many of these had their own regimental medical arrangements which supplied all that was necessary at that date, while Lieut.-Colonel Hartley, V.C., of the Cape Mounted Rifles, was appointed Principal Medical Officer of the division.

The original scale of transport for the medical units, as authorised by the "Organisation and Details of Transport" (Cape Town, 1899), was as follows:—

Bearer company—	Water cart	...	...	...	...	1
	Buckwagons	...	...	...	...	2
	Ambulances	...	...	...	...	10
	Ox cart	...	...	...	...	1
Field hospital (corps troops and brigades)—						
	Water carts	...	...	...	...	2
	Scotch cart	...	...	...	...	1
	Buckwagons	...	...	...	...	4
	Ox cart	...	...	...	...	1

The divisional field hospital to have one water cart less, and one additional buckwagon.

The loads of these vehicles are:—Scotch or ox cart, 1,500 lbs.; buckwagon, 3,000 lbs. Ten per cent. of spare mules were authorised.

It is specifically noted that "all units will draw and organise their own regimental transport."

Up to this time the medical units were in possession of their transport according to this scale; but by Army Order No. 4, dated at Cape Town, January 24th, 1900, "with certain exceptions," all regimental transport was withdrawn and became general transport. These exceptions were detailed in Army Order No. 2, of January 29th:—"The following vehicles only will remain with units; all others will be available as general transport":—

Bearer company—Water carts	...	...	...	...	2
Ambulances	...	...	...	...	2
Field hospitals—Water carts	...	...	...	...	2

All these were to be muled by the Transport Department.

By the "Scale of Equipment and Transport" (authority C. of S., telegram No. M.87, dated Driefontein, O.F.S., 11.3.00), the transport allowed for technical units is shown as follows:—

Bearer company—Mule wagon	...	...	...	...	1
Scotch cart	...	...	...	...	1
Field hospital—Mule wagons	...	...	...	...	2

This is the scale with which the medical units left the western line; that is, the bearer companies had their ambulances reduced to one-fifth, their transport to three-fifths of the original scale, while the field hospitals lost three-fifths of their transport.

It was not expected that the necessity for this reduction would continue so long as proved to be the case. Such an important alteration was, of course, the outcome of urgent military necessity, and the best arrangements possible under the circumstances had to be made. But the result was a cutting down of the stores and equipment to the bare minimum necessary to maintain these units as efficient entities; their utility was undoubtedly impaired during the subsequent operations, and on their arrival at Bloemfontein they had only a reduced equipment to carry on their work with, and little was to be obtained in that town to supplement this.

The position at the end of January as regards the medical arrangements on the western line was a difficult one. The great body of the force was concentrating there, but it was evident that with the relief of Kimberley this massing of troops would cease, while Kimberley itself was the most suitable place in which to place the general hospital which would be necessary on that line should the operations be prolonged in that area.

A general hospital is not a unit to be too lightly disposed of; its equipment is bulky, and makes a serious difference on a congested single line of railway; its erection and preparation take some time, and in the event of its having to be moved at a later date, it becomes useless for some considerable time. Further, it must be placed on a site where supplies can be obtained without much difficulty. Hence the question of the location of a general hospital can only be decided after a careful consideration of the present and future possibilities. The choice in this instance was between De Aar and Orange River. Neither of these were good sites, where it would be possible to retain a general hospital after the concentration had ceased. At De Aar, as has been stated, the space available within the defences was insufficient; Orange River, from its position, could only be of importance for a brief period. The only alternative was to extend the stationary hospitals at De Aar and Orange River and the temporary hospital at Modder River, while the evacuation of sick was rapidly effected by the hospital trains.

Wisdom after the event is always easy, and if it had been suspected that so long a delay as did occur at Paardeberg and Oshfontein was probable, and that the number of casualties would be as large as actually happened, probably this knowledge would have turned the scale. But as matters stood, this information was not available.

The same conditions obtained in lesser degree at Sterkstroom and Arundel. Neither of these places was likely to be of more than temporary importance, nor did the event in these instances falsify the prediction. Naauwpoort, as an important railway junction, was somewhat different, hence a stationary hospital was established here, followed later by a general hospital (No. 6), which remained till the occupation of Johannesburg.

For these reasons the policy of maintaining sufficient temporary accommodation at Modder River, with a small hospital at Enslin, a more elaborate temporary hospital at Orange River, and an increase of the accommodation at De Aar, was a necessary arrangement, and in the end justified by results, while the temporary hospital at Sterkstroom, with the establishment of No. 2 Stationary Hospital and the hospital ship "Trojan" at East London provided for the troops in that district.

J.—ADVANCE TO KIMBERLEY AND BLOEMFONTEIN.

In the end of January, Lord Methuen's force remained in front of the Magersfontein lines, and the larger force which concentrated on the line between Orange River and Modder River consisted of the Cavalry Division, and the 6th, 7th, and 9th Divisions, with the usual additional troops. The medical arrangements for this force were as follows:—

P.M.O. with headquarters—Colonel W. F. Stevenson.
Secretary—Lieut.-Colonel G. H. Sylvester.

Cavalry Division—

P.M.O.—Lieut.-Colonel W. Donovan.

1st Brigade—

Bearer Company (half No. 11)—Major A. B. Cottell.
Field Hospital (half No. 11)—Major D. L. Irvine.

2nd Brigade—

Bearer Company (No. 12 Co.)—Major E. North.
Field Hospital (No. 6)—Major T. W. O'H. Hamilton.

3rd Brigade—

Bearer Company (half No. 11)—Major H. C. Thurston.
Field Hospital (half No. 11)—Major A. E. Tate.

Mounted Infantry Division—

New South Wales Ambulance—Major Fiaschi.

6th Division—

P.M.O.—Lieut.-Colonel W. L. Gubbins.

13th Brigade—

Bearer Company (No. 16)—Major J. R. Fayle.
Field Hospital (No. 18 Co.)—Major R. E. Molesworth.

18th Brigade—

Bearer Company (No. 1 Section, Cape Field Hospital)—Major H. P. Birch.
Field Hospital (6th Divisional)—Major R. W. Ford.

7th Division—

P.M.O.—Lieut.-Colonel J. A. Gormley.

14th Brigade—

Bearer Company (No. 7)—Major C. E. Faunce.
Field Hospital (No. 19)—Major D. F. Franklin.

15th Brigade—

Bearer Company (No. 19)—Major L. R. Colledge.
Field Hospital (5th Divisional)—Major G. Wilson.

9th Division—

P.M.O.—Lieut.-Colonel J. C. Dorman.

Highland Brigade—

Bearer Company (Cape Medical Staff Corps)—Captain J. J. Brownlee.
Field Hospital (No. 3 Company)—Major H. W. Murray.

19th Brigade—

Bearer Company (Cape Field Hospital)—Major J. H. Greenway.
Field Hospital (7th Divisional)—Major R. H. S. Sawyer.

Prior to the advance the troops were spread out along the railway line, using Modder River, Enslin, and Graspan as points of departure, from which the whole force arrived on the 11th, 12th, and 13th at Ramdam. The object for which this concentration had taken place was kept secret, and in the cavalry division orders were issued to prepare for an expedition of about five days, a purpose which was changed by the course of events.

The cavalry division was the first to enter the Free State; leaving Modder River in the early morning of February 11th, it reached Ramdam in the forenoon (28 miles), and on the following day marched at 2 a.m. in three columns (having the field hospitals and ambulances three miles in rear of the centre column with the ammunition column) to De Kiel's Drift (12 miles), which was reached soon after noon. Part of the division was engaged during the day, but there were few casualties. Later in the day the 7th Division also arrived at De Kiel's Drift, but the supply column did not come in till the following day, the 13th. On this date the cavalry division marched and occupied Klip and Rondavel Drifts, after some opposition, but with a very small number of casualties. The division remained here till the morning of the 15th, when the 6th Division marched in, and the cavalry, marching at 9.30 a.m., after considerable opposition, resulting, however, in comparatively few casualties, entered Kimberley in the evening.

On the 16th two brigades of cavalry were actively engaged to the north-east of Kimberley, with about 30 casualties, a long and hot day, while the same evening the remaining brigade, with an additional regiment was ordered off to intercept Cronje, arriving at Koodoesrand Drift about 11 a.m., in time to accomplish this. The remaining brigades rejoined on the 19th and 22nd, when the division was again complete in the vicinity of Paardeburg.

In the relief of Kimberley the cavalry division had marched 100 miles in four days over an arid country in very hot weather. Supplies were not always available: the 1st Brigade transport was deficient from the 15th to the 23rd, and for 11 days the men had no blankets, but only their cloaks.

This involved very heavy demands on the endurance of the N.C. Officers and men of the field units with the cavalry division, who, although unmounted, and having to handle the ambulance and transport wagons when crossing the numerous dongas and drifts, kept well up with their columns, and met all the difficulties in the most willing spirit. The medical units, but more particularly the bearer companies, were very heavily tried during these marches. The division covered a front of from 8 to 10 miles, and casualties had to be collected from both flanks. Even with the full number of ambulances this would have been a difficult task; with the number reduced to one-fifth it became all but impossible.

The 7th Division reached Ramdam on the 11th, and relieved the cavalry division at De Kiel's Drift on the 12th, from which the division marched to Wegdraai on the 15th, while from there the 14th Brigade went to Waterval Drift after the attack on the convoy there, but returned almost at once to Wegdraai. Meanwhile the 15th Brigade had occupied Jacobsdal on the 15th, after some opposition, and found there a well-established Boer hospital under the German Red Cross Ambulance. In this were some of our wounded, and it is important to note that two churches in the town were full of Boers suffering from enteric fever. The 14th Brigade followed them to Jacobsdal on the 17th.

The 6th Division were a day later in entering the Free State. From Ramdam, on the 12th, the division marched by Waterval and Wegdraai to set free the cavalry division at Klip Drift on the 15th, for the dash into Kimberley. From this place the 13th Brigade started in pursuit of Cronje on the 16th, and the division, reuniting at Brandvallei Drift on the 17th, marched at 5 p.m., and were in action at Paardeberg in the morning of the 18th.

The 9th Division followed practically the same route as the 6th Division, but one day later. From Wegdraai, where the division arrived on the 15th, the 19th Brigade marched into Jacobsdal on the 16th, but at 9.30 p.m. on the same date it marched again for Klip Drift, arriving there at 4.30 a.m. on the 17th. Leaving Klip Drift again at 4.30 p.m. it arrived at Klip Kraal Drift at 7 p.m., and marching again at 10.30 p.m. arrived at Paardeberg about 6 a.m. to take part in the action.

The Highland Brigade remained at Wegdraai till the evening of the

16th, when they marched at 11 p.m., and arrived at Klip Kraal Drift in the early morning of the 17th. Leaving this at 5 p.m., they arrived near Paardeberg at 11 p.m., and went into action early in the morning of the 18th.

The 14th Brigade, leaving Jacobsdal on the 18th, marched to Klip Drift, leaving there about 11 p.m. they arrived at Klip Kraal Drift about 6 a.m. on the 19th, and marching again at 9.30 a.m. reached Paardeberg about 3 p.m.

The conditions during these operations were trying; there was a good deal of night marching, the country was almost waterless, and the weather extremely hot, especially on the 12th and 13th, when the 13th and 15th Brigades suffered considerably. On the 12th, Major Wilson, commanding the 15th Brigade Field Hospital, found it necessary to pitch some tents (about 1 p.m. and about five miles from De Kiel's Drift) for the protection and succour of some 130 men of various corps, who had fallen out from the effects of heat. Many of these were able to proceed by 5 p.m., and most of the remainder were sent on by ox wagon the same evening, while the hospital rejoined the brigade next morning. On the 13th, the 13th Brigade had a similar experience on the march from Randam to Waterval, a long hot march with no water till within three miles from camp. By 8 p.m. there were 43 cases in hospital, who were unable to proceed; these were left behind in tents under charge of a small party of the Royal Army Medical Corps, and later were sent in to Enslin on empty supply wagons. None of the cases referred to proved fatal.

The 6th Division were severely tried on the forced march from Waterval to Klip Drift. Leaving Waterval on the 13th, the division reached Wegdraai (12 miles) at 1 a.m. on the 14th, marching from Wegdraai again at 5.30 p.m., and arriving at Klip Drift (11 miles) about 1 a.m. on the 15th. On the 16th, the 13th Brigade, in pursuit of Cronje, was marching and fighting for over 15 hours, and having out-paced its supply wagons, the men had to depend on what they carried.

During these marches, a systematic evacuation of sick and such wounded as were able to travel was kept up. Small rest hospitals were established for a few days as opportunity offered in houses, if these were conveniently situated, otherwise in tents, and from these convoys were sent back, utilising empty supply wagons, to Enslin and Modder River via Jacobsdal. One of these hospitals (at Klip Drift) was kept open for some weeks. To this place a section of the Guards Brigade Field Hospital was sent on February 18th to supplement the original small hospital, and the whole field hospital joined there on the 21st, where it remained till the brigade moved off on March 5th.

On the 15th, 170 wagons with 150,000 men's rations and 500 slaughter cattle were lost at Waterval Drift, partially replaced by a convoy of 100 wagons which arrived at Jacobsdal on the 16th. But this did not compensate for the unexpected diminution of the reserve supply. The cavalry and 6th Divisions were at this time falling short of supplies, and the whole force suffered from the unavoidable cutting down of the grocery and bread ration. Till the end of February only half rations of these articles were issued, and from that date till the entry into Bloemfontein only three-quarter rations. The meat ration was, however, increased, so that it was the lack of farinaceous food that was really felt.

These three factors, excessive exertion, reduction of food, and a scanty and impure water supply are most important in relation to the conditions affecting the health of the troops at Paardeberg and afterwards.

The greater part of the work of the field units during the operations preceding the investment at Paardeberg, consisted in looking after sick in comparatively small numbers, with a large proportion of men footsore or exhausted by the hardships of the march. Many of these would not have been lost to the force if it had been possible to carry them for a few days, but the reduced ambulance transport was barely sufficient for the sick. The cavalry division handed over some sick to the 7th Division at Randam, and again at De Kiel's Drift, where a small rest hospital had been established. On the 15th the cavalry division ambulances were overloaded with the casualties which had occurred during the day, the mules were exhausted with their exertions in consequence of this overloading, and of the distances that had to be covered in collecting them. The medical units, therefore, remained with the 2nd Brigade at Alexandersfontein, and when the 1st and

3rd Brigades advanced towards Dronfield on the following day, ambulances were only obtained for them from Kimberley after some delay. On the 17th, the 2nd Cavalry Brigade units went with their brigade to Koodoesrand Drift, while those of the 1st and 3rd accompanied their respective brigades a few days later, when the three brigades were situated near Koodoesrand Drift, the 1st on the right, and the 2nd and 3rd on the left bank of the river.

The 7th Division units had only a few casualties, but more sick and exhausted men to deal with, till the 16th, on which date they established a temporary hospital in a good house at Klip Drift, receiving a considerable number of wounded. On this date the 13th Brigade Bearer Company (Major R. J. Fayle) took part in the pursuit of Cronje. In the early stage some 28 casualties were dealt with, and as it was impossible to remove them at once to Klip Drift owing to the want of ambulances, they were accommodated in the operating tent, which was pitched in a donga, in charge of Lieutenant Rattray, R.A.M.C., and a sufficient staff. The remainder of the company proceeded with the brigade for about three miles further, where a dressing station was formed in some farm buildings close to the firing line. The wounded from the donga were sent back on empty supply wagons, and next day those in the farm were handed over to the field hospital. The bearer company had by this delay with the wounded lost touch with the brigade, but after a short halt during the night overtook the brigade just moving into action at Paardeberg.

The right half of the 13th Brigade Field Hospital (Major R. E. Molesworth) went out in rear of the brigade on the 16th in pursuit of Cronje. During that evening and the next day (17th) the left half received 76 wounded from the fight. These were sent back in supply wagons in charge of a party from the hospital to Klip Drift. The left half joined the right during the day, and the whole moved on again after its brigade, now some 24 hours ahead. After halting for an hour during the night, the hospital arrived at Paardeberg about 11 a.m., while the action was in progress.

The experiences of the 13th and 15th Brigade Field Hospitals with cases of heat exhaustion have already been referred to in detail. The 15th Brigade Field Hospital dealt with a few casualties at Jacobsdal on the 15th, where they remained with the brigade till the beginning of March, looking after the local sick, and passing on convoys from Klip Drift and Paardeberg to Modder River.

The 14th Brigade units accompanied their brigade to Paardeberg.

As regards the 9th Division, the 19th Brigade Field Hospital reaching Klip Drift at 5 a.m. in the morning (17th), after marching from Jacobsdal, was occupied all day with some 150 wounded sent in from the 6th Division. The brigade marched off in the afternoon for Paardeberg, and the hospital followed later, and caught up the brigade at Paardeberg on the 18th. The wounded were left behind at Klip Drift in charge of Major Raymond, R.A.M.C.

The field units tended to lag behind their brigades, owing to the deficiency of transport and the consequent difficulty of dealing with the sick and wounded, but all joined their brigades at Paardeberg, though some did not arrive till after the action had commenced.

There the units, speaking generally, at first followed their brigades, but later in the day, owing to the occupation of Kitchener's Kopje by the enemy, their position had to be changed, and they came eventually to be placed along the left bank of the river; the 19th Brigade Field Hospital to the extreme left occupied a farmhouse close to the main drift.

The dressing station of the 13th Brigade Bearer Company, behind the left of the line, was practically under fire the whole day, as otherwise it would have been impossible to deal at once with the wounded. When the medical units, owing to the occupation of Kitchener's Kopje, had to evacuate their position, the change was made slowly and with difficulty on account of the small number of ambulances available. Many of the wounded were carried on hand seats as well as on stretchers, and some stragglers of various corps were impressed for this purpose. But even with this assistance, five seriously wounded men could not be removed till sunset, until which time they were compelled to remain under fire.

The 13th Brigade Field Hospital was pitched about a quarter of a mile behind the dressing station of the brigade, and by about 2.30 p.m., when about

150 cases had been received, a series of shots from the enemy's pom-pom (and rifle fire) fell into the camp. Some of the patients left the hospital, the remainder were removed to a fresh site about a mile away, when the hospital staff returned to bring off the tents and equipment. When these were brought in it was found necessary to move the hospital again some three-quarters of a mile further back to the top of a low flat hill. This movement began at sundown, and owing to the arrival of fresh cases from the advanced position, had to be continued all night. On the morning of the 19th there were 200 cases in hospital, and again the hospital had to be moved, this time to the river bank, where the worst cases were accommodated in tents, the others bivouacked under the adjacent trees, where they were protected by shelters made of tent flies and wagon covers. By the 20th there were 249 wounded and 109 sick under treatment, and on the following day the first of a series of convoys left for Jacobsdal. The hospital remained on this site till the division moved to Osfontein.

The 18th Brigade Bearer Company, under Major H. P. Birch, was pushed up to the right and left of its brigade where it was under fire for some time.

The 18th Brigade Field Hospital (Major R. W. Ford) accompanied its brigade, arriving at Paardeberg on the morning of the 18th, when it was immediately pitched close to Kitchener's Kopje, about $2\frac{1}{2}$ miles from the enemy, and made ready for the reception of the wounded. These came in in large numbers. About 4 p.m. the hospital (like the others) had to be moved as it was under fire. The wounded were removed about three miles further back, but the tents had to be abandoned till next morning, when the hospital was pitched on the bank of the river, where it remained till the brigade left Paardeberg.

These two field hospitals of the 6th Division received 18 Officers and 277 N.C. Officers and men wounded from this action, besides sick.

The Highland Brigade Field Hospital (Major H. W. Murray) was established in a clump of trees on the river bank about a mile above the farmhouse occupied by the 19th Brigade Field Hospital, and close to the fighting line. Here they received during the day some 280 wounded from that part of the field.

The 19th Brigade Field Hospital (Major R. H. S. Sawyer) after marching all night on the 16th and 17th, reached Paardeberg at 6 a.m. on the 18th, and established itself in an empty farmhouse near the drift and some 50 yards from the river. Here a portion of the personnel had to be detached to assist the bearer company. During the night of the 18th, and early morning of the 19th, 232 wounded were admitted, all of whom were dressed by 6 a.m. on the 19th. The house accommodated some 50 wounded, the remainder were put in tents and under shelters made from wagon covers.

The 14th Brigade with its medical units did not arrive on the scene till the 19th.

When the 19th Brigade crossed the river about noon on the 18th the ambulances were unable to get across, and consequently the wounded had to be carried back by hand and ferried across in a small pontoon. In the earlier part of the day, before the position of the medical units had been changed, there was difficulty about water. The river was the main source of supply, and for obvious reasons, it was not easily reached. Both water carts of the 18th Brigade Field Hospital were taken by the enemy.

In this action of February 18th there were over 1,200 casualties and, owing to the numbers admitted to hospital, there was great difficulty in providing the sick and wounded with blankets and waterproof sheets. Only 100 of each (weighing 790 pounds) are included in the equipment of a field hospital, and it was of course impossible that the men should bring their own with them to the hospital, nor was it possible at the time to communicate with their Commanding Officers with a view of having them sent up. Later during the investment this difficulty was accentuated: blankets and ground sheets had to be sent away with the men sent down by convoy, so that there was a constant depletion of the hospital stores. To meet this the blankets and greatcoats of the N.C. Officers and men of the Royal Army Medical Corps were given up, and in addition blankets were requisitioned from the mounted infantry who had an extra one. Much trouble was experienced in getting back the blankets lent in this way, and about half were never returned.

There was also a very great deficiency in tents for the cases. When the transport was cut down the number of tents carried had also to be diminished, while the actual numbers treated were far above those for whom the equipment of a field hospital is designed. The deficiency was met in some degree by making shelters out of tent flies, wagon sails, tarpaulins, and the like; some temporary shelters were also erected by the Royal Engineers. But a large number of the slighter cases had to bivouac under the shade of the trees on the river bank. Fortunately the weather was warm though there was a good deal of rain with thunderstorms during the investment.

The excessive numbers also caused a difficulty about the rations, especially at first, as no reserve for so great a number was on hand, while the regiments to which the patients belonged were some distance away, and the Supply Park had no extra rations to issue. On the 19th and 20th the 13th Brigade Field Hospital only obtained rations for about half their cases from the Supply Park, but on the latter date some rations were also obtainable from the Army Service Corps, and from that date no further difficulty occurred.

On the 19th the 13th Brigade had five killed and 21 wounded, but with this exception between the 18th and the 26th there were few casualties. One man of the Gloucester Regiment was killed and five injured by lightning on the 21st. On the 25th, owing to heavy rain, the drift became impassable, and communication between the north and south banks was cut off, except by ferry.

Prior to the attack on the night of the 26th it was arranged for one of the bearer companies (Cape Medical Staff Corps) of the 9th Division to cross to the north side to bring the wounded in the attack on the laager to the pontoon ferry, where ambulances were collected to carry them to the field hospitals. The attack took place before dawn on the 27th; the wounded, some 28 in number, were brought slowly along the river bank (so as to be under cover) by the bearer company, and were all in hospital (most in that of the New South Wales Ambulance) by 8 a.m.

Following this, during the forenoon the unpleasant duty of removing the sick and wounded (160) from the Boer laager devolved on the units of the 6th Division; this operation took some four hours. Many of the wounded had received their injuries in the engagement of the 18th, and had received no attention since; naturally they were in a terrible condition. These cases were carried to the drift by a party of some 200 men of two regiments, taken across the drift by the bearer companies, and thence removed by ambulance to the shade of some trees a mile away, where they were put in the charge of two doctors of the Boer ambulance, to whom medical and other stores were given from the field hospitals. The following day the remainder of the Boer ambulance arrived from Jacobsdal with complete equipment, and took over these cases.

It should be noted here that among the cases removed from the laager were at least 10 well marked cases of enteric fever; further, that among the prisoners captured on this date and sent to Simonstown a severe epidemic of enteric fever broke out, beginning in the second week of March. Also these prisoners stated that (enteric) fever had been prevalent in the laager, and that a good many deaths had occurred from it there. The laager itself was indescribably filthy. The Boer force of about 4,000, with some women and children, had been confined with their horses and oxen in a limited area for 10 days in a climate alternately hot and wet. Men, cattle, and horses had died; of some the bodies had been carried down by the swollen river and stranded below the laager, others remained on the banks. The sanitary arrangements of the Boers are, at the best, of the most primitive description, and in this impossible situation things were even worse than usual. Hence a condition of which our troops were sensible before seeing the laager when the breeze blew from that foetid spot to our trenches.

The water supply during the action of the 18th was, as has been stated above, scanty, but during the investment some little improvement took place. In parts of the area occupied by us, of which the perimeter reached 25 miles, wells afforded a small supply to limited numbers of the troops in their vicinity. But the great body of the force was situated closer to the river, and had to depend on it for its water supply. The water of the

Modder River, as its name implies, is never clear; at this time it was not only loaded with the usual fine mud, but fouled by all kinds of organic pollution from the laager which was up-stream. The means of purification was limited. Berkefeld filters are useless with a water of this description; there was barely enough fuel to cook food; none to spare for boiling water.

It is difficult to see any practical solution to this difficulty, the supply of pure drinking water in such circumstances. The question is not purely one of transport, though in this particular instance the want of transport made itself felt in many ways, there was not even enough to supply full rations to the troops. But allowing that the additional weight of boiling apparatus and the necessary fuel may be so small that it can always be carried, and taking for granted that the organisation is by sub-divisions certainly not larger than companies, it is difficult to see how, in the stress of an action such as that of February 18th, or in the constant reliefs in the trenches, and the other incidental and somewhat irregular movements, any regular channel of communication between the thirsty man and the pure water can be maintained. Filling a water bottle with pure water in the morning is only temporising, it does not last the soldier half a day, and afterwards he drinks from any source that is convenient. The only way to ensure a pure supply is to make it easier for the soldier to get a large quantity of approved water than to help himself to some other supply, and no practical means of doing this under war conditions seems possible.

There is no doubt that the soldier drinks more water than he needs; this is a matter of education and custom. He drinks oftener and more largely than his Officer, and the man who drinks least is he who is accustomed to hard outdoor work in a hot climate. But, besides this question of habit, there is no doubt that there was a certain feeling that it was unmanly to be afraid of drinking any water, that the possibility of contracting disease was one of the chances of war, and should not be shirked. This was apparent among Officers as well as men, and the obvious remedy is a little instruction in elementary hygiene, with a special application as regards duty towards one's neighbour.

The question of boring for water under such conditions as accompanied the investment of Cronje is one that need not be seriously discussed.

There was no possibility of getting separate transport for medical and surgical stores during these operations, but by putting boxes of the various drugs and dressings needed in every supply wagon that left the western line for the front the supply was so well maintained that, except immediately after the action on the 18th, there was no deficiency. As regards Medical Officers, in addition to those with regiments and on the staff of the field units, 17 had been sent up from the base to join the force before Paardeberg, so that in this respect there was no want of assistance, though occasionally there may have been undue pressure in individual units for a time.

Sick convoys were sent off regularly towards the base, beginning on February 21st. These went at first by Jacobsdal and Modder River, but later, as the drifts became possible, they were sent to Kimberley, and prior to the advance from Ofontein, the field hospitals were cleared of their sick, and a large convoy sent to Kimberley on supply wagons. Ambulances were, of course, not available for this work from the units with the force, as the two per brigade which remained were insufficient for the advance, nor was it possible to bring up others from the western line, as all the transport animals that were available were needed for the haulage of supplies for the force. There is much conflict of opinion as to the suitability of these wagons for purposes of sick transport; there is little doubt the additional length of the supply wagon diminishes the jolting, and there is much evidence to show that these wagons are not more uncomfortable than the ambulance wagon if they are filled with straw or the like. But, quite apart from this question of suitability, there remains the fact that no other method was possible.

At Modder River the small hospital which had been established in December by Colonel Townsend, P.M.O., 1st Division, and staffed from his field units, was partly in a house and partly in tents. In January, a small house having been found for their accommodation, four nursing Sisters were sent up, and later another small house was taken over as an Officers' hospital. In the beginning of February a small hospital was established in the hotel on

the "Island," under Mr. Cheatle, for surgical cases only, and at this time seven additional Sisters were sent up.

Nos. 2 (Captain C. C. Fleming) and 3 (Major M. W. Russell) Hospital Trains were constantly employed on the western line during the whole of this period, transferring cases from Modder River and Kimberley to Orange River, De Aar, and to the base hospitals at Cape Town.

On March 1st the force moved from Paardeberg to Osfontein, where it was joined on the 6th by the Brigade of Guards from Klip Kraal and Klip Drifts, by a brigade division of artillery from Jacobsdal, while on the 7th the 15th Brigade joined from Jacobsdal, making a total of about 35,000 men, now including four brigades of mounted infantry.

Pending the further advance to Bloemfontein, the position of affairs on the line of communications and at the base must be referred to.

L.—KIMBERLEY.

When the Loyal North Lancashire Regiment moved up to Kimberley in September, 1899, a small hospital was arranged for under Lieutenant O'Gorman, R.A.M.C., who was the only officer of the corps in Kimberley during the siege.

The regular troops in Kimberley did not exceed some 500 men, the remainder of the garrison, over 3,200 men, was composed of local Volunteer corps, the Town Guard, &c. Arrangements were made for the treatment of the sick of the garrison in the civil hospital on the commencement of the siege, and most of the medical men in Kimberley were attached for duty to the various corps. Dr. W. W. Stoney, the Medical Officer of Health for Kimberley, was responsible for the sanitation of the town, while Lieutenant O'Gorman looked after that of the camp. Special measures were taken from the first to ensure the boiling of the drinking water, as the sources were not above suspicion, but enteric fever first appeared among the civil population in the middle of December (as it did in the relieving force at Modder River and among the Boers), and increased in prevalence till the relief. The health of the troops, however, was good till the end of January, in spite of their privations and exposure. At this time the civil hospital was very full, and arrangements were made to take over various buildings (the Christian Brothers' Schools and the Convent) in order to obtain increased accommodation for the sick.

After the relief the 9th Brigade Bearer Company, with a portion of the field hospital moved into the town, leaving the remainder of the hospital under Major H. J. Peard at Modder, to assist the Divisional Hospital (No. 10) in staffing the temporary hospital there for the reception of convoys from the front, via Jacobsdal.

The remainder of the 9th Brigade Field Hospital moved into Kimberley on February 26th, joining the other section and the bearer company at Newton Camp. On the following day the staff of these units took over the Christian Brothers' Schools, and Nazareth House (the Convent) already occupied as a military hospital. On this date also the drill hall and public schools were taken over, and arrangements made for their equipment as military hospitals. By March 5th additional accommodation was necessary, the rink and St. Mary's Hall were taken over and equipped, and on the 7th, the Masonic Temple, the Presbyterian and Main Street Schools were also taken over and equipped. As the Ordnance Department and the Army Service Corps were at this time unable to assist, the whole equipment of these buildings (except the Christian Brothers' Schools and the Convent) had to be purchased by Major Peard, assisted by the manager of De Beers. Further, as the Royal Engineers could not help, on him also fell the duty of providing for cookhouses and their equipment, for latrines, and for the lighting of these buildings. As the Army Service Corps were not in a position to supply the various articles necessary for the sick, but issued orders to buy, this duty also fell on Major Peard.

On March 7th the divisional hospital arrived from Modder River, took over some of these buildings, and relieved the strain. In addition to the personnel furnished by these units, local medical men and Sisters were employed. Civil surgeons and, later, Sisters were sent up from the base also.

Altogether there was accommodation in Kimberley for some 380 sick in buildings, while the stationary hospital in Newton Camp at a later date gave accommodation for 160 slighter cases. The greatest stress was during the week ending March 16th, when some 800 men passed through the hospitals in Kimberley, in addition to those remaining in hospital for treatment. This was chiefly due to the arrival of the large convoy from Osfontein, prior to the continuance of the advance on Bloemfontein.

At Modder River, owing to the arrival of convoys from the front, via Jacobsdal, the numbers were largest some three weeks earlier, and from about the middle of March, when No. 10 Field Hospital moved into Kimberley, there were practically no sick in hospital there.

Evacuation down the line was steadily carried out, principally by Nos. 2 and 3 hospital trains, with additional trains made up locally from saloon carriages. But the congestion of traffic caused by the obstruction at Modder River Bridge (which had been blown up and the line carried across on a deviation), rendered this evacuation less speedy than would have been possible if the line had been working under more favourable conditions. Most of the patients were transferred direct to the base hospitals at the Cape by the hospital trains, but those sent down by the local trains, and the cases which it was not considered advisable or necessary to send on the long journey to Cape Town, were accommodated in the hospitals at Orange River and De Aar, while a certain number were taken by local trains to Naauwpoort, where No. 6 General Hospital was open by the end of February.

M.—FURTHER DEVELOPMENTS AT BASE AND ON LINE OF COMMUNICATIONS.

The general hospitals in the vicinity of Cape Town, Nos. 1, 2, and 3 (the latter assisted by the Portland Hospital), were gradually increasing their accommodation in proportion to the probable demands for beds for cases from the front. The Officers' section of No. 1 General Hospital was increased till it gave accommodation for 120, while a sanatorium at Claremont, which had been partly taken over in December, provided about 50 separate rooms for the accommodation of convalescent Officers. An Officer of the Royal Army Medical Corps was in charge, assisted by two Sisters. This convalescent home proved extremely satisfactory, and allowed of the transfer of Officers from the hospitals at an earlier date than would have been possible otherwise, and of the direct transfer from the front of many cases who required only rest and good food to set them right. Thus in two ways, it increased the available accommodation, and, in addition, the greater freedom was much appreciated by the Officers themselves. Sir James Sieveright had kindly offered the use of two houses at Somerset West for a convalescent home, but the distance from Cape Town and the limited accommodation rendered it impossible to take advantage of this offer.

In February authority was received for the enlistment of two additional companies of the Cape Medical Staff Corps, in order to provide the bearer companies needed for the new brigades, for which equipment was available but no personnel. These men were rapidly put through a course of first aid and stretcher drill and sent to the front, where "F" Company, under Major C. E. Nichol, did most excellent service with the 19th Brigade during the remainder of the campaign. The other company was utilised in replacing casualties. In addition to this the Jewish inhabitants of Cape Town offered to furnish a party of 20 men without pay, to be absorbed into the existing field units. This was gratefully accepted, and these men also did very good work for a long period.

No. 5 General Hospital arrived in Cape Town on January 20th, but as the whole of the personnel was required to make up the field units and advanced hospitals to the necessary strength, it was never established. The equipment was stored at Cape Town, and the personnel drafted to various positions on the advanced line, Lieut.-Colonel Dorman (who came out as Officer in charge of the hospital) being appointed Principal Medical Officer of the newly formed 9th Division. A demand for the personnel of a general hospital to work with this equipment was made by cable, and this fresh staff arrived in South Africa in the middle of March, when the station hospital at Woodstock, which had been enlarged by the addition of huts and the other

necessary annexes, was opened as No. 5A General Hospital, under Lieut.-Colonel J. F. Williamson.

Early in February also the personnel of a field hospital was asked for by cable from England.

Two measures adopted early in February relieved the pressure on the hospitals at the base. A convalescent camp which had been established at Green Point in November, 1899 (to which men were sent from the hospitals when they no longer required definite treatment in hospital, but only feeding and rest), was extended and made more important. This worked well, and the system formed an important part of the medical organisation later in the campaign.

The other measure which relieved the hospitals was an arrangement by which (Line of Communication Order No. 3 of 4.2.00) men might be discharged from hospital as "fit for service in garrison but not in the field." This enabled the hospitals to be cleared of cases of men suffering from deformed or flat feet, varicose veins, or rupture, &c., such as always accumulate among a large body of men doing heavy work, men who are not permanently unfit for all duties, whose services are valuable under certain conditions, who at the same time did not need medical treatment, and whom it was therefore impossible to invalid. This system also became an important factor in the medical arrangements later, and gave the services of many men to the hospitals in times of pressure.

At this time (early in February) there was considerable difficulty in getting stores up the line as fast as was desirable, owing to the congestion on the railway, partly the result of the concentration then taking place on the western line. But the hospital trains were able to carry up a large quantity of the less bulky articles, so that the difficulty was felt most with ordnance stores, such as bedsteads. As a matter of fact, the hospital trains were regularly used throughout the campaign for the transport of such articles as could be got into them, so as to render the supplies to hospitals as far as possible independent of the ordinary goods traffic.

In the end of January a consultation was held with Mr. J. G. Hamilton, the civilian director of the Imperial Yeomanry Hospital, with regard to the site on which this hospital was to be established. It was again proposed that if authority could be obtained for a site outside the lines at De Aar, it should be established there. This, however, not proving practicable, a site at Deelfontein, some 30 miles from De Aar on the main line to Cape Town, was recommended and approved in the middle of February. The hospital staff arrived on the last day of that month, and immediately proceeded to Deelfontein. There was some difficulty in opening the hospital, owing to the want of stores. The tents (except those for the personnel) did not arrive for some days, and had to be supplied by the Ordnance Department, blankets and clothing for the patients had not arrived from England, and had to be obtained locally. The materials brought from England for the erection of the huts had not arrived in Cape Town, and the erection of the local pattern huts, supplied by the Royal Engineers, was delayed owing to the loss of the bolts for holding the sections together. Added to this there was a difficulty about the water supply, and it was only by the energy of Lieut.-Colonel A. T. Sloggett, the Royal Army Medical Corps Officer with the hospital, that it became possible to provide accommodation in tents for 200 sick by March 18th. After this date the erection of the huts proceeded, and the hospital developed into a large and complete establishment of 1,000 beds, provided with every luxury.

No. 6 General Hospital, under Lieut.-Colonel Somerville Large, arrived in Cape Town on February 17th, and on the 19th proceeded to Naauwpoort, where it opened 250 beds on February 24th, and its full number (520) on February 27th. Out of a total personnel of 140, this unit contained 50 of the St. John Ambulance Brigade. Deelfontein having been already approved as a site for the Imperial Yeomanry Hospital, Naauwpoort (70 miles from De Aar), was the most suitable site for the establishment of this hospital; it was comparatively safe (although at one time it seemed as if the hospital must be evacuated), within an easy railway journey of the western line, and in touch with the troops under General Gatacre operating in the adjacent districts.

The second half of the New South Wales Ambulance, which had been asked for (consisting of 90 of all ranks), arrived in the third week of February,

and proceeded to Sterkstroom to take over the hospital there. Fourteen Sisters accompanied this unit to South Africa: four proceeded with the staff to Sterkstroom, the rest were distributed among other hospitals in Cape Colony.

With the enlargement of the hospitals, and the increasing proportion of partially trained personnel, the employment of nursing Sisters became more important. There were, in the end of February, 109 employed in the hospitals in Cape Colony alone, of whom a number had been engaged in South Africa, while others, also locally engaged, were utilised on the sick transports. A large draft of 40 Sisters arrived from England in the beginning of March, and were distributed among the hospitals.

Subsequent to the surrender of Cronje, arrangements had to be made for the care of the prisoners of war at Simonstown. Most of them were kept on board ship in Simons Bay, but a number were placed in an enclosure on shore. A small hospital was opened in huts and houses close to the camp, but when measles and enteric fever broke out among the prisoners, the Palace Barracks were converted into a satisfactory hospital of about 70 beds. The difficulty experienced in dealing with these men was extreme, both in camp and hospital. Their disregard of elementary cleanliness rendered it impossible to maintain things in a satisfactory sanitary state, and this undoubtedly was an important factor in the causation of the epidemic of enteric fever which developed. The first cases recorded occurred about March 14th. Although this gives a comparatively long incubation period, there is no doubt that the disease was contracted in the laager at Paardeberg.

The establishment of No. 5 General Hospital at Woodstock completed the hospitals in the vicinity of Cape Town. With the opening of the Free State it became possible to move general hospitals nearer the front, and the number in Cape Town was reduced, though for a time the accommodation in those remaining had to be increased. But from that date Cape Town became more and more an invaliding centre as contrasted with its previous function as a centre for treatment of the sick.

N.—THE MARCH TO BLOEMFONTEIN.

Prior to the advance from Oosfontein the field hospitals were cleared of their sick by transfer to Kimberley, to which place a large convoy was sent back under a Medical Officer, and a large supply of medical and surgical stores having arrived, the equipment of the units was completed as far as possible before starting. Two bearer companies of the Cape Medical Staff Corps joined the force: one, under Major C. E. Nichol, R.A.M.C., became the 19th Brigade Bearer Company (in place of the Cape Field Hospital, under Major Greenway, which, however, remained with the 9th Division); the other joined the 6th Division.

Poplar Grove.—At Poplar Grove, on March 7th, the casualties occurred chiefly in the cavalry division. This division moved off in the early morning, and by daybreak had outpaced the medical units, except the well-horsed New South Wales Field Hospital (with the mounted infantry), which was fortunate in possessing its own transport, and was thus enabled to keep with the division. No. 11 Field Hospital struggled on some distance in rear of the division, but the bearer companies were hopelessly behind, and, indeed, received orders to remain with the infantry. No. 11 Field Hospital received the wounded, and had to be left behind, its place being taken by half No. 6 Field Hospital from the 2nd Cavalry Brigade (under Major F. J. Greig), which, with the bearer companies, joined the division on the morning of the 8th.

On this date also (7th) the 6th Division had a very long and hot march of some 10 hours. Owing to the heavy ground, the medical units were in difficulties with their transport; some of the mules died on the way, and the 13th Brigade Bearer Company alone arrived in camp about 9 p.m.; the remainder did not rejoin till the next morning.

Driefontein.—At Driefontein, on March 10th, the casualties were almost entirely confined to the 6th Division. The cavalry division had a few; the Guards Brigade and the remaining divisions were not engaged, so that their field units were able to assist those of the 6th Division in their arduous task. The action lasted a long time; the ground was rocky, much broken, and very difficult, so that it was not possible to bring in all the wounded to the field

hospitals before nightfall, owing to the distance which had to be traversed by the stretcher bearers and the deficiency of ambulances. The removal of wounded went on till the moon set about 2 a.m., when it became no longer possible to continue on account of the extreme darkness. Fires had been lighted at the dressing stations which had been formed among the kopjes, and the remaining wounded, about 50, were collected round these, and hot bovril served out to them. Although these men were not taken to the field hospitals till the next day, no man was left on the field without attention.

The 6th Division, with the rest of the force, moved on the following day, leaving the 13th Brigade Field Hospital, with the Cape Medical Staff Corps Company (acting as a divisional hospital), to look after the wounded, to whom were added about 100 sick. The hospital was established in a farmhouse of fair size, with some outbuildings. The worst cases were put into the house and outbuildings and the few tents with the hospital; other cases were put in the hospital wagons and other wagons obtained on the spot, but the majority of the slighter cases had to bivouac in the open. A large supply of provisions, medical comforts, and medical and surgical stores had been left with the hospital, and a farmer sent a herd of cows, so that there was plenty of fresh milk. The greatest difficulty was in cooking for so large a number; meals had to be served in three relays, which materially increased the work of the personnel. Ambulance wagons were sent back from Bloemfontein, and on the 19th the majority of the cases were sent into Bloemfontein, leaving only 63 of the worst cases, which were taken with the hospital when it left Driefontein on the 26th, arriving in Bloemfontein on the 29th.

The other medical units accompanied their brigades to Bloemfontein; the 19th Brigade Field Hospital managed to secure an extra wagon at Aasvogel Kop, but even with the lightened loads on the vehicles the mules were exhausted; on the march next day two died, and seven tents had to be left behind.

At most of the camping grounds between the western line and Bloemfontein, dams formed the only available source of water supply. Usually the Royal Engineers, when possible, went ahead and laid down a length of hose with a hand pump; one side of the dam was reserved for men, the other for animals, but the animals, uncontrollable through thirst, soon stirred up the mud and fouled the supply. As stated already, there was no means of boiling the water, and the medical units alone appear to have used the Berkefeld filter systematically; these, indeed, were not at that time supplied to all units.

Ten field hospitals and 10 bearer companies marched into Bloemfontein with the force on March 13th. They took with them about 200 sick and wounded, and on the following Friday, March 16th, there were 327 cases under treatment in Bloemfontein (including 17 cases of enteric fever), of whom 11 Officers were housed in the Dames' Institute, a high-class ladies' school.

O.—BLOEMFONTEIN.

Bloemfontein, the old capital of the Orange Free State, is situated in latitude $28^{\circ} 56' S.$, longitude $26^{\circ} 18' E.$, at an elevation of about 4,500 feet above the sea. It lies on an open plain, bounded on the west by some low hills, rising about 200 feet above the general level, and on the south, by a lower elevation, on which, among other buildings, stand the old fort and the Staats Artillerie Barracks.

On the remaining sides the plain sweeps away for many miles broken by kopjes, prominent among which on the east are Boesman's Kop and the hills over Thabanciu. Some 13 miles north of the town, as it runs north-west from Sanna's Post (where the waterworks from which the town is now supplied have been formed), the Modder River crosses the main line north at Glen Station. A few small spruits in and around the town drain northwards to fall into the Modder, but no large stream exists close to Bloemfontein itself.

The population of the town before the war was some 6,000, of whom rather more than half were white. It is of the usual type of the South African towns, a few good buildings among many inferior.

Bloemfontein lies well within the area of the summer rains. The average rainfall over a period of ten years was 25.39 inches, of which about two-thirds fell within the five months, December to April, and about one-sixth of the total rain occurred in March.* The climate is pleasant, not excessively hot in summer, but very cold during the winter months.

The distance by rail from Bloemfontein to the coast ports is as follows:—To Capetown, 750 miles; to Port Elizabeth, 450 miles (to both places by Norval's Pont and Naauwpoort); to East London by Springfontein and Bethulie, 400 miles; or by Norval's Pont, Stormberg, and Rosmead, 510 miles. There are only two exits by rail from the Free State to the sea, crossing the Orange River at Norval's Pont and Bethulie. At the former the railway bridge, the only means of crossing, had been blown up by the Boers; at Bethulie the road bridge remained intact, but the railway bridge had been destroyed. Behind them part of the railway between the river and the sea was in the hands of the Boers, and railway communication with Norval's Pont from the coast was not resumed till March 17th, and with Knaapdaar (17 miles from Bethulie Bridge on the Cape side) not until the 22nd.

Work on these two bridges was commenced as soon as possible, with the result that the temporary bridge at Norval's Pont was so far ready that trucks could be moved across by hand on March 28th; while at Bethulie, by laying rails on the road bridge, it was possible to move trucks across by hand a few days earlier. But this last was of little assistance, and so for 16 days after the occupation of Bloemfontein not one truck reached it, and it was not till March 29th that the first train from beyond the Orange River arrived in Bloemfontein.

The first and most pressing necessity was food, and up to April 7th only supplies were sent forward which indeed fell short of the actual quantity required. This shortage, but to a less extent, continued till April 17th, but during this last 10 days, by cutting down the other supplies, it was possible to send forward a certain number of trucks with medical comforts and supplies for the hospitals. But the whole traffic was delayed by the accumulation of loaded trucks south of Norval's Pont, while the repairs were being made.

Hence it was that the needs of the medical service in Bloemfontein as regards material had to be satisfied at first with what was obtainable on the spot. On the afternoon of the 13th the Principal Medical Officer with Headquarters, Surgeon-General Stevenson, inspected those buildings which were pointed out to him as suitable by the local authority, and arranged for their occupation as military hospitals. The following buildings were actually occupied during the first week after our entry:—Grey's College and Old St. Andrew's (boys' schools), giving good accommodation for 180 sick; the Dames' Institute (a girls' school), with good accommodation for 140; the Industrial Home (a technical college), with good accommodation for 100 cases; while the Volks Hospital (a local institution), had been employed from the first, giving a total of some 500 beds prepared within a week after our entry.

During the following week the Convent, St. Michael's Home (a school and Sisterhood), the Artillery Barracks, and New St. Andrew's College (a school), gave additional beds for 233; or a total of about 740 in all by the end of March. Every one of these buildings required some temporary structures erected for latrines, cook-house, or bathrooms.

Later other buildings were also occupied, Bishop's Lodge, the Cottage Hospital, with fairly good accommodation, the landrost's house, and for a time, through the kindness of Lady Roberts, the ballroom of the Residency, gave accommodation for about 30 cases. This exhausted the buildings which were at all suitable for use as hospitals with the limited personnel then available.

Such equipment as was in these buildings was employed and added to from the little obtainable in Bloemfontein. All the beds and bedding that were available in the town were bought up by Surgeon-General Stevenson. Two firms were ordered to make mattresses; one contracted for 100, but

* 1885-94, "Cape of Good Hope Meteorological Commission, 1897," p. 22.

after supplying 50 in 10 days ceased work; the other supplied a few in 10 days and also stopped work; in both cases because the material in the town was exhausted. Surgeon-General Stevenson bought up all the crockery, knives and forks, and other articles till the supply was exhausted. Beds and bedding were also obtained from the empty houses in the town. Clothing for the men in hospital was also bought as far as it was available. But certain other things could not be obtained locally in sufficient quantity, particularly bedpans and urinals, nor was there any tinworker in the town who could make substitutes.

The net result by the end of March was accommodation in buildings for about 740 sick, in addition to the field hospitals, with a deficiency of beds and mattresses and of some other necessities. No. 5 Stationary Hospital opened during the following week in the Raadzaal, adding another 130 beds.

As regards the supplies, while the railway remained blocked the local resources had to be depended on. But fresh milk was the only necessary of which there was any real deficiency. The supply of milk forms a constantly recurring difficulty in those parts of South Africa where the cold season is also the dry season. There is no artificial feeding, cattle depend entirely on the natural growth of grass for their sustenance, hence as the grass becomes scarce the yield of milk falls off. Further, dairy farming is far from common among the Boers, and even in the English Colony of Natal the supply of milk is frequently short of what is required for hospital purposes. Add to this carelessness and want of cleanliness in the storage and conveyance of the milk, the consequence is that a large proportion of the supply frequently become unfit for use, and the net result is an insufficient supply even in times of peace. The normal supply in Bloemfontein is probably less per head than in the towns of Natal, and with the dislocation consequent on the war, and the increased demand resulting from the presence of a large sick population, the inevitable result was a considerable deficiency in the supply. Nor was it practicable to secure every ounce of the actual quantity produced, but substantially all the fresh milk that could be obtained was so obtained for the use of the sick. A central dépôt was established in the town from which all hospitals were supplied in proportion to their needs. The deficiency was made up by the use of tinned milk. It had been the custom to supply two kinds of tinned milk in equal quantities, one sweetened and the other unsweetened. The former, though a nutritious article, is not liked by sick men, but there are several brands of unsweetened milk, which, when properly diluted, are so good that it is not possible under ordinary circumstances to distinguish them from ordinary fresh milk, while they are superior in nutritive value to anything but the best fresh milk. Arrangements were made by which these unsweetened brands were supplied to the hospitals to the exclusion of the sweetened varieties.

Personnel for the temporary hospitals was found by utilising the field units, especially the bearer companies, who would otherwise have been little employed. The 13th Brigade Field Hospital occupied New St. Andrew's College as a special ward, while the Artillery Barracks were staffed by the New South Wales Ambulance. Altogether 12 Officers and 160 N.C. Officers and men were employed in these temporary hospitals at the end of March.

Some 24 nurses were found in Bloemfontein on our entry, and were employed, while Sisters from the base were called for by wire. Of these 20 arrived in Bloemfontein on March 22nd, crossing at Norval's Pont by the pontoon bridge, and travelling from there to Bloemfontein in carts and wagons. Twelve more arrived a few days later, making a total of 56 employed in Bloemfontein by the end of March, to whom 67 more were added in April, making a total of 123.

Before the occupation of Bloemfontein two hospitals, No. 5 Stationary and the Irish Hospital, had been held in readiness to proceed there as soon as the line was open, while others, due to arrive at an early date, had been detailed for Bloemfontein on arrival. No. 3 Advanced Dépôt Medical Stores was also held ready to go forward to provide the necessary medical and surgical stores to replace the expenditure on the march across from the western line.

No. 5 Stationary Hospital having arrived in South Africa towards the end of February, was immediately despatched to De Aar and held in reserve there pending the development of the campaign. Here while waiting the

personnel were most usefully employed in No. 3 Stationary Hospital, while its equipment remained packed. Early in March it was decided to send it to Bloemfontein as soon as the rail was open, and on the 17th, when the rail was free as far as Norval's Pont, the order to move was given. Owing to the block there the hospital was detained at De Aar till the 26th; it arrived at Norval's Pont on the 28th, where 45 tons of stores had to be carried by fatigue parties for a mile and a half to entrain for Bloemfontein, where it arrived on the 29th. On the 30th, 104 patients were admitted, all of whom were on beds or stretchers; by April 6th (70 bed-cots having been obtained to replace some of the stretchers), there were 168 in hospital, all of whom were supplied with bedding.

The Langman Hospital was the next to arrive. This unit disembarked in Cape Town on March 22nd, and was ordered to Bloemfontein at once. It arrived there on April 2nd, opening some days later.

Three general hospitals (as detailed below) arrived in Bloemfontein between the 7th and 11th of April.

The Irish Hospital arrived in South Africa on the same date as No. 5 Stationary Hospital, and after having been detained for about a fortnight in Cape Town (chiefly owing to the congestion on the line), it proceeded to Naauwpoort, arriving there on March 10th, when it received orders to be ready to move to Bloemfontein immediately the line was open. During this halt at Naauwpoort part of the staff, with transport and equipment, accompanied Lord Kitchener on his expedition to Prieska. Owing to blocks on the line after the bridge at Norval's Pont had been opened, this hospital did not leave Naauwpoort till April 11th, arriving in Bloemfontein the following day, and opening a few days later.

The Portland Hospital, which had been stationed with No. 3 General Hospital at Rondebosch, handed over its patients there on April 6th, left two days later, arriving in Bloemfontein on the 14th, to open on April 17th.

The Langman and Portland Hospitals had little difficulty in getting through to Bloemfontein with their equipment complete, which is mainly attributable to the fact that they were comparatively light units; they had also the important advantage of starting from a terminus where trucks could be more easily detailed specially for their use.

At the date of the occupation of Bloemfontein there were three general hospitals on the voyage out from England, all of which were destined for Bloemfontein. No. 8 General Hospital (Lieut.-Colonel R. T. Beamish) arrived at Cape Town on March 21st, after a slow voyage of 29 days in the "Cephalonia." It was at once ordered up country, via East London, but the ship was detained at Cape Town, and the hospital only disembarked at East London on April 4th, to arrive in Bloemfontein on April 9th. Owing to the pressure on the line, priority was only given for 200 tons of hospital stores; part only of the equipment of this hospital could be taken up, the whole not arriving till April 13th, while the hospital opened on April 23rd.

No. 9 General Hospital (Lieut.-Colonel Barrow) arrived at Cape Town on April 1st, and disembarked at Port Elizabeth on April 4th, to arrive in Bloemfontein on April 7th. The same difficulty occurred with regard to its stores (excepting the tents), the whole of which had not arrived till April 22nd. But by borrowing from all possible sources the staff were able to open the hospital for the reception of some patients by April 19th.

No. 10 General Hospital (Surgeon-Lieut.-Colonel W. Lake, R.A.M.C. Militia) arrived at Cape Town on April 4th, disembarked at East London on the 8th, and arrived in Bloemfontein on the 11th. The stores were delayed, arriving in Bloemfontein between the 15th and the 20th, and the hospital opened as a general hospital on the 29th. But the personnel of No. 10 General Hospital took over the charge of the temporary hospitals at once on arrival, and the hospital remained established in the buildings already mentioned (and some smaller buildings added at a later date) so long as it continued to be in the town. While the other hospitals were waiting for their equipment, their personnel was also employed in the temporary hospitals.

No. 3 Advanced Depot of Medical Stores opened in Bloemfontein by the end of March (29th), and was of much assistance, as the stores of medical and surgical material in the town were early exhausted by purchase to provide for the needs of the field hospitals.

For more than a month after the occupation the supplies of all kinds received fell short of the minimum considered necessary. But it was possible to get up some 62 trucks of medical stores and comforts, in addition to 461 trucks of ordnance material, some of which were for the hospitals. In addition to this the hospital trains on each of their trips from the base brought up as much as they could carry of the smaller and more portable articles, which were most in demand.

It is convenient to divide the further account of Bloemfontein into two parts, before and after the advance to Kroonstadt.

The force under Lord Roberts which marched into Bloemfontein was composed of 1,405 Officers, and 32,549 other ranks, or a total of 33,954 of all ranks, with 11,540 horses. It consisted of the cavalry division (three brigades), four brigades of mounted infantry, the Naval Brigade, the Guards Brigade, the 6th, 7th, and 9th Divisions, with the usual details. The 6th Division marched in on the 14th, the 7th and 9th some days later. The infantry divisions were encamped on the slopes to the westward of the town, the Naval and the Guards Brigades on the plain to the south, while the cavalry and mounted infantry were scattered round the town at a greater distance from it.

The soil in the vicinity is somewhat shallow, the subjacent, soft mudstone crops up here and there, and the surface is much broken by small spruits and dongas. After heavy rain traffic converts the surface layers into a sticky mud, which dries rapidly, and forms a fine dust. Outside the municipal boundary there are, of course, no made roads, and from the situation of the camps such roads as existed were much cut up, and new tracks were made over the open veldt.

The water supply of Bloemfontein until May, 1899, depended entirely on shallow and insufficiently protected wells sunk in and around the town. At that date waterworks had been opened at Sanna's Post, some 21 miles to the east of the town, where the water from the Modder River was impounded, pumped to a reservoir on Boesman's Kop, whence it flowed to a distributing reservoir on the side of Naval Kopje to the north-west of the town, from which it was distributed by gravitation. The system was not complete, the supply was not compulsory, and some of the inhabitants preferred to depend on the wells. The process of filtration at Sanna's Post was quite inefficient, but, such as it was, this supply was safer than that from the wells. The waterworks were occupied by the Boers on the night of March 31st, and from April 3rd the town was reduced to the old supply from wells.

For some years before the war, Bloemfontein had a bad reputation on account of the prevalence of enteric fever. It had appeared annually, beginning as elsewhere, after the first rains, increasing after the heavier, and declining after the maximum rainfall. In this respect it conforms to the conditions associated with its annual prevalence in Natal. In recent years it has been observed that enteric fever has been increasingly prevalent in the smaller towns and farms round Bloemfontein; this is probably part of a general increase which has occurred very widely in South Africa.

Sanitary problems receive very little attention in that country. Among the Boer and native population no attention whatever is paid to these matters, while even in the English colonies, outside the coast ports, the conditions approximate to those obtaining in England a century ago. There are, of course, difficulties which do not exist in this country; in the majority of cases a water-carriage system for the removal of excreta would be very difficult to arrange. Irrigation schemes and sewage farms hardly exist. It is not recognised so far that expenditure on sanitary matters is profitable, hence, the usual method is a more or less unsatisfactory pail system, and this was in use in Bloemfontein.

In addition to these well-defined sources of danger, the suspicious water supply, and the imperfect removal system, there was, as usual, a total disregard of any attempt at cleanliness in the surroundings of the houses, and, more important, of the wells. It is also important to note that whatever little may have been done in the towns to improve these conditions, the small dorps and farms remain in a state of primitive filth. Further, it must be noted that enteric fever occurs among the native population, and there is much reason to believe that before the war, the bacillus became widely

disseminated throughout the country by natives returning from the Rand, and probably also from Kimberley.

The local conditions were then an endemic area provided with an impure water supply, and in a bad sanitary condition generally. To this was added the human factor, an army exhausted by excessive exertion on a reduced diet, marching through a district where the only available water supply was scanty, and probably in many instances polluted.

Turning now to the history of the force which was exposed to these conditions, before it left the western line, enteric fever had been steadily increasing on the line between De Aar and Kimberley since the end of December, though the rate of incidence was not great in proportion to the strength of the troops. But in spite of the factors for evil which influenced the troops during the march, the general health at its beginning was good. Few cases of enteric fever had occurred, only six were admitted to the field hospitals during the first fortnight of the advance, and between March 2nd and 16th, 31 more. One has, of course, to consider along with enteric fever the so-called "simple continued fever," of which, during February, 78 cases were admitted to the field hospitals with the moving force, and 114 into the Guards Field Hospital at Klip Drift. During the third and fourth weeks of the march (ending March 2nd and 9th respectively for the purposes of the hospital returns), the admissions included under this head increased considerably, to fall again during the week ending March 16th. A large number of these cases of simple continued fever were undoubtedly due to fatigue, exposure, and other transient causes; this is shown by the numbers who returned to duty in a few days, which would have been materially increased had the transport available allowed of their being carried for a day or two. On the other hand, it is certain that some of these cases were the early stages of enteric fever. What the proportion was, it is not possible to say, but probably about one-third of the total would prove to be enteric fever. Calculation on this basis gives a total of about 220 cases of enteric fever in a force of nearly 34,000 men during a period of five weeks, or an admission rate over the period of about $1\frac{1}{3}$ per 1,000 per week.

The force left the western line on February 11th. From that date, inclusive, to March 2nd is 20 days, so that the admissions of the second and third weeks of the march (ending on February 23rd and March 2nd for the weekly returns) include the majority of the cases due to infection at Modder River. The admissions for the following week (March 9th) certainly exhaust the cases directly due to this infection, and probably include a large number contracted at Paardeberg, where the first exposure to infection dates from February 18th.

On March 16th, there were in the various field hospitals of the force in and around Bloemfontein 327 cases, of whom 17 were enteric fever and 93 simple continued fever. This is exclusive of the 13th Brigade Field Hospital then at Driefontein. It must be remembered that, including the cases in this hospital (415), the total of 742 sick and wounded represents the total sickness in the force on the march from Poplar Grove, from which place the last convoy went back to the western line. That is, on its arrival in Bloemfontein, the proportion of the force under Lord Roberts in touch with it, but inefficient on account of wounds or disease, was a little over 2 per cent. of the strength.

But immediately that the stimulus of the movement ceased, history repeated itself, and the sick rate began to increase. On the one hand, men who felt ill were no longer reluctant to report sick, and on the other, the effects of the march across the Free State became apparent. During the first week after the occupation of Bloemfontein, the admissions for the continued fevers (enteric and simple continued fevers) were nearly treble those of the previous week, and the numbers still further increased in the following week (ending March 30th). These probably exhaust practically the whole of the cases contracted on the march to Bloemfontein. The beginning of the outbreak among the Boer prisoners at Simonstown (already referred to) was synchronous with the increase in Bloemfontein.

The total admissions from all causes increased steadily till, in the third week in April, the admissions to hospital exceeded 1,400. During the next two weeks the number of admissions fell somewhat, but afterwards increased,

and rose to their maximum in the middle of May, from which date they rapidly and, with one exception, steadily fell to the end of July.

But, fortunately, for the first fortnight after our arrival the total number of sick, though large in comparison with the numbers for the previous weeks, was not excessive in proportion to the strength of the force. On March 30th the number remaining in hospital in Bloemfontein amounted only to 3.6 per cent. of the marching in strength, while a week later (including the wounded from Karee Siding and Boesman's Kop) it barely reached 5 per cent. There were for the care and attendance on these cases, only the personnel of the field units, lessened by the casualties which had occurred since the force left Modder River, but assisted by the nursing Sisters already mentioned.

As regards accommodation, by the beginning of April there were some 700 sick and wounded in buildings, leaving about the same number under treatment in the field hospitals. When No. 5 Stationary Hospital opened in the first week of April the accommodation in buildings rose to some 860 beds, but this practically exhausted all the buildings in the town which were at all suitable and could be staffed. The smaller buildings which could be and were occupied later, gave only a small and temporary increase. On account of the want of material, it was not possible to erect huts for use as temporary hospitals.

It therefore resulted that till the general hospitals arrived, a considerable proportion of the sick and wounded had to be accommodated in the hospitals of their brigades. This necessity resulted in much unavoidable hardship and suffering to the sick and wounded. Field hospitals are neither intended nor suited for the continued treatment of serious cases; they have neither beds nor clothing for the sick, the number of stretchers is small, and the supply of the various utensils limited. Their equipment, even when complete, is designed to give temporary succour only, for which purpose the experience of the campaign shows that it is well suited. But the equipment of the field hospitals in Bloemfontein had been necessarily reduced with the reduction of the transport, and it was for some time impossible to make any material additions to it beyond the replacing of the expended medical and surgical stores by purchase, and from No. 3 Advanced Depot of Medical Stores. The tents of No. 5 Stationary Hospital, which was established in the Raadzaal, were distributed among the field hospitals, together with some taken from the Boers, and later, when No. 10 General Hospital had taken over the temporary hospitals in the town, some of its marquees were also given to the units then remaining in Bloemfontein.

In April the admissions still further increased, and in addition to this influx, the numbers remaining in hospital were steadily increasing by the accumulation of serious cases which required a prolonged period of treatment. The result was a heavy strain on all the resources of the medical service. The serious cases increased more rapidly than beds could be found for them in the temporary hospitals in the town, and this in spite of the evacuation of such cases as were fit to move, a process which to a small extent had been going on since March 24th. It was, of course, impossible at first to send any but slight cases, which were in the minority in the hospitals in buildings, so that the evacuation, though lessening the actual number under treatment in Bloemfontein, did little to assist in the treatment of the more severe cases. At first only such cases could be sent as were able to walk across the pontoon bridge at Norval's Pont, and the number was limited. After the resumption of traffic, by April 6th it was possible to send about 60 at a time by the ordinary trains, which then ran across the bridge. The first hospital train, No. 2, under Captain C. C. Fleming, D.S.O., arrived in Bloemfontein on April 5th, and left on the 7th for the base, while No. 3, under Major M. W. H. Russell, arrived in Bloemfontein on April 8th, and left two days later with 144 of all ranks sick and wounded. From this date the evacuation proceeded steadily, both by ordinary trains, by trains made up locally, and by the hospital trains, Nos. 2 and 3.

There were available on the line between Bloemfontein and Cape Town at this time No. 6 General Hospital at Naauwpoort, No. 3 Stationary Hospital at De Aar, and the Imperial Yeomanry Hospital at Deelfontein. This last had opened some 200 beds on March 18th, and afterwards gradually increased its accommodation. In Cape Town, No. 5 General Hospital was established

at Woodstock, in addition to Nos. 1 and 2 at Wynberg, and No. 3 at Rondebosch. There were in this way a large number of beds available for those who could be got to them, and it was, of course, advantageous to utilise the hospitals nearest to Bloemfontein for the cases sent down by the ordinary trains, so that the hospital trains (in addition to the actual removal of sick from Bloemfontein) took cases which were fit to move from Naauwpoort to De Aar and Deelfontein, to make room for the cases sent from Bloemfontein by the ordinary trains, all of whom were in the first instance consigned to Naauwpoort. Nos. 2 and 3 Hospital Trains also conveyed suitable cases direct from Bloemfontein to the hospitals at Cape Town.

The arrival of the personnel of the three general hospitals gave welcome assistance. That of No. 10 at once took over the temporary hospitals in the town, setting free the staffs of the field units to return to their own hospitals, while part of the staffs of Nos. 8 and 9 also assisted, the remainder being employed with the stores and equipment, which arrived at irregular intervals from the coast. The Langman Hospital (established on the cricket ground), the Irish and the Portland (both encamped in the vicinity of the town), were well found and complete, and their aid, although comparatively small, was both valuable and timely.

The arrival of these six units completed the detail of hospitals for Bloemfontein. The next stage was the enlargement of the general hospitals to cope with the demands for accommodation. This could only be done gradually, owing to the delay and difficulty in getting up marquees and equipment, as the pressure on the line was still great. Bell tents, however, were available in considerable number, and were utilised in the absence of the hospital marquees.

The equipment of No. 10 General Hospital helped considerably in the extension of the other two general hospitals. Most of its marquees were divided between them, but a few, with some equipment, were given to the field hospitals. The hospital trains continued to bring up stores and equipment on their journeys from the base.

In the middle of April a convalescent camp was opened to accommodate those cases who no longer needed actual treatment in hospital, but merely rest and food. By the beginning of May this was able to accommodate 500 cases, for whom extra food was issued. Towards the end of April a similar camp was arranged for at Norval's Pont, for which some bell tents were sent from Bloemfontein, the remainder and mattresses from the base. These two camps reduced the pressure on the hospitals, and made room for more important cases. Meanwhile arrangements were made to increase the accommodation on the line near Bloemfontein. In the middle of April half of No. 3 General Hospital at Rondebosch had been warned to be in readiness to move to the Free State; on the 28th the order for its departure was given, and it arrived at Springfontein (under Lieut.-Colonel A. H. Keogh) on the 5th May, took in some sick the following day, and received a convoy of 300 sick on the 11th.

In the end of April the Edinburgh Hospital was being established at Norval's Pont, where a small stationary hospital was also formed to replace the half of the 12th Brigade Field Hospital which had been stationed there to look after the local sick. The Edinburgh Hospital did not open until the middle of May.

At this time the personnel (excluding Officers, Civil Surgeons, and Sisters) of the three general hospitals in Bloemfontein consisted of warrant and non-commissioned officers of the Royal Army Medical Corps, specially enlisted men, St. John Ambulance Brigade, and the Militia Medical Staff Corps. Of the total half only belonged to the Royal Army Medical Corps. Of the remainder, more than half (one quarter of the whole personnel) belonged to the St. John Ambulance Brigade. This made a very material difference in the working of the hospitals; these men, though willing and interested in their work, were yet untrained; they were not only ignorant of the routine duties required of the Royal Army Medical Corps, but had little or no idea of what is required of a sick attendant, and the result was that the strain on the whole staff of the hospitals was much greater even than a bare statement of the number of cases under treatment implies.

The same, to a less degree, applies to the Officers. The civil surgeons of these units were fresh from England; those sent up from the base had little more experience, and as a consequence the small number of Officers of the Royal Army Medical Corps were heavily taxed in organising their hospitals.

During April supplies of every kind were being accumulated in the town. Rations were good and plentiful; fresh bread was issued regularly in place of biscuit. Stores of clothing and boots arrived and were issued, not before they were urgently required. Tents for the troops began to arrive on April 3rd, so that regular camps were formed in place of the temporary bivouacs.

As regards sanitation, a removal system was instituted immediately on arrival. By the camp order of March 16th, General Officers Commanding Divisions were directed to depute an Officer to arrange with the City Engineer for the construction of latrines, the provision of buckets, and the removal of night soil and refuse daily. The execution of this plan naturally took some little time, but the trench latrines, which of necessity had to be employed at first, were gradually replaced by the more satisfactory bucket latrines.

The water supply was a considerable difficulty during April. Soon after our arrival in Bloemfontein, a system of pipes had been laid down to supply the camps close to the town with the municipal supply from the waterworks. The Boers, however, regained possession of the waterworks on March 31st, and on April 3rd the supply was cut off. The waterworks came again into our hands on April 24th, but owing to the deficiency of some of the working parts of the pumps, the supply to the town was not resumed till May 10th. During this interval the force in occupation was of necessity reduced to the old supply from wells. One particular spring (Fontein), which was reputed to be of excellent quality (a condition which was justified by the appearance of the area feeding it), was opened out and fitted with a pump. This formed the main supply to the camps on the south of the town, but as no means of distributing the water existed, except by water-carts, its use was limited by considerations of distance, and, as a result, in many instances local supplies of indifferent character were used. In the outlying camps water was obtained under arrangements made by the Royal Engineers; the quality of these supplies varied very greatly. At Sussex Hill a bore hole was completed on April 16th, which gave a satisfactory supply, sufficient for the needs of the troops stationed there, and in the end of the month a bore hole was completed near the Willows, to the south of the town; the excellent supply so obtained was distributed through the mains laid down to the camps. But from April 3rd to 27th at the least, only those camps within a practicable distance of the particular spring referred to were supplied with water whose character was at all above suspicion, and in some other instances the quantity as well as the quality was below the mark.

Little could be done to purify these supplies. Fuel was scarce; even with wood cut locally there was not more than sufficient for cooking, no special issue for the boiling of water was practicable. Oil was scarce. Only a proportion of the units were in possession of the Berkefeld filter; they were systematically used only in the medical units.

The weather during March and the early part of April was bad; much rain fell, to the detriment of the health of the troops, for whom tents did not begin to arrive till April 3rd. As a result rheumatism and bowel troubles were prevalent.

P.—MOVEMENTS IN THE ORANGE FREE STATE.

During the halt at Bloemfontein there was considerable activity in Free State. On March 29th the action at Karee took place, where the 7th Division, some artillery, with three brigades of cavalry and some mounted infantry were engaged, with a considerable number of casualties, and subsequent to this, pending the advance, Glen Station and Karee were held by the 7th Division. Soon after our arrival in Bloemfontein a small column had been sent eastwards towards Thabanchu, which was occupied. In the end of the month Colonel Broadwood left Thabanchu to fall back on Bloemfontein,

and on the way was entrapped at Koorn Spruit, and suffered a heavy loss. The remainder of the Cavalry Division, the 9th Division, and the 13th Brigade (6th Division) moved out from Bloemfontein for his relief.

The 3rd Division had now its headquarters at Springfontein, while a detachment falling back from Dewetsdorp was attacked at Reddersburg. At Wepener a body of the Colonial Division was besieged from April 9th to the 25th.

In the third week in April the Colonial Division with Hart's Brigade were moving towards Wepener from the south. The 8th Division joined the 3rd near Reddersburg, and the combined force advanced towards Dewetsdorp, being engaged for three days at Constantia Farm on the way. The 11th Division, with the cavalry under Major-General French, advanced from Bloemfontein, and, after an engagement at Leeuwkop, joined the 3rd and 8th Divisions at Dewetsdorp.

Major-General Ian Hamilton left Bloemfontein on the 22nd with a force of mounted infantry for the waterworks, where he was joined by the 19th Brigade. The following day the waterworks were seized and occupied, the main body of the column advancing were engaged at Israels Poort on the 25th, and occupied Thabanchu the following day. There came the cavalry, the 8th and 11th Divisions, leaving the 3rd at Dewetsdorp. From Thabanchu, Hamilton marched north towards Winburg, and, after a brisk action at Houtnek, halted at Jacobsrust, where he was joined by the 2nd Cavalry and 21st Infantry Brigades. The whole moved on and occupied Winburg on May 5th, where the remainder of the 9th Division also arrived. The 8th Division remained at Thabanchu, while the cavalry and 11th Division returned to Bloemfontein to take part in the general advance.

The 8th Division arrived from England with its field units complete as regards number, though the personnel consisted mainly of untrained men with a small stiffening of the Royal Army Medical Corps. The original 17th Brigade Field Hospital was, however, taken for use with the 5th Brigade, 10th Division (as the 10th Divisional units had been detained in Natal), and its place was taken by the 8th Divisional Hospital, thus reducing the total with the division from three to two. The 3rd Division, in addition to No. 16 Field Hospital and the Cape Medical Staff Corps Bearer Company, had half a field hospital and bearer company of the New South Wales Army Medical Corps.

But the various brigades which left Bloemfontein had to take with them their field units or sections of them. This involved the evacuation of the field hospitals of these brigades, and additional pressure on those remaining in Bloemfontein.

The 12th Brigade moved across the Orange River at Norval's Pont between the 15th and 19th of March, and on the 20th advanced in two small columns through the southern part of the Free State by Fauresmith and Petrusburg; they arrived in Bloemfontein on April 4th, when the brigade rejoined the 6th Division.

In addition to the increase of the force in the field in the Free State, reinforcements were being pushed up to Bloemfontein, while a large body of troops was employed on the line between Karee and the Orange River, at Norval's Pont and Bethulie. That is, during April, the strength of the troops in the Free State increased to more than double the original strength at the time of the occupation at Bloemfontein. The wounded (in considerable number) from Karee and Koorn Spruit, from Constantia Farm, Leeuwkop, and Houtnek, all came sooner or later into Bloemfontein, while most of the sick from all parts of the Free State were also received in the hospitals in Bloemfontein. This formed a very material addition to the cases which originated in the town itself, and so even for this period it is extremely improbable that any true estimate of the actual sick rate of Bloemfontein itself can ever be formed.

Q.—PREPARATIONS FOR THE ADVANCE.

On May 3rd, the concentration of the central forces for the advance to Pretoria took place at Karee, while the wings extended from the west of the railway line as far east as Winburg. The force then consisted of the 2nd Cavalry Brigade, four brigades of mounted infantry, the 7th and 11th Divisions, and the 19th and 21st Brigades. The remainder of the Cavalry Division was ordered to concentrate at Brandfort some days later.

The mounted infantry brigades were provided with sections of the New South Wales Ambulance, light and mobile units; the Principal Medical Officer of the Mounted Infantry Division (under Major-General Ian Hamilton) was Colonel W. D. C. Williams, New South Wales Medical Corps. The 11th Division was formed in South Africa of the Guards and 18th Brigades. Each of these had been accompanied by its field units on its arrival in Bloemfontein, but it had not been possible to add a divisional hospital to them. The 21st Brigade was formed in Bloemfontein, and for its field units were found by taking those of the 4th Cavalry Brigade; these in turn were replaced by halves of the units with the 2nd Cavalry Brigade. Half units were found to be quite large enough for the cavalry brigades then in the field.

The remainder of the force had the field units assigned to them which had accompanied their brigades on the advance to Bloemfontein. But there was considerable difficulty in moving the field hospitals from Bloemfontein with their brigades, partly owing to the accumulation of sick in them, and partly to difficulties regarding transport.

On March 15th, Lord Roberts had directed that the transport of the field units should be made up to the original scale, the balance being sent up as opportunity offered. This, however, did not appear in Army Orders till April 30th. But owing to the fact that the transport, left behind when the army entered the Free State, had been utilised for other purposes while so diverted from its original employment, delay occurred in replacing it, and in some instances it never was replaced. Owing to the pressure on the line, some time elapsed before all the ambulances could be got up. Further, in some cases at least, though transport for the field units was issued to the brigade, it never reached the medical units, and delay occurred before a second issue could be made.

The 14th and 15th Brigade Field Hospitals were detained at Glen and Karee respectively, when their brigades marched off, as they were full of sick. The 14th Brigade Field Hospital was, however, rapidly evacuated, and sent by rail to Brandfort, from which it marched and joined its brigade on May 14th, while the 15th Brigade Field Hospital left to rejoin four days later. The greater part of the 19th Brigade Field Hospital was detained in Bloemfontein till May 25th, owing to want of transport, only a section going on with the brigade. The field hospital of the other brigade (Highland) of the 9th Division was also detained for the same reason. The corresponding bearer companies were given tents and equipment to enable them to act as field hospitals for about 50 sick. The 21st Brigade units were detained till May 8th, as the transport issued was taken over by the brigade, which marched off leaving its medical units to wait for a second issue, which took some days.

The Imperial Yeomanry Field Hospital and Bearer Company was detained in Bloemfontein ready to move, except for the want of mules. On the march northward this unit was captured by De Wet at Roodeval, where, however, it was able to render valuable assistance to the wounded in the engagement.

The result of this was, that although the divisions had nominally only two instead of the normal three field hospitals, several even of these were delayed considerably after the departure of their brigades; hence, there was a deficiency of field hospital accommodation with the moving force, at least as far as Kroonstadt. This led to difficulties, especially in convoy duties; there was no spare personnel, and the attendance on the sick transferred to the line for transport to Bloemfontein had to be cut down to a minimum. One of the 10th Division units (No. 17 Field Hospital), however, arrived from Natal, and was utilised on the line for the reception and transfer of convoys from the front. No. 17 Field Hospital arrived at East London from Durban in the first

week of May. From there it was railed to Brandfort, where half remained, while the other half went on to Sand River, at that time the railhead.

It was after the occupation of Bloemfontein, and the opening of the railway to the south, that the troops on the lines of communication began to assume that importance which afterwards became so marked a feature of the campaign. Posts were established at every railway station, every bridge, and even every important culvert for their protection; and, with the advance to Pretoria, the chain of posts behind the moving force lengthened, till in the later stages of the war it extended over the 3,000 miles of railway then in our possession and use. The scale of the medical establishment laid down in war establishments makes no provision for these troops, for whom local provision had to be made.

In addition to the force marching towards Pretoria under the direct command of Lord Roberts, there were four divisions operating in the Free State, besides two (the 3rd and 6th) held in reserve in Bloemfontein. Lord Methuen was advancing from the west to reach Kroonstadt in the end of May, the 8th and part of the 9th were moving upwards in the eastern part of the area, with the Colonial Division in their rear. As a result temporary arrangements had to be made all over the Free State for the accommodation of sick and wounded who could not be taken on with these columns. Some of these temporary hospitals were only used for a few days, others from small beginnings were enlarged and improved to become more or less permanent hospitals. Staffs for these temporary hospitals had to be formed by the divisional units, with such local assistance as was available, while later, assistance was sent from the railway line.

Additional hospital accommodation was also opened on the railway line itself. The section of No. 3 General Hospital ordered up from Rondebosch opened at Springfontein in the beginning of May, while the Edinburgh Hospital opened a week later at Norval's Pont, where a stationary hospital for the local sick had also been formed. Here, too, the convalescent camp opened during April was increased during May to accommodate 1,000 men under canvas, many of whom had to use grain bags filled with grass in lieu of mattresses, which could not be got up in sufficient numbers.

R.—BLOEMFONTEIN.

Reverting to the position of affairs in Bloemfontein at the time of the advance, the evacuation of the field hospitals increased the pressure on the general and other hospitals in the town, both by the increase of the number of sick to be dealt with, and by the withdrawal of their personnel who had been utilised in these hospitals. The necessity of the evacuation of the field units had been recognised from the first, hence the detail of the units which were sent in to Bloemfontein during the month of April. But the extraordinary sick rate which developed during that month surpassed anything that had been anticipated, led to very great pressure in the town hospitals, and the use of the field hospitals for purposes for which they were not suited, with the consequent hardship and suffering to the sick.

To meet the demands for personnel, as large a draft as could be obtained was sent up from the base, while the accommodation of each of the general hospitals was increased by the addition of tents, some being hospital marquees, and the remainder (forming the greater part of the increase) bell tents. It was arranged that the bell tents should only be used for the slighter or convalescent cases, for whom such accommodation would be sufficient, but owing to the pressure of work and the impossibility of proper supervision, resulting from the paucity of the trained staff of the Royal Army Medical Corps, no doubt certain exceptions to this general rule occurred.

The strain was probably greatest on No. 9 General Hospital. This unit was encamped close to the railway line, from which a siding ran into the hospital camp. This is an arrangement which, generally speaking, conduces greatly to the comfort of the sick transferred along the line, and one that was invariably adopted when possible. But when, as in Bloemfontein, several hospitals are situated in the same town, only one of which is easily accessible from the railway at all times of the day or night, it follows that that hospital will inevitably become a receiving station for the whole of the hospitals in the

town. Such was the case in Bloemfontein, and even with due intimation of the probable arrival of convoys, the work would have been difficult owing to the numbers to be dealt with. But in addition to these, which may be called the normal difficulties of the position, there were added others due to the condition of the railway, and it may be added, of the telegraph service. Medical Officers in charge of posts or convoys up the line were instructed to telegraph the numbers and probable time of arrival of the sick. Sometimes this telegram was not despatched; sometimes it was despatched, or at least handed in for despatch, and either did not arrive or arrived too late to be of any use. There was little certainty about the time of departure of a train; there was none about the time of its arrival, but a strong probability that any estimate would prove false. These difficulties were all inherent in the situation; there was great pressure on the railway, while its administrators were handicapped by a deficiency of rolling stock, and especially of engines, those which actually were working were only kept going with the greatest difficulty. In addition to its proportion of the convoys expected in Bloemfontein, this hospital had to receive all the cases which came in to Bloemfontein without intimation or at unexpected times.

For these reasons the staff of No. 9 General Hospital were tried above the others in this period of pressure; moreover, not only had they the distribution of the new arrivals, but they necessarily retained the more serious cases which could not be passed on. Between April 20th and July 27th, when the pressure had ceased, close on 7,800 cases were treated in this hospital, of whom approximately 1,800 were cases of enteric fever. During this period there were 275 deaths, of which 249 were due to enteric fever. No deaths occurred among the patients in the bell tents. These figures show how well the work of this unit was done under the difficulties described.

No. 8 General Hospital had its accommodation increased in the same way, but the proportion of hospital marquees was slightly higher. This unit was situated to the south of the town, on the open veldt, and at some distance from the railway station. The accommodation of No. 10 General Hospital was almost entirely in buildings, but a small addition was made by the use of tents pitched in the vicinity of the buildings, and later, a camp section was opened on the veldt to the south for slighter cases. Of the Civil Hospitals, the Langman had at one time 120 patients, and the Portland about 150, but the Irish Hospital never exceeded its original accommodation for 100, so that the assistance of these units, though welcome, was but a small item in the hospital arrangements at the time.

But, in spite of the additional accommodation the number of sick increased to a still greater extent, causing much over-crowding of the hospitals. The result of this was a strain on the whole staff, which it could barely stand, especially as so large a proportion was practically untrained. Nursing Sisters had been pushed up during April, until no more could be accommodated, and by the end of that month there were over 120 in the town. The energy and devotion of these ladies was beyond all praise; they never spared themselves while anything remained that could be done for the sick. Second only to them were the trained N.C. Officers and men of the Royal Army Medical Corps, who have not received that recognition which is their due; not only was their work such as would have involved a severe strain on a personnel composed entirely of trained men, but, as the case stood, the small trained staff had the supervision, and to some extent the instruction, of the emergency personnel thrown on their hands. The same thing applies to the Officers of the Royal Army Medical Corps, who were much under the minimum numbers required to work the hospitals satisfactorily.

With the exception of fresh milk, there was little difficulty as to supplies. These were sufficient, and, as a rule, of good quality. But the cooking for so many patients, with the limited staff and the appliances at first available, was not easily managed. Appliances for a hospital of 520 beds are not sufficient when the number is increased to a thousand, and it was some little time before additional ranges and cooking apparatus could be procured, while it took longer to replace the temporary kitchens by the more elaborate structures with every convenience which were erected a little later.

The same difficulty occurred with the other articles required for use in the hospitals, and, for the same reason, that sufficient for the normal accommodation was short of what was necessary for the enlarged hospitals. Nor was it possible to get the needed articles up rapidly from the base. It has already been pointed out that, up to April 17th, the supplies which came into Bloemfontein were practically sufficient only for the immediate necessities of the troops, and, between that date and the advance, the reserves of food and supplies required for the march to Pretoria had to be accumulated. For this reason the demands sent to the base in the end of April (when the pressure was increasing instead of diminishing as had been hoped) could not be complied with for some time. There is this further point that, as the general hospitals which had been established elsewhere were not put to the same severe test as those in Bloemfontein, the fact that certain articles (such, for example, as bed-pans and urinals) were not in sufficient numbers, had never before been brought to notice. These special deficiencies were made good as rapidly as possible. During May supplies began to come up more freely; between the 4th and 14th, 117 tons; and between the 16th and 29th, 297 tons of hospital supplies were brought up through the Ordnance Department, in addition to the supplies of purely medical stores, brought up by the hospital trains and by ordinary channels, so that towards the end of this month, the hospitals were well provided with all that was needed to cope with the large number of sick in them.

The British Red Cross Society, as in other places, rendered most valuable assistance in providing both necessities and luxuries for the patients in hospital and for those on the hospital trains. Colonel G. S. Ryerson, in charge of the Canadian Red Cross Society in South Africa, also afforded great assistance both here and in Kroonstadt, and was indefatigable in his efforts to help in any and every way.

As has already been stated, the actual admissions to the hospitals in Bloemfontein during the last week of April and the first week of May fell somewhat short of the total in the third week in April. But on the other hand, the number in hospital (as distinguished from fresh cases) in the last week of April was half as large again as in the previous week, an increase which was continued during the following week, but at a diminished rate. This difference was the result of the accumulation of serious cases in the general hospitals, which had received the sick transferred from the field hospitals which had left, or were about to leave, Bloemfontein, and in addition to this, transfers from the hospitals at Glen and Karee, from the force under Lord Roberts, and from the various forces to the east of the railway.

Taking the period of 20 weeks from March 16th to July 27th, when the sick rate had returned to more normal proportions, the continued fevers (enteric and simple continued fever) gave about one half of the total admissions to hospital, in the proportion of three cases of enteric fever to two of simple continued fever. This proportion, the average of the whole period, varied considerably; during the first eight weeks the proportion of cases returned as simple continued fever was greater than those returned as enteric fever, while during the remaining twelve the converse obtained. There is little doubt that there was an error in each of these periods; in the earlier portion the incidence of enteric fever was under estimated, while in the latter it was exaggerated. This is the experience in all similar epidemics; at first the slighter cases are not recognised, while later on the tendency is to describe all cases of fever as enteric.

It is probably safe to assume that all the cases of enteric fever which had been contracted on the march to Bloemfontein, were admitted to hospital by March 30th at the latest. In the first week in April the admissions for all continued fevers were practically the same as in the last week in March, while in the second week in April (13th) they showed a marked increase (nearly 50 per cent.), afterwards falling steadily to the first week in May (4th), which was lower than any of the previous five weeks. But in the weeks ending May 11th and 18th there was a sudden and steady rise to the absolute maximum throughout the period.

There is no doubt that the local conditions in Bloemfontein immediately after our entry were little, if at all, better than those existing during the march from Osfontein, while the troops were exhausted by the exertions and

privations they had undergone. That is, the men were unusually susceptible to disease just at the time when they arrived in an endemic area, while the force itself was generally infected. There is no doubt that the admissions between March 13th and the 30th should be separated into two classes; first, those cases contracted outside Bloemfontein, of which the numbers seeking admission would diminish towards the end of the month; and, second, those contracted in Bloemfontein, which would increase to the end of the month. That is, the cases contracted in Bloemfontein are responsible for the increase towards the end of March to a degree which was maintained during the first week of April. It was at this time that the waterworks were captured by the Boers, and the old system compulsorily used, and it is probable that this may account for the sudden increase during the week ending April 13th.

It is very probable that the diminution in the number of admissions between April 13th and May 11th is only apparent and not a real change. It was just at this time that a large proportion of the force had gone to the eastward of Bloemfontein, and the cases which contracted the disease in Bloemfontein were admitted into the field hospitals, and only appeared in the returns from Bloemfontein later as transfers. That is, while swelling the numbers under treatment, they did not appear among the fresh cases. For this reason it is highly probable that the number of cases actually contracted in Bloemfontein remained practically constant between April 13th and May 11th, on which dates the numbers admitted were almost identical. This, however, does not account for the further increase in the week ending May 18th, after which the epidemic began to decline rapidly.

After enteric fever had been prevalent in the large body of troops congregated in Bloemfontein for over a month, it is not surprising that a high rate of incidence should have obtained under the conditions then existing; but towards the end of April these conditions were improving in many ways. The weather was fine, getting cold at night, and especially in the early morning. Food supplies were good and plentiful. A bore-hole, opened on April 27th, supplied part of the force with good water. The camps of the 6th Division had been changed, while most of the other troops had been in the field and outside Bloemfontein for longer or shorter periods. The sanitary condition generally had also been materially improved. In the end of April a proportion of the force again concentrated in Bloemfontein prior to the advance, bringing in again a number of men worn out by fatigue and exposure, aggravated by the increasing cold during the night and early morning—and so more susceptible to disease. The intense desire of the men to go forward in the advance must also be remembered; those who felt ill hoped that their indisposition would prove temporary, and it was only when they felt themselves absolutely incapable of going on that they reported sick. These men came into the hospitals immediately before the advance; they fell sick on the march, and were railed back to Bloemfontein, where they were admitted into hospital. This probably explains the increase during the fortnight following the advance. The increase in the number of men fresh from England, many of whom were abroad for the first time, was probably also an important factor.

Reviewing the epidemic at Bloemfontein after an interval of three years, one must recognise what an important part military necessities and the fortunes of war play in the development of such outbreaks. Our experience there, and the further experience of the rest of the campaign, have strongly emphasised the fact that fatigue and privation are most important factors. On service, any control of these conditions, which of course are secondary to infection, is entirely out of the hands of the medical service, nor does it seem that any provision against them is possible, beyond the precautions which every wise commander will take which are consistent with his first object, the defeat of the enemy.

The importance of a pure water supply has been always recognised, but the history of the South African War has done nothing to solve the problem as to how this is to be obtained. The more the attack is extended—the more the individual becomes important in action—the less possible does it seem to maintain the connection between the pure source and the soldier.

There is no doubt that under such conditions as obtained on our entry into Bloemfontein, only the most scrupulous attention to all the details of regimental and camp sanitation could have prevented an outbreak of disease.

Indeed this applies to all war service; no recommendation, no matter by what authority, will be of any practical use so long as the execution in detail remains with the uninstructed soldier, whose instincts are to avoid all labour which is not evidently and immediately useful. The most hopeful line of development appears to lie in the instruction of every Officer and man in the elements of hygiene and camp sanitation. The senior Officers usually have some practical knowledge of what is required, and for their own sakes are anxious to keep their regiments as efficient as possible. But until the junior Officers (whose duty it is to see that these requirements are carried out) have some real knowledge of the subject, and are induced to believe that these matters are of vital importance, the details will always be slurred over, and the attempt will consequently fail.

No special sanitary staff can compensate for this want of real attention by the units themselves to the details of their sanitary arrangements. Inspection and report too often is late; it may prevent a recurrence for a time, but some mischief has already been done, which may have far-reaching consequences.

During the period of 20 weeks from March 16th to July 27th, there were 1,134 deaths in Bloemfontein, of which 964 or 85 per cent. were due to enteric fever. As regards enteric fever alone, the ratio of deaths to cases "admitted" to hospital was 19.4 per cent., and as a very large number of the cases were not "admitted," but "transferred," the true ratio of deaths to cases under treatment is considerably lower than this. The correct figures will be given in the Statistical Section.

S.—KROONSTADT.

Lord Roberts left Karee on May 3rd, and arrived at Kroonstadt on May 12th, after considerable opposition at Brandfort, Vet River, and Zand River. Fortunately there were comparatively few casualties, but, as has been mentioned, there were a considerable number of sick, who had to be sent back to Bloemfontein. From points on the railway, they were sent back in empty trucks; from places off the line, they were first brought in by empty supply wagons, and then removed by rail. Small hospitals were opened at Brandfort (staffed by part of No. 17 Field Hospital) at Vet River and Smaldeel, while the remaining half of No. 17 Field Hospital was established at Zand River.

The retreating Boers did all in their power to render the railway useless to us. In addition to the destruction of innumerable culverts and smaller bridges, important high-level bridges over the Modder River at Glen, the Vet and Zand Rivers, and that over the Valsch River, leading into Kroonstadt, had been blown up. All these rivers run between comparatively high banks of different slopes, those of the Valsch being certainly the steepest. Hence the approach to the temporary bridges was over a long deviation, creeping gently down to the level of the river bed, and climbing slowly up the opposite bank. The slope of the deviation was such that a heavy train required the assistance of a special "banking" engine to get up, and for this and other reasons traffic could only pass over slowly. As has already been mentioned, the rolling stock was by no means in good condition, and with these difficulties on the line, through traffic was conducted slowly.

Kroonstadt is 128 miles from Bloemfontein, on the right bank of the Valsch River, which forms a loop round the town. Above the town the banks are comparatively low, and with a gentle slope. Opposite the town a stratum of hard rock runs across the bed of the stream; the upper edge of this is somewhat higher than the remainder and forms a natural weir, which has been built up further to hold back the river, forming a deep pool from which only a comparatively small stream passes down. Below this weir the banks become higher and the river winds on in a deep defile which is crossed by the railway bridge.

The town itself is small, and consists mainly of small dwelling-houses of the usual type. There is a large church, a town hall, and some three hotels, of which the Grand and the Kroonstadt Hotel were used as hospitals. Besides these, there are a few comparatively large stores, but the whole town is much smaller and less prosperous than Bloemfontein.

The water supply was from two sources: the main supply was drawn from the river by pumping from the pool formed above the natural weir; there were also a few wells. The supply from the river was very bad. The town stands on the right bank on a gentle but steady slope which begins above the railway line, and continues around and through the town to end on the banks of the river above and below the weir, and, consequently a great part of the natural drainage of this area passes into this pool, and most of it enters above the pumping station. The area to the north of the town below the railway line (which was occupied by A.S.C. and other depôts) shows the natural drainage channels very well marked in shallow dongas and spruits; these, as usual, had been used as latrines by the native population. Altogether, the conditions were exceptionally bad in this respect. The few wells were of the usual type, shallow, and imperfectly, or not, protected.

On our arrival on May 12th, the only hospital found in the town was the Russo-Dutch Ambulance, which was established in the school-house and some adjoining cottages. The staff placed their beds at our disposal, and to these others were added and kept open till the pressure ceased. But, with this exception, the force had again to depend on the field units, of which the 14th Brigade Field Hospital was then on the way to rejoin its brigade, while the 15th Brigade Field Hospital was still detained at Karee. With these exceptions (apart from the divisional hospitals) the field units of the central column were complete.

The first houses appropriated for hospitals were the Kroonstadt Hotel and the Town Hall, and every effort was made to equip these buildings from the scanty resources of the town. Many articles were purchased in the shops, and a large number of beds and mattresses were commandeered. The hotel had a number of comfortable bedrooms fully furnished; these were appropriated for sick Officers, and the men were placed on beds or mattresses in the public rooms. The hotel cook and some Kaffir boys were engaged, and these proved of great assistance. On May 15th there were 16 sick Officers and 127 men under treatment in the hotel.

The Town Hall contained 90 sick on May 16th. This building proved unsuitable, as it was impossible to make proper latrine arrangements or to set up a kitchen. It was therefore vacated on May 20th by transferring all its sick to the Dutch Church. This latter was a plain, oblong building, very lofty, and with an excellent wooden floor. It was situated in a large, clean, enclosed piece of ground, which proved an excellent site for the erection of tents. There was accommodation in the body of the church for about 100 sick, and in the tents for 200 more. The more serious cases were on beds or mattresses in the church, and the trivial cases were in the tents.

The 18th Brigade Field Hospital, under Major R. W. Ford, was brought into the town and put in charge of these temporary hospitals. Some additional personnel was borrowed from the other field units, and, with regimental orderlies, formed the temporary staff. A local practitioner was engaged and employed on sanitary duties, as the general condition was very bad, and an additional Officer of the R.A.M.C. was detailed to assist in the hospitals. Major Ford bought cooking appliances in the town and established field kitchens close to the church. There was an ample supply of tinned milk, beef-tea, and other medical comforts.

The troops on their arrival in Kroonstadt were more or less exhausted by the hardships endured on the advance, and daily contributed a large number of sick (many of them cases of enteric fever), and men unable to continue to march. Sick convoys left almost daily for Railhead in empty supply wagons. The sick for these convoys were carefully selected, and serious cases were not sent. By this means over-crowding was avoided, and it was not till the day before the advance to Pretoria that any over-crowding occurred.

In anticipation of this advance the evacuation of the field hospitals had been ordered, and arrangements had been made to send a convoy of 200 back to Railhead on the 21st, but at the last moment the expected wagons did not arrive, and the sick had to be accommodated in the hospitals in the town. More accommodation was urgently needed, and could only be found by taking the Grand Hotel, of which Dr. Manning was put in charge. This

hotel, which had up till then been only used for sick Officers, had to be utilised to the utmost extent, and the sick were accommodated in all the public rooms. The total number of sick on that date was 640, distributed in the two hotels, in the Dutch Church, and in the Russo-Dutch Ambulance. By this time all the available beds and bedding had been taken up, none remained for this unexpected addition, and much discomfort resulted to the sick.

The force left Kroonstadt on May 22nd, and on May 23rd 60 men, simply unable to march, were transferred to the Rest Camp; on the 24th the Grand Hotel was cleared of all except the Officers by moving the sick to the other hospitals.

The Russo-Dutch Hospital had a few nurses, and some R.A.M.C. and regimental orderlies were detailed to assist in this hospital. Stimulants and medical comforts were supplied to it from the stores accumulated at the Kroonstadt Hotel, as they had none.

At all the buildings used as hospitals, additional latrine accommodation had to be provided, and a removal system instituted. A medical store, partly supplied by local purchases, was established at the Kroonstadt Hotel, in addition to the store of supplies already mentioned. After the first two days, a fairly large supply of fresh milk was obtained, sufficient for the worst cases; the remainder had to use tinned milk.

On May 25th the first train arrived, bringing part of the Staff of the Scottish National Red Cross Hospital, 15 Nursing Sisters (including five Australian Sisters), and 30 Cape Medical Staff Corps.

The Scottish National Red Cross Hospital came out in three sections. This, the first section, consisting of 7 Medical Officers, 7 Sisters, 19 Dressers, and 25 N.C. Officers and men, arrived in Cape Town on May 13th, and was ordered to Kroonstadt, and the advance party, consisting of 5 Medical Officers, 6 Dressers, and 7 Sisters, went on at once. On this day, also, Major Macdonald with a small party of N.C. Officers and men arrived from Lindley with a sick convoy, and the whole party were detailed for duty in the church.

The Kroonstadt Hotel was handed over to the Staff of the Scottish National Red Cross Hospital. The Nursing Sisters were distributed in the two hotels and in the Dutch Church, and the 30 Cape Medical Staff Corps were all detailed to serve under the Staff of the Scottish Hospital at the Kroonstadt Hotel. This relieved the situation, and further, on inspection of the hospitals on May 25th, 1900, it was found that about 300 of the sick were suffering from such trivial ailments as sore feet, or were simply tired, and were unable to continue in the advance. These were all sent by train to the various hospitals on the lines of communication, which made a very great difference to the hospitals in Kroonstadt.

On the 27th No. 3 General Hospital and the remaining personnel and equipment of the Scottish National Red Cross Hospital arrived. A portion of the staff of the general hospital took charge of the Dutch Church and the Grand Hotel. At the same time the establishing of the General Hospital and of the Scottish National Red Cross Hospital was vigorously pressed forwards. The former had 200 beds ready in camp on May 28th, and received a number of sick and wounded sent in by the 1st Division. On June 4th this hospital had 400 beds equipped in camp, and the Scottish National Red Cross had 100. A convalescent camp for 600 men was established close to the General Hospital.

From this date there was no pressure in Kroonstadt. Convoys were coming in from all sides, but at the same time steady evacuation to the hospitals at Bloemfontein and Springfontein was maintained, at times it is true, with difficulty as De Wet's most active period on the line ensued; indeed No. 3 General Hospital at Kroonstadt was provided with a large bomb-proof shelter in a donga to the south of the hospital.

During the period from May 13th to 25th about 1,000 sick and wounded passed through the four Kroonstadt hospitals. About half of these suffered from ailments of a trivial nature, such as sore feet or temporary exhaustion, and only required rest and food.

No. 3 General Hospital (Lieut.-Colonel O. Wood, C.B., since deceased) was ordered to be in readiness to leave Rondebosch on May 8th, and the act 1 order to move was given on May 15th. The hospital left Cape Town on May 20th and received patients in Kroonstadt on May 28th—a most

creditable performance. Its services were no longer necessary at the base owing to the increased accommodation on the line at Springfontein, Naauwpoort, Norval's Pont, and Deelfontein.

When the original estimate of the requirements of Kroonstadt was made, in addition to the two hospitals which actually went there (No. 3 General and the Scottish Hospital), the Imperial Yeomanry hospital authorities in South Africa had been asked to detach 250 beds with the necessary personnel and equipment for service in Kroonstadt. This request was opposed by the staff at Deelfontein on the ground that it would lessen the importance of that hospital, and as a result more work was thrown on the two large hospitals in Kroonstadt than was originally intended. No. 3 General Hospital was enlarged, and the staff of the 1st Section of the Scottish Hospital also assisted by opening as many beds as possible prior to the arrival of their other section.

T.—JOHANNESBURG.

The force under Lord Roberts left Kroonstadt on May 22nd and advanced along the railway line, crossing the Vaal at Viljoen's Drift on May 26th and 27th. Major-General Ian Hamilton supported him on the east, advancing through Heilbron to cross to the west on the north side of the Vaal, where too Major-General French was operating. Here, at Doornkop, on May 29th the Cavalry and 19th and 21st Brigades were engaged and had a good many casualties. After a slight engagement at Germiston the whole force arrived before Johannesburg on the 30th and the town was entered on the following day.

With the exception of the section of the 18th Brigade Field Hospital which remained in Kroonstadt in charge of the temporary hospitals, the field units accompanied their brigades; a mobile section of the Irish Hospital had joined the 11th Division at Kroonstadt, where the 14th Brigade Field Hospital had rejoined its brigade. The condition of these units was better; they had been picking up additional transport as it became available on the way. The 21st Brigade and the Highland Brigade Field Hospitals had also joined their brigades.

As on the march between Bloemfontein and Kroonstadt, so here, the work of the field units was chiefly with sick and exhausted men who were sent back by rail to Kroonstadt and Bloemfontein.

A small hospital was opened at Heilbron by the 21st Brigade Field Hospital, where the sick of the 19th and 21st Brigades were left behind when the column advanced, and posts were established along the railway line.

On our entry into Johannesburg the large and well-equipped civil hospital gave us some 350 beds. The Victoria Hotel gave accommodation for 195 sick. As the 15th Brigade was detailed to garrison Johannesburg, its bearer company was employed in staffing this temporary hospital, for which also nurses were engaged in Johannesburg. The 15th Brigade Field Hospital arrived on June 3rd, and was also available for duty in this and the other buildings which were utilised. These were: the Jewish School and Ambulance giving 114 beds; the Masonic Hall (100 beds), and the Wesleyan Chapel with 50 beds. Of these the Victoria Hotel and the Jewish School were not satisfactory, and were closed as soon as other arrangements could be made. A small French hospital organised during the war was in existence on our entry. They had treated a few Officers and men who were prisoners before our entry.

The Jewish ambulance had been left at Germiston after the engagement there, and proved useful in bringing in cases to the town. This unit had been formed and equipped by Mr. Aaron, a resident of Johannesburg, who rendered us very great assistance in various ways during the early period of the occupation of that town. These arrangements sufficed for the immediate requirements of the garrison, pending the arrival of the general hospitals.

On June 3rd the cavalry advanced to the westward, and, with some few casualties, arrived to the north of Pretoria on the 4th. Meanwhile Major-General Ian Hamilton had been advancing to the left of the railway line, while Lord Roberts' column followed the railway, and after some considerable resistance, causing a good many casualties, established themselves outside Pretoria on the evening of June 4th, and the town was entered the following day.

U.—PRETORIA.

After its occupation in June, 1900, for two years Pretoria continued to be a most important centre. Situated as it is at the junction of three lines of railway, to the south (through Natal, the Orange River, and Cape Colonies), to Delagoa Bay on the east, and Pietersburg on the north, it formed not only a base for many important operations, but a centre through which every column of the many operating in the Transvaal passed at one time or another in the kaleidoscopic changes which were perpetually occurring. Here, too, gravitated all the cases from the outlying hospitals of the Eastern and Northern Transvaal, as well as from the Rustenburg Valley.

Second only in importance to Pretoria were the centres at Elandsfontein and Johannesburg, drawing from the areas commanded by the railway from Elandsfontein to Charlestown and to Springs, from Johannesburg to Potchefstroom and Klerksdorp, as well as the short stretch to the Vaal at Vereeniging, and beyond to Wolvehoek. Thus the most extensive hospital accommodation in the Transvaal had to be provided at these places, and of these Pretoria was the largest. It therefore merits some detailed description.

Pretoria stands at an elevation of 4,471 feet above the sea, more than 1,000 feet below Elandsfontein, and with the slopes on which it stands facing the north, so that both conditions help to make the climate hotter. The distances from the coast are as follows:—To Cape Town, 1,040 miles; Port Elizabeth, 740 miles; East London, 692 miles; through Natal to Durban, 511 miles; east to Delagoa Bay is 349 miles, with 283 miles to Barberton and 75 miles to Middelburg. The terminus of the northern line, Pietersburg, is 180 miles distant.

The average rainfall is about 26 inches, which falls almost entirely during the summer months. The mean maximum temperature for the three summer months is 89°, and the mean minimum for the three winter months is 42°. The summer climate in the town is certainly hot and unpleasant; one particularly notices this on descending into the valley from Elandsfontein. But as soon as one gets out of the hollow in which the town itself stands, the climate is not unbearable even at its worst, and where the large hospitals were situated, to the east, it was usually pleasant, generally with a slight breeze blowing.

During the hot weather there are frequent and severe thunderstorms, often preceded by a dust storm, which at times is very severe. The rain drains off, and is absorbed rapidly, and the soil being easily pulverised forms the usual fine penetrating dust. Dust is prevalent more or less throughout the year; in the colder months when the winds are gentler, less frequent and more parallel to the earth's surface, the lower strata of the air seem to get full of dust raised by traffic, and carried up by the ascending currents from the sun-heated soil. This may remain as a cloud for some days till a stronger breeze sweeps it away. It is in the hot weather that the winds seem to blow at a greater angle with the surface, and so actually and violently lift the dust up to form the dense opacity of the dust storm.

Pretoria had the reputation of being an unhealthy place; "fevers" were said to be prevalent. But of late years much had been done to improve the sanitary condition, and in many respects it compares favourably with the other older towns of South Africa.

Like most South African towns, it lies in a hollow, for convenience of water supply. But in this case it would be more correct to describe the site as in a trough between two parallel ridges which run nearly east and west. The southern ridge between Klapperkop and Schanzkop is cut across by a small stream, along whose side a railway line enters Pretoria; this falls into a larger stream, the Aapies River, which rises among the hills to the south of the town, flows between the ridges, and finally, after it has been joined by the stream just mentioned, passes through the northern ridge at Daspoort, crosses the outer valley, and cuts through the Magaliesberg range at Wonderboon. The result is, that while the lateral slopes of the Pretoria Valley are steep, the gradient from the level of these streams east and west is comparatively slight; indeed, to the west the rise is very gradual, towards the east the slope is more abrupt, and it was on the top of this, to the east of the Delagoa Bay railway line, that the large general hospitals were established.

The municipal water supply of Pretoria is beyond suspicion; it comes from a water-bearing stratum to the east of the railway line beyond Klapperkop. The actual source is covered in, and from this point the water is brought into the town in pipes. There is no means of purification; none is required, as repeated analyses, both chemical and bacteriological, have shown it to be of first-rate quality. The collecting area is uninhabited, and no possible source of contamination exists at the source. The supply is ample—in fact, part of the yield is not impounded, and, with a comparatively large quantity from the same stratum on the opposite side of the valley, forms the main source of the stream already referred to. The source, however, is comparatively low, and, though the town is satisfactorily supplied by gravitation, it was found necessary to establish a reservoir and pumping station half way up the eastern slope for the supply of the hospitals on its summit.

There is a system of surface drains along the main streets in the lower part of the town, through which a current of water is sent at intervals during the day; this comes from the stream alongside the railway, and drains into the Aapies River. This water is, of course, not pure. These drains, besides being used for irrigation, are supposed to carry off storm water, but are not intended for other purposes. It goes without saying that they are used for other purposes; slop water and worse find their way into these drains, while the water flowing through them is taken for washing various utensils. This happens universally where such supplies occur. There are shallow wells scattered through the town, which as usual are hardly protected. Thus, in spite of the pure water supply from municipal sources, there is every means for the propagation of water-borne disease.

A pail system is in force for the removal of excreta. It is probably not more unsatisfactory than usual, except that the warmer the climate the more obvious the defects of this system. The material is disposed of on a sanitary farm to the west of the town.

The town itself is well laid out on the usual Dutch rectangular plan. The older part is that nearest to the river, and the lowest; this is surrounded by the more modern villas which now stretch up the sides of the basin. To the north-west are the Kaffir locations, highly insanitary; on the west are the Staats Artillerie Barracks, the Volks Hospital and the Asylum, while still further west is the Leper Hospital, beyond the Sanitary farm. In the middle of the older part stands the Palace of Justice, a magnificent building, while some half mile away stand three schools. The Artillery Barracks, the Palace of Justice, and the schools, were used by us as hospitals, while an adjacent building was used temporarily, and the Volks Hospital gave us some forty beds.

Six forts existed round Pretoria, five on the summit of the ridges north and south of the town, with one at the extreme east of the valley. These were all garrisoned by us, and, in addition, numerous redoubts were built along the various ridges, and, later, blockhouses were established at a large number of points. Camps were laid out to the west and north (beyond Daspoort) of the town, and in the end the perimeter covered by our outposts, and the area within this occupied by troops from time to time, became very great. In addition to the garrison of Pretoria, which was a large one, there was a large floating population—columns concentrating prior to moving out, columns coming in to refit, drafts and reinforcements from the coast, convoys and remounts—so that movements of some kind were constantly going on, with the inevitable sequence, a large number of cases for treatment.

These are the conditions which had to be met during the next two years: the following section shows the growth of the provision for dealing with them.

On our entry the following hospitals were found in working order, each contained some of our own men:—

(1) The Volks (Civil) Hospital, to the west of the town and close to the Artillery Barracks. This contained about 70 beds, of which 20 were occupied by our men. It was a fairly good hospital with an adequate staff of Nurses and subordinates. An Officer of the Royal Army Medical Corps was put in charge, with some personnel to assist in the work. Forty beds were retained for the troops, the remainder were set apart for the needs of the civil population.

(2) The Bourke Hospital had been established and maintained by a Mr. Bourke (a resident of Pretoria) at his own expense. It was originally intended for the Boer sick and wounded, but sick Officers from among the British prisoners of war had been treated in it, and a few remained when we arrived in Pretoria. It was a long one-storied building, containing a number of small rooms, and could accommodate some 50 cases.

(3) The Racecourse Hospital had been established by the Boer Government for the treatment of the sick prisoners of war, and on June 5th there were 100 patients under treatment. Assistant-Surgeon De Santos, of the Indian Medical Department, was in charge; he had been taken prisoner at Dundee and brought to Pretoria, where he offered his services for the care of the sick prisoners, and was placed in charge, while a number of the prisoners were detailed as orderlies to assist him. He did excellent service. There was one good ward in the pavilion which would accommodate about 50 cases. The rest of the accommodation was not good, part was under canvas, while the loose boxes had also been used, and were less objectionable than seems possible.

An Officer of the Royal Army Medical Corps with a small staff was placed in charge of the Bourke Hospital, while the 14th Brigade Bearer Company took over the Racecourse Hospital, and was assisted for a time by the 14th Brigade Field Hospital, and, latterly, by half the 18th Brigade Field Hospital, pitched in its vicinity.

(4) The German Ambulance had about 20 of our men among its sick. It closed up soon after the entry into Pretoria, and left for Europe.

(5) The Dutch Ambulance was in the Girls' School, known as No. 3 Model School. In it were 15 of our men. This ambulance remained in Pretoria till August, when its staff left for Europe after selling its stores and equipment to the Imperial Government.

This accommodation was insufficient, and steps were taken at once to equip suitable buildings for use as hospitals. No. 1 Model (Boys) School, a one-storied building (which had been used for the British Officers, prisoners of war), and No. 2 Model (Girls) School, a fine two-storied building, were equipped by local purchases. Additional outbuildings for latrines, kitchens, &c., had to be erected for these buildings. The Artillery Barracks were equipped with the necessary furniture (bought or commandeered) for use as a hospital, while additional equipment was obtained in the same way for the Bourke and the Racecourse Hospitals.

The money spent in local purchases in the equipment of these temporary hospitals amounted to about £15,000. The resulting accommodation, about 1,000 beds, was distributed as follows:—

Artillery Barracks	...	...	...	...	300 beds.
No. 1 School	...	...	...	...	150 „
No. 2 School	...	...	...	...	210 „
Bourke Hospital	...	...	...	...	50 „
Racecourse Hospital	...	...	...	...	250 „
Volks Hospital	...	...	...	...	40 „
				<hr/>	
				1,000	„

The 14th Brigade Field Hospital took over the Artillery Barracks, and from it an Officer (Major Cummins) was detached with some personnel to take charge of No. 1 Model School. "C" Company, Cape Medical Staff Corps, under Surgeon-Captain Temple Smyth, was placed in charge of No. 2 Model School. The detail for the other hospitals has already been mentioned.

In addition to the hospitals in Pretoria on our entry, there was another at Waterval North (about 20 miles from Pretoria on the northern line) where the large camp for the prisoners of war had been formed. This hospital of 200 beds had been established by the Boer Government, and was latterly under the charge of Dr. Von Gernet, of Pretoria. This arrangement was continued temporarily.

It had, of course, been obvious that hospital accommodation, in addition to any local arrangements, would be needed in the Transvaal as soon as we

occupied Johannesburg and Pretoria, but with the small force in and around Johannesburg as compared with that in Pretoria, it was evident that the latter had to be first arranged for. The difficulties in the line were increasing in proportion to the length in our possession. Every mile that came into our hands added to the repairs required, while the engines were getting into worse condition. Supplies of all kinds were still needed in large quantity, and till the opening of the Natal line on July 6th, there was great congestion over the 1,000 miles of single line between Elandsfontein and Cape Town, which made the transport of the bulky equipment of a general hospital a matter of some difficulty.

On May 21st orders had been issued for half of No. 2 General Hospital (Colonel A. W. Duke) at Wynberg to be ready to move to the Transvaal, and on the 26th the second half was also warned. Sanction for the move was obtained on May 28th, with the proviso that it should not leave until it could run through to the Transvaal without detraining. The first section was packed and ready to start by May 31st, and by June 2nd the whole personnel had started from Cape Town for the Transvaal. Owing to blocks on the line the personnel was detained at Bloemfontein from June 3rd to 21st, during which time a party under Major Lougheed was sent to Zand River to assist with the wounded in the fight there of the 14th, while the remainder were attached to No. 9 General Hospital. The whole personnel leaving Bloemfontein on the 21st were detained again at Kroonstadt till the 29th, and part reached Pretoria on the following day, the remainder arriving two days later.

The equipment of the first section was loaded up before the personnel left Cape Town, but in its transit to the Transvaal trucks got dropped here and there; the first got to Pretoria on July 5th, and by July 19th only 12 trucks (of 18 which left Cape Town on June 6th) had arrived.

No. 3 Advanced Depot of Medical Stores at De Aar was warned in the end of May to be ready to move up, and on July 8th it received orders to move to Pretoria, where, after some little delay on the line, it was established in two small houses close to the railway station.

The main factor in the delay of both the personnel and equipment of this hospital was the extreme activity of Christian De Wet on the railway line. On June 7th he attacked the 4th Derbyshire at Rhenoster Kopje and captured a train of mails and supplies at Roodeval two miles further south. Following this, both Rhenoster and Roodeval bridges were blown up, much of the line itself and the telegraph destroyed. On the 14th he attacked the construction party at Zand River, but was repulsed. In addition to these larger efforts, he succeeded in cutting the line at various points between Kroonstadt and the Vaal. Little wonder then that the traffic was disorganised, and the hospital stores again detained in favour of supplies when it became possible to send these on.

With the knowledge that assistance from the outside was delayed, more had to be done locally. About the middle of June the Military Governor of Pretoria formed a medical committee, of which some of the members had local knowledge. This body made large purchases, furnished the Palace of Justice as a hospital, and supplied additional equipment to the other hospitals. But here, as elsewhere, there was some overlapping, and at least one Commanding Officer of a unit who endeavoured to buy for himself, found that the available stock had been already taken up by this committee, and that his individual efforts were thus rendered nugatory.

The Palace of Justice was handed over to the Irish Hospital on June 21st; this gave an additional 450 beds, making the total accommodation close on 1,500. The personnel of the Irish Hospital was, however, insufficient for so large a charge, and had to be added to from the military hospitals.

Thirty Nursing Sisters arrived with the personnel of No. 2 General Hospital, and were distributed to the various hospitals in Pretoria.

The site chosen for No. 2 General Hospital was a very good one. It was on the high ground to the east of the town, and on the Delagoa Bay line, by which communication was obtained directly with all three railway lines running out of Pretoria. Water was laid on from the pumping station already spoken of, the necessary buildings commenced, and, as part of the equipment arrived by the middle of July, the hospital was opened for the

reception of sick by the 17th. This made a very great change for the better in Pretoria, the pressure was relieved, and from this date the development of the hospital system in the Transvaal proceeded regularly.

Although the arrangements for the improvement of the hospital accommodation in Johannesburg were commenced early in July, it is more convenient to complete the description of the medical arrangements in Pretoria at once.

Colonel W. L. Gubbins, R.A.M.C. (formerly P.M.O. 6th Division), was appointed P.M.O. of Pretoria and the northern line of communications.

No. 2 General Hospital, opening on July 17th, had 450 beds ready before the end of the month; this number was increased to over 600 in August, and, by a steady growth, the total accommodation in this hospital reached 1,000 beds in November, at which point it remained till March, 1901, when a diminution in the demands for accommodation enabled the number to be somewhat reduced. While the accommodation was being increased the general arrangement of the hospital camp was considerably improved; very excellent wood and iron buildings for offices and stores, operating and X-ray rooms, kitchens and latrines were erected, while the actual sick accommodation was provided in the hospital marquees, to which were added the very satisfactory Indian pattern "European Privates" tent. A separate Officers' section, composed entirely of these tents, was opened on the north side of the camp, while behind the whole was a large encampment for the Nursing Sisters. The hospital was supplied with electric light, for which an engine and dynamo were established.

The ground on which the camp was laid out was at some distance from the slope of a small kopje to the south, in addition, it was slightly cupped in the centre, but an extensive system of surface drains was made which kept the actual camp dry in the wettest weather.

Three important adjuncts were at first under charge of No. 2 General Hospital, the Infectious Hospital, the Sisters' Hospital, and the Convalescent Camp. The Infectious Hospital was established on an elevation about half a mile from the boundary of the Hospital Camp. A small building gave accommodation for stores and reserve equipment, but the sick accommodation was under canvas.

The Sisters' Hospital was established in a very excellent villa, with a good garden, on the road leading up to the Hospital Camp.

The Convalescent Camp, opened early in August, was laid out on the lower slopes of the kopje to the south of the Hospital Camp. Accommodation for 500 men was provided in Indian pattern service tents, each of which accommodated six men on mattresses. In addition to the ordinary ration, the Officer in charge had power to order various additional articles of diet for those who required them. An Officer from the staff of No. 2 General Hospital was in sole charge of this camp, for which the medical authorities were entirely responsible.

A platform was made on the side of the railway just outside No. 2 General Hospital, and a party met every train of any description that passed along the line towards Pretoria, so that any cases sent in from along the eastern line were immediately taken care of.

Two of the smaller Civil Hospitals were ordered up to Pretoria. As there was no longer any need for its assistance in Bloemfontein, the Langman Hospital was ordered from that town on July 21st, and having arrived in Pretoria, it was established to the north of No. 2 General Hospital; its accommodation was increased to 150 beds by the supply of additional tents and equipment, and it opened to receive sick on August 2nd. The Welsh Hospital, then at Springfontein, was ordered to Pretoria on August 4th, where it was established alongside No. 2 General Hospital, to which it was attached. The accommodation was increased to 200 beds, and this hospital opened to receive sick again on August 11th.

A small rest hospital of 12 beds was established in two small houses close to the railway station, and adjoining the Medical Store Depot, and opened in the end of July. This not only provided immediate assistance for cases of sickness coming in unexpectedly by rail, but it provided rest and refreshment for the very numerous small parties or individuals who, without this, would have had no assistance. It formed a most valuable auxiliary to the regular

hospital service, as the conditions under which all three railways were working rendered it quite impossible to know when trains carrying sick might arrive. The staff of the rest hospital met all trains on arrival, and were then enabled to deal at once with any cases requiring assistance, while the other hospitals could be warned, and ambulance or stretcher carriage called for by telephone at once. Much delay and consequent discomfort was saved in this way.

During the last week in July also, the hospital in the Artillery Barracks was closed, and the sick transferred to No. 2 General Hospital. This building was not satisfactory for prolonged occupation. The Racecourse Hospital was also partially evacuated, only one ward (in the pavilion) was retained for the use of the troops in the immediate vicinity. No. 2 General Hospital received the sick transferred from this hospital also. The Bourke Hospital was also closed.

When No. 3 Model School was vacated by the Dutch Ambulance it was occupied by a party detached from the Imperial Yeomanry Field Hospital under Mr. Openshaw, F.R.C.S. This gentleman, with some slight assistance, thoroughly overhauled the buildings, and converted dirty rooms into clean and well kept wards. This building afforded accommodation for 160 sick. Part was used as an Officer's hospital, for which it was well suited. The three schools (which were all close together) were at a later date amalgamated into one unit known as No. 19 General Hospital.

Towards the end of June it had been pointed out to the Imperial Yeomanry Hospitals Committee that, if the war continued, another yeomanry hospital, lightly equipped for 400 beds, would be required for the Transvaal. In response to this a hospital was organised, part of which sailed on June 30th, the remainder on July 7th, by mail, arriving in Cape Town in due course. The hospital was ordered up to Pretoria, where a large private house to the east of the town, standing in extensive grounds, had been secured for its use. The house was principally used for Officers, but there was ample room in the grounds for tentage. Much of the equipment was obtained locally—from army stores and elsewhere—as it had been specially asked that the hospital should be lightly equipped. The hospital opened to receive sick in the third week in August.

The periods for which the civil hospitals had offered their services were now drawing to a close. The Irish Hospital in the Palace of Justice ceased to receive sick on September 30th, and handed over the remaining cases to a military staff on October 15th on leaving for England. The Langman Hospital ceased to exist as a civil hospital on November 4th, and the Welsh Hospital on November 15th, on which date the equipment of these units was very generously handed over by the organisers to the Imperial Government, and a military personnel relieved the original staff of the care of the sick in them.

The Palace of Justice was never entirely satisfactory as a hospital, mainly owing to its construction and position in the heart of the town, and these defects became more prominent with the passing off of the cold season. It was therefore decided to give it up, and it was closed early in November. The accommodation, however, could not be spared, and the necessity was met by ordering up No. 7 General Hospital from Estcourt, Natal, where it was no longer needed, to Pretoria.

No. 7 General rendered its last sick returns at Estcourt on October 26th, and its first in Pretoria on November 9th, so that but little time was lost in the closing, transfer, and re-opening of this hospital. No better site could have been found for it than that actually occupied to the north-east of No. 2 General Hospital, where, although irregularities of the surface made the hospital camp less satisfactory to the eye than that of No. 2 General Hospital, the site was in practice somewhat better, as the natural drainage was good. The number of beds was increased from the normal establishment of 520 to 692. This hospital also was lighted by electricity generated in the camp. The accessory buildings were brought up from Natal with the rest of the equipment. A special siding was made here for the hospital trains alongside the main line, so that they could be loaded or unloaded with the greatest ease, where also the trains could lie in the interval between their journeys.

In this way there came to be a very large hospital camp in the curve of the Delagoa Bay railway, stretching from No. 7 General Hospital on the

north to the Convalescent Camp on the south. The whole, known as the Howitzer Camp, remained with some modifications till after the end of the war, and as time went on many minor improvements were made. Of these, the most important was the replacing of the marquees and E.P. tents of No. 7 by wood and iron huts. These had been sent out from England in sections for the use of the troops, and were used for this hospital, as it had been decided that it should remain till the permanent hospital for the garrison of Pretoria had been completed.

When the development of the hospital arrangements in Pretoria were complete, there were 2,700 beds available in all.

Reverting to the position in Johannesburg after our entry, which has already been referred to, the arrangements then made were only temporary, till it became possible to bring up a general hospital. In the beginning of July, half of No. 6 General Hospital at Naauwpoort (Lieut.-Colonel B. W. Somerville Large) was warned to be ready to move to Johannesburg with forty marquees and light equipment, as the whole hospital was no longer needed at Naauwpoort. The hospital arrived in Johannesburg on July 19th and opened a few days later in the Wanderers' Club grounds, near the station. Only two trucks of equipment were sent up with the unit, more followed later, and much was purchased in the town. The hospital gradually developed into a very complete unit, having at one time accommodation for 1,000 cases.

No. 2 Stationary Hospital was ordered from East London to Kroonstadt in the end of May, to wait there till opportunity offered to go forward into the Transvaal. While at Kroonstadt it was attached to No. 3 General Hospital to assist in the work there. It arrived in Johannesburg with No. 6 General Hospital, took over the Masonic Hall, and also opened under canvas in the Show ground.

As accommodation became available here, the temporary hospitals were closed, setting free the 15th Brigade Field Hospital, which was established (as a hospital for special and light cases) on the Show ground on July 26th.

Additional civil surgeons and nurses were engaged locally. It may be stated here that there never was any difficulty in engaging personnel for service in Johannesburg; indeed, the applications for engagement for this duty became an embarrassment as they exceeded the numbers required, and few of the applicants were willing to be employed elsewhere, when their services would have been most useful.

A convalescent depôt was opened in some railway sheds in the end of July, blankets and mattresses for 300 men were supplied and the necessary arrangements made for cooking. The men had their rations and such extras as were considered necessary by the medical officer.

The convalescent camps in Johannesburg and Pretoria were peculiarly important during July, owing to the delayed evacuation to the base consequent on interruptions to the line in the Orange River Colony. Hospital trains ran north of Kroonstadt only by special authority, and as the Natal line was only opened for traffic on the 6th, evacuation through that colony was not yet possible to any large extent, while the trains prepared for the Cape lines were not suitable for the steep gradients and sharp curves of the Natal Government Railway. As a result many cases, unfit for further service but not requiring hospital treatment, were accumulating and occupying beds in the hospitals which were needed for fresh cases. The convalescent camps received these until they could be sent to the base.

About eight miles east of Johannesburg lies the important railway centre of Elandsfontein, on the main line from the Vaal to Pretoria, where the western line through Johannesburg to Klerksdorp branches off, and the eastern line to Springs. It is also the junction for the Natal Railway. It was a position of much importance and required hospital accommodation for the troops passing through.

A nucleus for this was found in the hospital of the Simmer and Jack Mine, which was occupied (by permission of the manager) by the 19th Brigade Field Hospital (Lieut.-Colonel R. H. S. Sawyer) on June 13th. The hospital had been looted by the Boers, but the bedsteads remained, and mattresses and some sheets were obtained from various sources. This gave 40 beds in an excellent building with additional accommodation in tents. The Primrose Mine Hospital was also used during July and August, 1900. On July 8th

the 19th Brigade Field Hospital, having to proceed with its brigade, handed over this hospital to a party detached from No. 2 General Hospital, which was available pending the arrival of their own stores. This detail was again relieved (in the end of July) by the left half of No. 15 Field Hospital (from Bloemfontein), the accommodation was then increased to 250 beds, and finally in the end of September No. 2 Stationary Hospital being no longer required in Johannesburg itself, moved to Elandsfontein, and assumed charge of this hospital. The accommodation was gradually increased by the addition of hospital marquees and E. P. tents till it reached 536 beds, when the unit so formed was designated No. 16 General Hospital.

Anticipating later developments, it is convenient to state here, that two other general hospitals were established between Elandsfontein and Johannesburg. No. 20 General Hospital was organised and equipped in South Africa; it opened in March, 1901, with 400 beds, afterwards increased to 600. No. 13 General Hospital was brought up from Wynberg, where it had been used more as an invalid depôt, and opened 438 beds in May, 1901, afterwards increasing its accommodation to 520 beds. In September, 1901, there being no longer any absolute necessity for a general hospital in Johannesburg itself, while the authorities wished to set free the Wanderers' Club grounds for the use of the public, No. 6 General Hospital was reduced and closed in the end of the month. To complete the account of the medical arrangements in the Johannesburg district, it only remains to add that a large convalescent camp at Elandsfontein replaced the original depôt in Johannesburg, and that a convalescent home for Officers, established on the top of Hospital Hill in Johannesburg in a house belonging to the Barnato estate, was of very great service during the remainder of the war. Arrangements were also made for a convalescent home for Nursing Sisters, which proved of much service.

The medical arrangements in these two towns, Pretoria and Johannesburg, formed the foundation upon which the whole hospital system of the Transvaal (except on the extreme west) was built up. They were the depôts to which all cases of men unfit for the field gravitated, and received the overflow from all the hospitals on the line of communication in their vicinity.

V.—ADVANCE TO THE EAST.

So far the main advance has been described in some detail, as the medical arrangements followed so closely the advance of the army. But after the occupation of Pretoria, the movements in the field became more and more complicated, while the development of the hospital system still took place, mainly along the lines of communication, and it was only at a later period following the establishment of the lines of blockhouses that the hospitals were pushed out into the districts away from the railway line.

Between June 9th and 11th important operations, culminating in the battle of Diamond Hill, took place some 17 miles east of Pretoria. There were a good many wounded, who were brought into the Pretoria hospitals.

In the middle of June General Sir Redvers Buller, V.C., entered the Transvaal and pushed on to Standerton, while Major-General Ian Hamilton occupied Heidelberg. Following this, on July 6th, communication was opened by rail with Natal, but it was some days later before the line was cleared of the enemy.

In the end of July the advance from Pretoria to the east was continued, and Middelburg was occupied on July 27th. General Sir Redvers Buller, moving by Ermelo and Carolina, was close to Belfast on August 21st, while the 11th Division occupied this town on the 24th. On the 27th the action at Bergendal, resulting in a considerable number of casualties, took place, and following this the advance was steadily pushed along the line through Machadodorp, Waterval Onder, and Noitgedacht. General Buller now turned to the north, through Helvetia to Lydenburg, which he occupied on September 6th, and thence pressed forward towards Spitzkop, still further north, which was occupied on the 15th. Meanwhile, General French had occupied Barberton, General Pole Carew had pushed on to Kaapmuiden, and occupied Komati Poort on September 24th, where he was joined on the following day by General Ian Hamilton.

During these operations the aggregate number of casualties was considerable. East of Belfast the country is hilly, becoming mountainous, and especially to the south of the Krokodil Valley, where the Devil's Kantoer is a prominent feature in the landscape. The cavalry had very heavy work previous to their occupation of Barberton, while the forces under Generals Buller and Ian Hamilton were operating in a country hardly less difficult to the north of the railway line, and the central force pushed through the sub-tropical vegetation of the Lower Krokodil Valley. Fortunately the hot season had not then set in, so that the conditions, though trying, were not at their worst. The field units accompanied their brigades, but the nature of the country made it difficult for them to work. The Indian units (with the Natal Field Force), which had dandies and Indian bearers with them, were more fortunately situated, but the units of the home establishment had great difficulties with their ambulances, which in places had to be let down with ropes as the gradients were so severe.

As the troops advanced small temporary hospitals were formed behind them. The first of these was opened at Eerste Fabriken, 16 miles from Pretoria, in the end of June by a section of the 18th Brigade Field Hospital, in some houses belonging to the distillery there. When the section marched on August 11th to rejoin the headquarters the hospital was continued with a fresh staff. Similarly a small detention hospital was established at Piensaars Poort by a Cape field hospital, and remained in existence a good many months.

Middelburg, 94 miles from Pretoria, was occupied on July 27th. On the following day the right half of the No. 6 Field Hospital (attached to the 4th Cavalry Brigade) took over the Dutch School as a temporary hospital. In the beginning of August the Guards Brigade Field Hospital opened about 40 beds in the church. As the sick were increasing, it was decided to open at least 200 beds, and for this purpose marquees and equipment were sent out from Pretoria. The Stationary Hospital (afterwards known as No. 17) was opened as a distinct unit on August 15th, and to it Sisters and additional personnel were sent, as the Guards Brigade Field Hospital marched from Middelburg on the 20th with the brigade. Some accessory buildings were erected, and the accommodation had to be increased from time to time in accordance with the numbers in the field on the eastern line, till, in the middle of 1901, the accommodation reached 600 beds, but afterwards diminished.

A small hospital of 50 beds was opened at Belfast in the end of August, but was used only for a very short time as the advance continued.

When our troops entered Waterval Onder, in the end of August, they found a very good railway hospital in existence. This was taken over at once, and gave 40 beds, afterwards increased to 120 by the addition of tents. This hospital was quite close to the railway station, and proved extremely useful. For a good many months westward bound trains halted for the night either here or at Waterval Boven (the other end of the rack section of the railway), so that all the sick on them were taken into this hospital, and only those fit to travel were allowed to continue their journey. Further, it was advantageous to use this as an intermediate station between the hot and damp climate of the lower valley, and the much cooler and drier climate of the higher veldt; it was found that cases of malarial fever did better after some time in the comparatively cool and healthy station at Waterval Onder than if transferred at once to Middelburg or Pretoria. A staff was detailed for the hospital when it was taken over, and Nursing Sisters were sent to it. The hospital remained in occupation as No. 20 Stationary Hospital till the end of the war.

At Machadodorp, 154 miles from Pretoria, a small hospital was opened on September 12th, in the Railway Hotel, which provided comparatively good accommodation. This station was an important one from the time of its occupation till the end of the war. All troops and convoys from and to Lydenburg (48 miles) pass through Machadodorp, the terminus on the railway of the Lydenburg Helvetia Road. It became later an important centre from which columns started both to the north and south of the line. The ground beside the hotel was levelled, and the accommodation increased to 125 beds by the erection of marquees on it. Equipment, Sisters, and other personnel

were sent from Pretoria, and the hospital, as No. 21 Stationary Hospital, remained in occupation till the end of the war.

Lydenburg was occupied by General Buller on September 6th. During his further advance to Pilgrim's Rest and Spitzkop, sections of the field units of his force remained in Lydenburg looking after the local sick, and on his return on October 1st, No. 24 British Field Hospital established itself in some buildings in the town, which became (from October 13th) the Stationary Hospital, which, as No. 37, remained in occupation till the end of the war. A large store and the Agricultural Hall, and later, two iron huts, were taken over, and with some alterations made a very good hospital. Two good houses were used as an Officers' hospital. Beds and bedding, with other articles of equipment, were procured locally, and others sent from Pretoria. The hospital had beds for 125 cases, of which not more than 115 were occupied, besides nine beds in the Officers' section, while the field hospital tents provided for any increase. Three Sisters were sent out from Pretoria to this hospital.

Between Lydenburg and Machadodorp, four military posts were established, and an assistant surgeon of the Indian establishment was placed in charge of each. Small parties of sick were sent by ambulance from post to post en route to the railway at Machadodorp, and it was the duty of each assistant surgeon to see to the comfort of these cases as they passed through his post.

General French entered Barberton on September 14th. The civil hospital gave excellent accommodation for about 40 cases, and on the cavalry marching out again in the beginning of October, a small staff was left behind to work this as a stationary hospital for the requirements of the garrison, all sick then in hospital having been previously transferred to Pretoria by hospital train. The 18th Brigade arrived in Barberton, and the field hospital occupied the civil hospital, which was formally taken over (for pay of the civil staff) from November 5th. This staff included one superintendent and four Sisters and a number of subordinates, mostly natives. Additional accommodation, raising the total to 200 beds, was obtained by pitching tents round the hospital. The necessary outbuildings were erected, and the equipment added to and improved. This hospital, as No. 36 Stationary, continued in occupation till the end of the war.

Barberton, 2,825 feet above the sea, is laid out on the slopes of the De Kaap Valley. In the early history of the town, it had a bad reputation for malarial fevers. Their prevalence has now somewhat diminished with the growth of the town and the clearing of its vicinity, but during 1900-01 the garrison suffered considerably from malarial fevers, partly contracted locally and partly among men who had been in detachment at Avoca, Kaapmuiden, and Komati Poort.

Komati Poort, 293 miles from Pretoria and 56 from Delagoa Bay, is the frontier town of the Transvaal. It is only 626 feet above the sea level, and stands at the junction of the Komati and the Krokodil Rivers. It is surrounded by high ground, and the valley itself supports a tropical vegetation. It is notoriously unhealthy on account of the prevalence of malarial fevers, and owing to the heat and moisture the climate is at all times enervating.

The 11th Division occupied Komati Poort on September 24th, after a most arduous march of 13 days from Waterval Onder and Helvetia, during which there were repeated difficulties with the transport on account of the badness of the roads. The sun was very hot during the day, and it was impossible to march at night, as the road could only be followed with difficulty even in daylight, while both men and animals were on reduced rations.

General Ian Hamilton's force followed the 11th Division, entering Komati Poort on the 25th; their experiences were much like their predecessors'.

The Guards Brigade Field Hospital established themselves in the Railway Restaurant, and the 19th Brigade Field Hospital took over a building belonging to the railway employes, for which the Officer commanding the unit commandeered 17 spring bedsteads. When the Guards Brigade left on September 30th, the 19th Brigade Field Hospital took over the Railway Restaurant also. When this unit left on October 11th to rejoin its brigade a section was left behind to work the hospital. Tents pitched near the station brought the accommodation up to 60 beds. Although the station was

convenient for many reasons, especially for the easy transfer of sick by rail, yet it was hot, and in consequence a hospital was opened in huts on the Lebombo Hill, where most of the troops were also accommodated in huts. The hospital remained in occupation till the end of hostilities.

It was, of course, evident that cases could not be kept in Komati Poort for treatment, and their transport by rail westward was uncertain owing to the interruptions on the line, which is rather a difficult one. For this reason arrangements were made in November to have a hospital ship stationed in Delagoa Bay, to which cases from the lower valley and from Barberton could be transferred for treatment. The "Orcana" arrived there early in January, and continued during the hot weather, an arrangement that was repeated during the hot season of 1901-02. The vessel was moored about a mile from shore; convoys were railed through from Komati Poort to the landing stage at Lourenço-Marques, and transferred to the ship in barges. Occasionally the ship had to go to Durban for stores, and opportunity was then taken of sending to Natal by sea all cases unlikely to be fit for further service. This plan worked admirably; the men recovered rapidly on board ship, while the invalids were brought to their port of embarkation for England with the least possible discomfort. Without some arrangement of this nature it would have been very difficult to deal at all satisfactorily with the large sick rate in this district.

W.—FURTHER DEVELOPMENT OF HOSPITAL SYSTEM.

Meanwhile operations were continued in the Orange River Colony, where the 8th, 9th, and 10th Divisions were actively employed. Small hospitals, of which the most important was that at Winburg, were opened throughout the colony. This hospital was opened in May, 1900, by the 12th Brigade Field Hospital, and was established in various buildings in the town, with some 135 beds, increasing to a maximum of 225 later, and continued in occupation till the end of the war.

Winburg, the railway terminus of the roads from Senekal and Ficksburg, was a position of some importance, and received the sick from the troops which, for a considerable length of time, were operating in the district. It was, however, for a time, and naturally at the most important juncture, somewhat difficult of access. The short railway from the town to the main line at Smaldeel was cut on more than one occasion, and traffic was for various reasons not infrequently interrupted. Hence the evacuation of the sick was irregular, and the maintenance of the personnel difficult.

Heilbron was in somewhat the same position. A small hospital had been opened there during Major-General Ian Hamilton's advance, and arrangements had been made to establish a large hospital; indeed, 200 of the 400 beds destined for it had been sent there, but the town was suddenly evacuated and the equipment sent back.

A small hospital was again opened there in June, 1900, which continued in use during the remainder of the campaign, and indeed during the last months, the period of the "drives" in the Orange River Colony, its accommodation was increased to 350 beds. But like Winburg, Heilbron lies at the end of a short branch line, and railway communication was somewhat uncertain.

The third important hospital in the Orange River Colony, not already referred to, was No. 19 Stationary Hospital at Harrismith. This was opened in August, 1900, on the occupation of the town. It was at first established in the schoolhouse and Dutch Church, giving a total accommodation for about 130 cases, and additional accommodation was available under canvas. With the development of the operations in the east of the Orange River Colony, Harrismith, the terminus of the Natal Railway on that side, became of more importance, and an entirely new hospital was erected in huts in the vicinity of the town, to which the cases from the original hospital were transferred. This hospital (No. 19 Stationary) was very complete; it gave accommodation for 450 cases, which was increased considerably for a short time during the last stage of the war.

Smaller hospitals were established at Thabanchu, Senekal, Ficksburg, Reitz, Bethlehem, Vrede, and Brindisi—all originally by the 8th Division.

These were all in isolated towns, with communication with larger centres only by convoy; Vrede and Bethlehem were cut off from Harrismith frequently, the latter on one occasion for four months. The difficulties in their working were therefore considerable.

Small hospitals were also established at Boshof and Edenburg about the same period, which remained in use throughout the war, while other smaller hospitals were opened in the smaller towns occupied by us, which were only held for a few months, after which these units ceased to exist.

After General Buller occupied Standerton in June, 1900, the 2nd Brigade Field Hospital remained in the town to look after the small number of sick, till in August, No. 4 Stationary Hospital (Major R. Kirkpatrick) was moved from Newcastle, and opened there to meet the increasing requirements of the district. This hospital gradually extended, till in January, 1901, it was converted into a general hospital (No. 17) of 520 beds, and remained in occupation till the close of the campaign. The accommodation was at first in tents; gradually huts were erected, as these became available. The accessory buildings were of the usual type.

At Heidelberg, half of the 4th Brigade Field Hospital (Major F. S. Heuston) carried on the necessary work. For some time buildings in the town, including the civil hospital, were used. The arrangements were, however, not satisfactory, and a tented hospital with the usual accessories was established close to the town, which as No. 15 Stationary Hospital continued in occupation till the end of the war.

To the west of Johannesburg No. 17 Field Hospital (Lieut.-Colonel C. W. Thiele) was established at Krugersdorp as a stationary hospital, where some buildings were occupied. This arrangement was not found to work well, and as at Heidelberg, a tented hospital (No. 18 Stationary) with the usual outbuildings was established close to the railway, and continued in occupation till the conclusion of the campaign.

At Klerksdorp the civil hospital was taken over by us, with some additions to the subordinate staff; while at Potchefstroom No. 15 Field Hospital was established in tents with some buildings. Both these remained in occupation till the end of the war.

During the last months of the campaign, the period of the "drives" in the Western Transvaal, there was considerable pressure on this line. Half of the Canadian Field Hospital was established at Vaalbank as an advanced hospital, and rendered valuable service. Evacuation into the large hospitals at Elandsfontein was maintained by the hospital trains (mainly by the "Princess Christian" train), and in addition a small local ambulance train travelled regularly up and down the line, clearing the small posts and preventing accumulation in the smaller hospitals.

Hospitals off the line were also established at Rietfontein and Rustenberg. From Rietfontein the sick came by convoy into Pretoria when necessary. From Rustenberg they were at first sent through Rietfontein to Pretoria; later, as the blockhouse lines were developed, they were passed along this line to meet the railway at Krugersdorp. Still further west the small hospital at Lichtenburg was in communication with Vryburg and the western line. But with all these outlying hospitals communication was difficult owing to interruption by the enemy.

The arrangements in Kimberley after the relief have already been described. These were only temporary, and the addition of reinforcements to Lord Methuen, with the arrival of the Fusilier Brigade from the 10th Division early in April, had emphasised the necessity for additional hospital accommodation. No. 11 General Hospital (Lieut.-Colonel M. D. O'Connell) was detailed for this duty; this unit left England on March 26th, 1900, and arrived in Table Bay on April 16th. It was, however, not able to disembark till April 23rd owing to difficulty of berthing the ship. But the previous day an advance party, with light equipment had been able to leave for Kimberley, and on the 25th the remainder of the personnel and equipment left for Kimberley, arriving there on the 28th. It had not been possible to send up the advance party earlier owing to the congestion on the railway line. For some days after the arrival of the hospital there was difficulty in getting transport for the stores from the railway to the Dynamite Siding where a site had been selected, and it was not till May 3rd that

the pitching of the hospital actually began, when it admitted patients on May 11th.

The Principal Medical Officer of No. 11 General Hospital, on arrival, assumed direction of the medical arrangements in Kimberley. The hospital at Newton Camp, which had been formed under canvas, was taken over at once; this was, in the main, a convalescent hospital, but the more serious cases that it contained were removed to the general hospital by ambulance, while the tents and equipment were moved to No. 11 General Hospital, and by May 14th all sick were cleared out of this camp. As regards the buildings in the town which had been occupied as hospitals, the cases in them were gradually evacuated as they recovered; those who were fit to travel were sent to the base, the remainder transferred to the general hospital.

From this date the arrangements in Kimberley were entirely satisfactory. The hospital developed into a large establishment, having for some months 800 beds. At first, with the exception of the usual accessory buildings, it was under canvas, but later was hatted as the marquees were wrecked by a gale. There was never any difficulty about supplies or equipment in Kimberley; like Johannesburg, it has many resources, and recovered with startling rapidity from the effects of the siege immediately after the relief.

Evacuation to the base was in great part arranged for locally. Trains were made up of saloon corridor carriages with a kitchen car attached, and worked very well in lieu of the regular hospital trains which, during the halt at Bloemfontein and the advance to Pretoria, were more urgently needed on the longer line from the Orange River Colony to the base.

The history of the medical arrangements in Kimberley from the establishing of No. 11 General Hospital became an uneventful record of steady work till the close of the campaign.

To complete the account of the western line as far as Kimberley, it only remains to add that the temporary hospital at Modder River was finally closed on June 1st, 1900, having been but little used after the beginning of March, and that the hospital at Orange River was reduced gradually and closed in August, 1900, limited accommodation (as a detention hospital) being however maintained there till the end of the war.

A Militia bearer company had been formed (in March, 1900) of volunteers from the Militia regiments, with N.C. Officers and some men of the R.A.M.C., to work with the 10th Brigade, equipment being available in South Africa. It worked satisfactorily, but an attempt to raise a second (which was authorised) failed, as only a few men offered themselves.

At the base the hospital at Greenpoint was enlarged, and arrangements made for the accommodation of the sick from among the large number of Boer prisoners then encamped on the cycle track. For this purpose huts were erected, and the general accommodation had been increased by taking over a new building built for the Somerset (the Cape Civil) Hospital. Rondebosch had been vacated as a hospital centre by the removal of the Portland Hospital to Bloemfontein, and No. 3 General Hospital to Springfontein and Kroonstadt. Before No. 2 General Hospital left Wynberg for Pretoria, some huts had been erected; these were taken over by No. 1 General Hospital, and additional huts erected. In July the huts built on the site of No. 2 were taken over by No. 13 General Hospital, newly arrived from England. No. 5 General Hospital was in full working order at Woodstock.

With the opening of the general hospitals in the Orange River Colony and Transvaal, the hospitals at the base became almost entirely convalescent and invaliding depôts, and though the work continued to be heavy on account of the numbers dealt with, its character had considerably altered, the accommodation of the hospitals could be increased without detriment to the sick, and in Wynberg for some months there were over 2,000 beds available for transfers from the front.

From this date till the end of the campaign there was little alteration in the arrangements at the base. No. 13 General Hospital moved to Johannesburg in July, 1901, as a unit; but the work which had been done by it was continued in the huts at Wynberg till the end of the war.

X.—DEVELOPMENTS DURING 1901 AND 1902.

Towards the end of 1900 the medical arrangements entered on a new phase. Up to the entry into Pretoria the larger necessities had been the maintenance of the field units in some degree of efficiency, and the establishment of more elaborate hospitals behind the central force advancing towards Pretoria. With the occupation of Johannesburg and Pretoria, and the establishment of the large hospitals in them, the further advance to the east and the irregular and complicated movements that took place both in the Transvaal and the Orange River Colony, had little effect on the hospital arrangements; the main centres were established and the further changes which took place in them were of the nature of a natural development of their resources. The general arrangements at this time can best be seen from the accompanying outline map which shows the general, stationary, and temporary hospitals (apart from the field units) as they existed in October, 1900.

Following this the character of the war changed. In place of the steady advance of a large force, concentrated over a comparatively limited area, operations of varying magnitude and importance were carried on over the whole of the five components of what is now British South Africa. Natal from June, 1900, to the end of 1901, was, indeed, comparatively free, nor were the operations in Rhodesia of any great magnitude, but in the Transvaal, Orange River Colony, and Cape Colony a persistent warfare was waged by comparatively small bodies on either side. With an extremely mobile enemy, whose policy was essentially opportunist, it followed that the movements of our troops were uncertain and irregular. In one month our principal force was operating in the Eastern Transvaal, in the next the brunt of the fighting was in Cape Colony; at one time the enemy was attacking us vigorously in the Western Transvaal followed by an extremely active opposition on the western border of Natal.

From this two results followed, the number of columns was much increased while their strength was reduced, and, *pari passu*, additional but smaller field units were required. Secondly, as it was impossible to say when and where the next concentration of troops might be necessary, all the hospitals in the various Colonies had to be maintained at almost their maximum accommodation, in order to provide for sudden demands for beds consequent on the arrival of a large body of troops, large, that is, as compared with the normal strength in the district. This, of course, resulted in local excesses of permanent accommodation, and a spreading out of the sparse personnel where, had the circumstances been other than the were, a concentration would have been economical both as regards beds and staff.

As the campaign advanced certain districts became quieter, and it was possible, tentatively, to reduce some hospitals to enable others to be opened at a distance from the trunk lines, in order that they might be in touch with the troops as these gradually pushed further into the field, and came less frequently to the railway. The final stage came with the development of the system of lines of blockhouses, which enabled hospitals to be maintained and relieved of their sick by convoy along these protected lines. It is not necessary to enter into details regarding these smaller hospitals; their conditions varied with their position and the circumstances under which they were formed and maintained, and their importance does not justify a detailed description of each of them. Table A (p. 156) shows the places where they existed, and the dates on which they were opened and closed, while the complete hospital system as it existed in October, 1901, is shown in the second map. Table B (p. 158) shows the hospitals opened between the beginning of November, 1901, and the close of the war.

The personnel of these smaller hospitals varied. Some were staffed from the field units, to others a smaller staff was detailed from the nearest large centre, and was increased from local sources. To many, Sisters were sent; for the others, nurses were engaged locally to assist. Some equipment was usually obtainable locally, which was added to from the nearest advanced store as opportunity offered to get it sent out. But in other cases, such as at Ermelo, nothing whatever was available, even the buildings were barely

habitable and every article had to be sent out, in this particular instance, from Standerton.

One additional railway, the Pretoria-Pietersburg line, was opened by us during this period. Warm Baths was occupied on March 30th, 1901, and Pietersburg itself on April 8th. Hospitals were opened at each of these places; at Warm Baths the large hotel was taken over and opened on April 5th. It made a very good hospital, giving a normal accommodation of 75 and a maximum of 100 beds. At Pietersburg a hospital for 100 beds was opened on April 19th in buildings and tents. Both were in occupation till the end of the war, and had a sufficient staff, including Sisters.

At Pienaar's River (42 miles from Pretoria) a field unit provided the necessary assistance till, in September, 1901, its services were required in the field, and a small hospital was established there. Regular evacuation down the line from Pietersburg to Pretoria was maintained by two wagons fitted a ambulance coaches with standards to carry stretchers and the other necessities, while the hospitals were periodically cleared by the hospital trains. As on the other lines, a few beds were maintained for urgent cases at the intermediate stations.

In November, 1900, some cases of plague occurred among natives near King Williamstown, and all the Principal Medical Officers of the various sections of the line of communication and the base were warned to watch for any suspicious cases, and to take all the necessary precautions if such cases occurred. In January, 1901, plague appeared at Cape Town among the natives employed at the docks, and from them spread to the native, and later to the European, population of that city.

This was, of course, a very serious complication, as Cape Town was the principal port of disembarkation of troops and foodstuffs. The preventive measures put in force followed three lines:—(1) Cape Town as far as possible ceased to be a port of disembarkation of supplies. A complete stoppage could not be effected owing to the needs of the western line, and the troops in Cape Colony itself, but every precaution was taken in the supply depôts to limit the possibility of infection being conveyed by foodstuffs, forage, &c. (2) Cape Town was evacuated as far as possible, particularly Greenpoint Camp, which was close to the docks. The evacuation took some little time to complete, and the largest number of cases came from Greenpoint Camp. (3) Movements of troops from Cape Town could not entirely cease, but arrangements were made for the inspection of troops passing up country at the various stations at which the troop trains halted, and for the accommodation of any cases or contacts that were amongst the troops travelling. The troop trains from Cape Town carried a yellow flag to enable them to be easily identified.

In April a conference was held at Cape Town to arrange for common action by the military and civil authorities. At first it was arranged that all cases among the troops should be treated in the civil plague hospitals. This, however, did not prove satisfactory, and a special plague hospital was established at Maitland, with a bacteriological laboratory, the whole under the charge of Lieut.-Colonel D. Bruce, F.R.S., R.A.M.C.

Additional attention was directed to the sanitary measures in use in Cape Town, where an Officer of the R.A.M.C. was a member of the advisory board (which had been formed to assist the Colonial Secretary), and kept touch with the civil authority.

The precautions against the conveyance of plague by the moving troops were successful. Of the 24 cases that occurred among the Imperial forces one only occurred outside Cape Colony, at Mafeking, while one occurred at Hermon, near Wellington, and another at Port Elizabeth, both of which places were in frequent communication with Cape Town. One case also occurred on board ship, between Cape Town and Durban.

Of the remaining 20 cases 11 occurred at Greenpoint (close to the docks, the original focus of the disease), five in Cape Town itself, and four at Maitland. Four cases of the 24 admissions died.

Nine cases occurred in March—that is, some six weeks after the outbreak of the epidemic—six in April, three in May, two in June, three in October, 1901, and one in February, 1902. The total cases reported by the Medical Officer of Health, Cape Town, as occurring in Cape Colony from the beginning

of the epidemic to March 1st, 1902, the corresponding period, was 877, of whom 221 were Europeans and 24 belonged to the Imperial forces. In the Cape Peninsula alone 745 cases occurred, of whom 192 were Europeans, and of these 20 belonged to the Imperial forces. This shows a very small incidence rate among the troops.

With the multiplication of small columns, the field units underwent a complete reorganisation. It was no longer necessary nor possible to maintain the field hospitals as distinct from the bearer companies, and a unit to fulfil both functions was formed by adding ambulance transport to the field hospitals, or by sending additional equipment to the bearer companies. The total strength of the unit was also reduced. Two Officers, 25 N.C. Officers and men, with four or six ambulances (or tongas in place of some of the ambulances), were found to be quite sufficient. Indeed, the great desideratum at this period was mobility. Tongas were found to be very useful, or in their place, as the supply was limited, Cape carts or the four-wheeled spider. Equipment was materially reduced; some Officers found it possible to do equally good work with considerably less material than others, but in this respect the Commanding Officer of the unit was allowed absolute discretion, so long as he did not exceed the limited general transport with which he could be supplied.

In the operations in Cape Colony under Major-General French, the nature of the country made it impossible for wheeled ambulance transport to keep in touch with the troops, and in these conditions, as formerly in Natal and the Eastern Transvaal, the Indian bearers with dandies, from the Indian field hospitals, were of much service. These men were collected from the various hospitals, and a large number of dandies sent down to the Colony.

The use of these small units was, of course, only rendered possible by the fact that the columns were never away from their supply base for long, and that, speaking generally, the casualties were limited, while the actual distance to some point on the line of communications was never great. In the earlier part of this second period the columns came on to the line to refit; later they obtained supplies from advanced bases pushed out into the district, and it was at these points that the small advanced hospitals were placed, and from these the sick left by the columns sooner or later were conveyed to the hospitals of the line of communications.

When the large "drives" were instituted, the hospitals on the line of communications, where the drive was destined to end, were evacuated as far as possible to make room for the incoming sick, while the hospital trains were ordered to convenient points to meet the columns arriving.

The action at Brakenlaagte on October 30th, 1901, is probably that one of those actions resulting in a considerable number of casualties which occurred furthest from the line. But even in this case the evacuation was quickly carried out; a few of the wounded went to Middelburg, the majority to Springs, where a hospital train met and conveyed them to the general hospitals at Elandsfontein.

Although our larger operations were carried out as parts of a general scheme, yet this did not constitute the whole. Local activities in various districts necessitated the sudden formation and despatch, at very short notice, of fresh columns, so that at no time was it possible to be certain that an unforeseen demand for a field medical unit might not arise. But for the greater part of the time one or even two units were generally available to meet such emergencies. Columns were being constantly broken up, and their constituent units re-arranged; this frequently left the medical unit unattached for some little time, and opportunity was then taken of bringing it into some central position whence it could be railed to the point of concentration of any new formation. In this movement of these field units every assistance was received from the Quartermaster-General's Department, from whom, indeed, the earliest possible information of a concentration, or its probability or possibility was invariably received. But in spite of all this it was not always possible to get sufficiently early intimation of the fresh movement to enable any medical unit, which might then be free, to be railed to join the new column, and under these conditions, local arrangements had to be made by which personnel, equipment, and transport were found for the improvised unit. It is satisfactory to be able to add that the movement of a column

was in no instance delayed because its medical unit was not present on the ground to accompany it.

But these continuous movements pressed heavily on the personnel of the field units. Many of them were on trek without a break during the whole period, except for short delays while the columns to which they were attached were refitting. Others had from time to time a few weeks' rest, either with their columns, waiting a fresh movement, or in reserve on the breaking up of their original column. There are very few units of the other branches of the service which have such a record of continuous marching as the majority of our field hospitals and bearer companies during the South African War.

The wastage among their personnel was, under such conditions, very large, and the maintenance of their strength at times proved a very difficult problem. The nucleus was, of course, formed of Royal Army Medical Corps N.C. Officers and men, but the rest of the personnel was made up principally of the specially-enlisted men of the Royal Army Medical Corps, Cape Medical Staff Corps, and the similar body enlisted under the general term of South African Irregulars with, for a time, some of the Imperial Hospital and the Imperial Bearer Corps. These men were in every way more fitted for these duties than for work in the hospitals on the line of communications. It is of course true that, to a large extent, the proportionate wastage will always be greatest at the beginning of a long campaign, since the weaker succumb first, but continuous hard work, often on an indifferent ration and under trying climatic conditions, finds out the weak points among even the strongest men.

Y.—NATAL.

The conditions obtaining in Natal at the beginning of the war have already been referred to. Natal formed one administrative charge with Cape Colony prior to the war, but even then this arrangement had certain disadvantages, owing to the delays in communication by land and sea. These were not facilitated by the outbreak of the war, the land route was closed while the mail service was disorganised. Hence at the first, arrangements in Natal were made locally, under the general direction of the Principal Medical Officer, Cape Colony; later, Colonel R. Exham was sent out from England as Principal Medical Officer of the Natal Field Force, and was shut up in Ladysmith, so that on the arrival of the 2nd Division in Natal, its Principal Medical Officer, Sir T. J. Gallwey, K.C.M.G., C.B., took over the direction of the medical arrangements in that colony, and continued to perform that function till his departure for England in October, 1900. His report on the arrangements made by him is therefore attached (Appendix II).

A special report by Colonel R. Exham, C.M.G., on the early arrangements is also attached (Appendix I).

From the end of 1900 to the close of the war the medical arrangements in Natal remained practically unchanged. The Natal hospitals had the local sick of a comparatively small force to deal with, but were of much importance as centres to receive the overflow from the hospitals and the invalids for England from the Transvaal. A regular system of evacuation was maintained through Natal, viâ Durban, to England. Invalids, or cases requiring change, were collected in the hospitals in Pretoria, Johannesburg, and Elandsfontein, from the eastern, northern, and western lines (as well as those treated locally, and, in smaller numbers, from the hospitals at Heidelberg and Standerton), and transferred by hospital train to the Natal hospitals at Newcastle, Charlestown, Howick, Maritzburg, and Pinetown. There, many of the cases recovered after change and further treatment; the rest were sent home by hospital ship or sick transport. From the time traffic on the line between Elandsfontein and Charlestown had become at all regular, practically the whole of the invaliding from the Transvaal was carried out through the Natal hospitals, while all invalids south of the Vaal passed through Cape Town. The considerable number of invalids and transfers from Harrismith were also sent through Natal, so that the hospitals there were steadily employed till the end of the war.

Z.—CONCLUSION.

In concluding this section of the report on the medical arrangements in the South African War, it appears advisable to summarise the features of the campaign by which these arrangements were chiefly affected.

(1) The magnitude of the operations, their duration, and the strength of the force engaged, far exceeded the anticipation. Consequently the Medical Service, like other branches, was hampered by an insufficiency of personnel, both Officers and men, and the additions to it during the war were untrained in their special duties, while the proportion employed exceeded that which can safely be added to any permanent trained staff. In the same way the provision of hospital accommodation as at first estimated fell far short of the actual requirements, and the provision of the additional hospitals took some time, during which only local arrangements, dependent on the resources in the country, were possible.

(2) The changes in the plan of campaign at an early stage upset the field medical arrangements for a time. It is, of course, true that such changes must be reckoned with, and there should be sufficient elasticity in a medical service to permit of its adaptation to new conditions without any unusual strain. But the primary condition, allowing of any such rearrangement, is a sufficiency for the force engaged, plus a reserve, to meet contingencies. In the late war the allotment of field medical units was sufficient only for the divisions from England, and that formed in Natal, mainly from Indian troops. For the new divisions and odd brigades formed in South Africa, no provision existed, and their urgent needs had to be supplied from existing divisions with some small local help.

Under such conditions it was impossible to expect that the work should be carried on as smoothly and efficiently as with a full cadre of field medical units, and the excellent result obtained was entirely due to the energy and devotion of the Principal Medical Officers of all the divisions, and the Officers of the Royal Army Medical Corps serving under them.

(3) The greatest obstacle to the work of the Medical Service was the transport difficulty. The first necessities for an army in the field are food and ammunition: where the only means of forwarding these from bases (never less than 400 miles away) is a single line of railway, where, again, this line is exposed to constant damage and interruption, when the rolling stock is insufficient, and the engines in need of repair, what wonder that the first use of the inefficient transport is to supply the necessities without which an army cannot exist, and that the question of hospital supplies falls for the time into the background. It was this alone that delayed the development of the hospitals north of the Orange River. Those in Cape Town were excellently equipped and maintained from the outset, and as it became possible with additional facilities on the railway, the others were rapidly developed into the establishments which, in the middle of 1900, excited favourable comments from the members of the Royal Hospital Commission, while steady progress brought them into such a condition as to invite comparison with any hospital in any country.

Transport difficulties again are largely responsible for the difficulties in the advance from the western line to Bloemfontein, for the unfortunate conditions which obtained there for some weeks after our entry, and in a similar but less serious condition at Kroonstadt.

The position must be faced. Either the sick and wounded at the front must be dealt with by imperfect and often improvised means, or the Medical Services must be given priority for the transport of their stores to a degree which can hardly ever be consistent with the true function of an army in the field, that is, the defeat of the enemy.

PART II.

REGIMENTAL UNITS.

Report of the Committee dealing with Regimental Units, with reference to the Experience gained during the South African War of 1899-1902.

1.—ON THE MARCH.

The causes of men falling out on the march (apart from blistered feet) are, in the early morning, diarrhoea and colic, later on in the day exhaustion due to heat and fatigue, producing a tendency to heart failure. The latter is sometimes a most serious condition, and having once affected a man tends to return again and again if he has to undergo any extra exertion, or from the excitement or nervousness of going under fire. These cases multiply rapidly if the physical strength of the men cannot be kept up by good and sufficient food and the necessary amount of sleep and rest. Blistered feet were very common after the first day's march, and perhaps for another two or three days. After the first three days this condition is not a serious cause of incapacity. It is generally found that when new boots are issued—a necessary evil in a long campaign—care has to be redoubled on the first day or two out of camp. It is impossible for men to march with badly blistered feet, and it is fortunate that one or two days' rest in the ambulance, coupled with cleanliness and the application of vaseline, will invariably make the men quite fit for the road. It is advisable to always open a blister, and also to direct that after bathing, the feet must be very thoroughly dried and fresh socks put on.

In the above-mentioned cases of exhaustion it was found that if relieved of their rifles and ammunition the men were then generally quite able to continue the march, showing that the extra strain of carrying heavy weights, and also the pressure on the chest of the straps had been too much for the heart. The loaded pouches, pressing more or less on the heart, stomach, transverse colon, and liver were causes of great discomfort and many complaints, and possibly was one of the causes of the early morning diarrhoea. The bandolier is a much better arrangement, and the men much prefer it. The cardiac exhaustion cases were much more frequent among the men of the volunteer companies than among the regulars, probably due to the great difference of their usual daily occupation from the life of a soldier on active service.

When speaking of the medical arrangements for a battalion on the march, it is, as a rule, not plainly enough stated that medical attention is always called for sooner or later, and also that this medical attention includes getting the sick and wounded into camp. Whether the battalion is or is not attacked by the enemy the cases of incapacity for marching will occur, and arrangements should always be made to meet them. The numbers will, as a rule, be in proportion to the length and difficulties of the road as well as to the climate and the fitness or otherwise of the men.

If a battalion is forming a rearguard there is no more difficult position for the Medical Officer. The battalion is continually falling back (following the column), and therefore frequently and unavoidably placing the stretcher bearers and the ambulance between their own and the enemy's fire. It is particularly on such occasions that a sufficient number of ambulances must be available for the use of the Medical Officer. The many difficulties have to be met, but it is not possible to lay down rules of action; the Medical Officer must make the best of the situation, and must, above all things, get his ambulance emptied at every possible opportunity. Medical aid on the march is generally limited to giving temporary attention, either of a medical or surgical character, to any man needing it. The wounded or sick from

flanking guards must be brought to the central roadway, and if unable to march must either be placed in the ambulance attached to the battalion, or if this is already full they must be given a slip of paper showing the name of the man, his regiment, the cause of incapacity, and a request for conveyance to the camp. This paper will be signed by the Medical Officer and presented by the man to the Officer Commanding Bearer Company. The Medical Officer must enter all cases going sick in his own note-book for the information of the Officer Commanding the battalion and the Principal Medical Officer of the column. Sometimes it is necessary to leave one or two stretcher bearers with the man, though unless the man is seriously hurt or ill, it is best to take the bearers on with the battalion, or they may not find it possible to catch up their unit, especially if they are carrying a stretcher. It is, of course, quite impossible to carry a loaded stretcher at the pace a regiment usually marches.

2.—MEDICAL AID IN ACTION.

Attention to the wounded during an action is now perhaps more difficult to carry out than when the range of firearms was less. The area now covered by a battalion attacking a position is necessarily very extensive on account of the increased risk due to the low trajectory of the bullets and the rapidity and precision of the fire. The difficulty now of attending to the wounded is due to two main causes—firstly, the extensive area covered by the battalion, and secondly, to the question as to whether the danger to the wounded man (as well as to the bearers) makes the removal of the wounded (except during a lull in the fight) the right thing to attempt at all. It is generally quite possible to reach the wounded man and apply a temporary dressing, but if you give him a voice in the matter he would, as a rule, prefer to lie where he is; often he is in or near some comparative shelter, selected perhaps by himself when advancing.

It is not considered that the rapid carrying off the field of all wounded is one of the chief things to aim at. The best possible arrangement for the safety and welfare of the patient is what should be tried for, there can be no hard and fast rule.

Dressings should be of the simplest kind, remembering that permanent dressings are not put on in the field, but are carefully and deliberately applied in the field hospitals.*

3.—REGIMENTAL STRETCHER BEARERS AND AMBULANCES.

The wounded should be brought to some central sheltered spot, if that is possible, and there field dressings should be applied, the Medical Officer keeping up as well as he can with the battalion. When the stretcher bearers from the bearer company are at hand, they take charge of the wounded and carry them to the rear, otherwise it will be necessary to leave one or two regimental bearers to see that the men are properly looked after, the Medical Officer giving orders to the bearers to rejoin the battalion as soon as possible, and report themselves to him for instructions. The collecting station and dressing station are not separate places when speaking of the medical arrangements of a battalion. The Medical Officer cannot be in several places at once, and it is therefore necessary to select central dressing stations as he advances. When a battalion is attacking, the following positions should be taken up by the Medical Officer and the stretcher bearers, and will be found satisfactory:—

The battalion will be in the usual open formation, and the frontage is, say, half a mile, and the depth from front to rear is probably about 500 yards. If the country is only moderately uneven, or covered by bush, it is impossible for the Medical Officer to get a good view of the fighting line. Two stretchers (eight bearers) should therefore be placed to right and left of him, well extended. The Medical Officer should march with the reserve ammunition, the corporal, carrying the field medical companion and one water bottle,

* In a good many cases of simple wounds of the fleshy parts, the first field dressing applied on the field was all that was ever necessary. This was particularly noticed in the wounded sent to Wynberg from the early engagements in Natal.

remaining with him. By this arrangement he can, as a rule, see the two stretcher squads to his right and left, and the bearers can always inform him of any casualties occurring in the lines near them. The surgical haversack and remaining water-bottle should be sent to the flank where the greatest number of wounded are expected. The bearers, it will be found, soon come to the limit of their strength when carrying loaded stretchers, the Medical Officer must therefore arrange to have their journeys shortened as much as possible, or their use as bearers will soon be lost to him. It should be noted that the man's blanket or greatcoat makes a better and safer means of carrying him down the side of any steep or rocky hill than does a stretcher. Sometimes a severe injury to a leg or other part will make the use of a stretcher absolutely necessary, but in this matter the Medical Officer should himself make the decision. If the man must be placed on a stretcher, at least six men will be required to carry it down any rugged hill with safety. With regard to tallies, it is considered that it is not possible or necessary to fix them on to every wounded man, but it is necessary to attach them to all serious cases, and to write a few particulars of the wounds or other injuries, name and regiment, &c., in the Medical Officer's note-book, for the future information of the Principal Medical Officer, and the Officer commanding the battalion.

It must be plainly laid down that on the march the ambulance wagons are under the control of the Medical Officer of the regiment, and he must be careful to see that they are always used for their legitimate purposes. We would recommend two light four-wheeled ambulances, drawn by four horses, each of which can be driven and looked after by one man on the march. The Canadians had a light ambulance of this character. These two ambulances carry easily between them four lying down and six sitting patients. These small ambulances are generally more manageable, do not require such expert drivers, and carry between them more patients than one ordinary ambulance, and only require the same number of horses and men. They are to be with the battalion during the march, in camp, and when an action is pending they should rejoin their unit, viz., the bearer company. If it is necessary to have an ambulance with a battalion in camp on account of the distance of the men from the nearest hospital, this could be easily arranged. The bearer company would only lend these ambulances to the Medical Officer of the battalion for the march. The advantage of having two ambulances is that if one is delayed to pick up a wounded or sick man, the other can keep up with the battalion and be ready for use.

[NOTE.—This will probably necessitate the increase of the number of ambulances with the bearer company, which in other respects also is very desirable.]

It has been suggested that two-wheeled ambulances are as useful as four-wheeled; we do not agree to this. With the latter the same number of horses are needed, they are more comfortable and safer, and if on the march, or in any temporary camp, the lying-down cases can remain safely in the four-wheeled ambulance while the horses are taken out to graze and water.

Light two-wheeled ambulances on the lines of a tonga are required for cavalry, which should accompany this arm of the force in the proportion of one per squadron or battery of Royal Horse Artillery. These should be lent from the cavalry brigade bearer company, to which they should take their wounded for transfer to the larger ambulances. Ten of the light ambulances required for a cavalry brigade should replace five of the larger ambulances at present forming the ambulance transport of that unit. The "Danjiboy" tongas used in the recent campaign were of the greatest service. They could follow and keep up with mounted troops over any ground, however rough, and collected wounded from the flanks who would otherwise have frequently not reached hospital until the following day.

The number of stretchers with a battalion should be eight (8), that is four for use in action and four to be kept in reserve. The Mark IV or V pattern is very serviceable. A lighter stretcher could be made, but for all-round general work there is little to be said against the present one; the firm

sides and the wheels raise it off the ground when the bearers are resting, and this is imperative in a good stretcher and makes it far preferable to the lighter ones that are often illustrated and described as superior to our own. The stretcher with hood is not recommended.

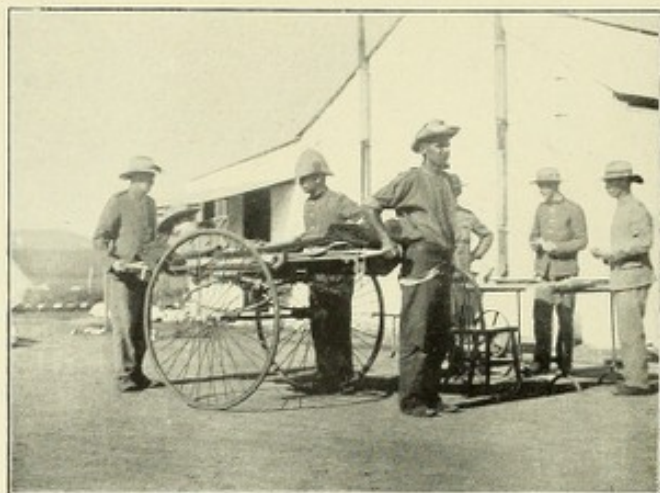
The stretcher bearers, according to Regulations, march fully armed with their respective companies, and only when an action is about to take place are they to report themselves to the Medical Officer. This appears to be a most serious mistake, which is largely due to making an erroneous distinction between the position the battalion is placed in "on the march" and "in action." This distinction cannot be practically drawn. The battalion is on active service in an enemy's country, and therefore is always in the position of a battalion "in action." The bearers may not always be able to report themselves "when an action is about to take place," or if they can do so the Maltese cart may not be to the fore for some reason, and there is, therefore, no place to put their rifles and ammunition, and no stretchers ready for them; besides, the corporal told off to the Medical Officer cannot be expected to carry the medical companion, surgical haversack, and two water bottles, until relieved by the bearers. There is nothing gained by making these men tire themselves on the march by carrying rifles and ammunition, and the necessary belts and straps, if they are not to use them when the enemy comes in sight. The stretchers should, as already ordered by Regulations, be carried in the Maltese cart when the battalion is marching; but if the cart for some reason should not be available, it will be found that four stretchers are the outside number that can be carried by the bearers with advantage. The remaining four must be placed with the medical panniers in the Maltese cart. Stretcher bearers, from the time a Medical Officer is attached to a unit, should be entirely under his control. He should train them and they should work under him on the march, in action, and in camp. If they are only to report to him "previous to an action taking place" three-quarters of their usefulness is lost to him and to the battalion. In camp they, with the pioneers, should make the latrines, and perform other regimental sanitary duties,* also report immediately any cases of illness in their companies, such as diarrhoea. They should go on piquet with their companies, taking a stretcher with them. They never require their rifles and ammunition, and should never carry them except in savage warfare, nor should the regimental medical equipment cart ever be used for this purpose. Under this arrangement they could wear the red cross brassard as they would be strictly non-combatants throughout the campaign. To meet possible objections of Commanding Officers of units to the exclusive use of two men per company for such non-combatant duties, the Committee would point out that during the recent campaign it was found impracticable to utilise stretcher bearers for other duties than those enumerated. The alternative to this course would be the employment of men of the Royal Army Medical Corps or other medical units in similar numbers. The training of bandsmen in time of peace to be used as stretcher-bearers on service is a mistake, they do not possess the necessary physique, their presence in the battalion cannot be counted on, and in their absence the training of fresh stretcher bearers has to be commenced at short notice and under unfavourable conditions.

The regimental medical equipment cart should be distinguished by a red cross and used for medical purposes only.

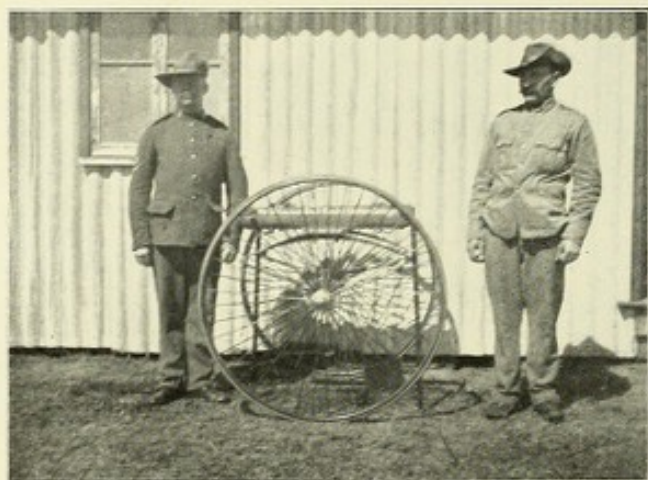
4.—PROPOSED MODIFICATION OF EQUIPMENT AND PERSONNEL (see Appendix III).

The following notes and suggestions, if adopted, would make it possible for the Medical Officer of a battalion to be more generally useful than at present, and are chiefly concerned with alterations in the medical equipment. A larger amount of surgical dressings should be allowed, and a box similar to the anti-septic case (tin lined) containing much the same materials, and having a smaller "expense" box inside it for holding the materials in actual use is recommended. The Medical Officer of a battalion is not as well equipped as he ought to

* It would be far better to have a separate sanitary staff. Stretcher bearers should certainly not be employed in these duties.



McCORMACK-BROOKE WHEELED STRETCHER.
(Open, with stretcher *in situ*.)



The same Stretcher closed—without stretcher.



WHEELED STRETCHER USED IN JOHANNESBURG.

be to meet ordinary dressings, and to combat minor complaints. A much larger amount of vaseline or some similar material for blisters or chafed parts should be allowed. The perforated zinc for making splints, together with the hammer and anvil, are not suitable things for a Regimental Medical Officer to depend on on active service. It is not at all probable he is in a position to make a splint from such materials just when it is required. It is considered that perforated zinc and the cardboard splints cannot take the place of ordinary wood or wire splints. The Medical Officer should have a sufficient number of reliable ready made splints with him (say, two sets). The addition of another surgical haversack (which would allow of one for each half battalion) is required, and if three more water bottles were allowed, each stretcher squad and the N.C. Officer with the Medical Officer would be in possession of one. This additional equipment would well repay the extra labour of carriage. On the march the Medical Officer must be able to treat cases of diarrhoea, colic, ordinary colds, malaria, dysentery, and collapse, and this leads us to suggest that increased quantities of the drugs to meet these diseases might take the place of the following rarely used remedies in the medical panniers, viz. :—Gallic acid, arg. nit., antipyrin, iodoform, aconite, pot. bicarb., Blaud's pills, and also such large quantities of pulv. ipecac. The amount of tincture of opium might be doubled and the extract omitted, the quantity of castor oil should be increased, and the olive oil could be omitted. The case containing the hypodermic syringe would be improved by adding a little cup that would stand and was large enough to allow the top of the syringe to enter it. For use on the field we propose a flat leather case divided into two compartments that would fit into the left breast pocket, one compartment to contain a flat bottle (capable of holding half an ounce of solution of morphia), the mouth of which must be fairly wide, or fitted with an indiarubber tube, to allow the solution to be easily drawn into the syringe, and the other a metal case with screw or bayonet-catch lid to hold a hypodermic syringe and two needles.* It is very difficult with our present arrangements for a Medical Officer to have the morphia solution and the syringe always at hand, and the above would, perhaps, meet the difficulty. The solution for the bottle is freshly made before an action, using the case of tablets. A binaural stethoscope should take the place of the present single one, as nothing can be heard with the latter in camp. Two good-sized enamelled basins would be a most useful addition to the Medical Officer's equipment. An additional lantern, and some cleanly means of carrying a supply of candles is required.

In the Army Medical Department Report, 1899, p. 467, there is a description of an "emergency carrier"; it would be of service for bringing in cases from short distances that do not require a stretcher, and as the "carrier" only weighs 8 ounces, it seems worthy of a trial. Light frames on wheels, called the "McCormack-Brooke," for carrying loaded stretchers, were used in hospital camps a good deal, and gave much satisfaction. If these were modified, they would be of use on the march, in action, and also in camp, saving the labour of turning out an ambulance for perhaps one case of sickness, and also because they would be able to go into many situations that would be impossible for an ambulance; yet the fatigue to the bearers wheeling the carriage is very slight, and two men could bring the patient many miles over a fair road with moderate comfort to the man and ease to themselves. The modifications recommended are the following :—The wheels must be made about 6 to 9 inches less in diameter, and the legs increased from two to four; the wheels must be made easily detachable from the frame, so that when the carriage is not in use the whole can easily be packed in the Maltese cart. The modifications would allow of two bearers lifting a loaded stretcher on and off the frame with ease and safety, which the present wheeled carriage does not. One or two of these wheeled frames for each battalion are suggested. It is necessary that a Medical Officer should have at least two tents; these should be part of his equipment, and be carried in the Maltese cart. One tent is his "inspection tent," and serves, besides, to keep the rain and dust off his medicines and dressings; the other is the "emergency" or "detained" tent, to receive any sick man from the lines, or where he can wait until a conveyance to hospital

* See p. 315.

can be provided. From the description in "Munson's Hygiene," p. 899, of his hospital tent to hold six men, it would appear that these tents would be very suitable for the above purposes: they are light, and could be carried on the Maltese cart, and would be at all times known as the hospital tents, and by this means would not be mixed up with the other tents in the company wagons and so lessen the liability of spreading disease.

Medical Equipment for Regimental Units in the Field.—This should be arranged to meet in every way the wants of these units only, keeping in mind that they are frequently isolated, though perhaps only for short periods. The equipment at present consists of many articles that, it is suggested, are unnecessarily duplicated, and with this and the above opinion, that the supply of medical and surgical equipment should be worked out to meet the requirements of solely regimental units, alterations in the present equipment and other suggested additions have been made (see Appendix III).

The following men of the battalion should be considered always at the disposal of the Medical Officer:—

- 1 N.C. Officer.
- 16 stretcher bearers.
- 1 orderly to look after the Maltese cart, and to act as the Medical Officer's personal servant.
- 1 groom.

Suggested contents of the Maltese cart:—

- 8 stretchers and 1 or 2 wheeled frames.
- Field medical panniers, Nos. 1 and 2.
- Antiseptic case or similar box.
- 2 special tents.
- 2 hand-basins.

5.—SANITATION.

The Committee are of opinion that no satisfactory system of camp sanitation can be carried out without the intelligent co-operation of Company and Commanding Officers, and consider that in future all Officers should receive periodical instruction in elementary hygiene, as applied to barracks and camps. As it is anticipated that sufficient mastery of this subject will not be obtained without examination, it is suggested that elementary hygiene should in future form a part of the subjects required for every examination for promotion, and be taught practically during the annual company field training.

Purification of Water.—(1) *Filtration.*—The Committee do not consider that any pattern of filter yet invented will meet the requirements of active service. The Berkefeld filter supplied to units in South Africa was not a success, being too slow in action and very liable to breakage. Some means of sterilising water by heat should be carried by all units which now carry Berkefeld filters. It is suggested that the Forbes Waterhouse steriliser might be experimented with in view of its adoption as a standard pattern should the results give satisfaction.*

Disposal of Excreta.—The instructions laid down as regards the disposal of excreta in "Combined Training (Provisional)," Parts VI to IX, 1903, if efficiently carried out, leave little to be desired. Latrines and urinals should be dug immediately on arrival in camp to avoid soiling the ground. While the regulation trenches are in course of preparation a shallow trench of small dimensions for immediate use should be prepared. The latrines should not be placed too far from the bivouac, or men will soil the ground in the vicinity of their sleeping places. During the night empty biscuit tins or other receptacles should be placed near each company to be used as night urinals, as it is found by experience that men will not go even a short distance to a latrine at night for this purpose. In camps likely to be occupied for more than 24 hours, latrines and urinals should be dug in duplicate, to permit of their proper supervision and to allow for soakage; with trenches in constant use this not practicable. The sites of all latrines should be marked on

* This has been done.

evacuating a camp for the sake of others who may subsequently be obliged to use the same ground.

Dead Animals.—If dead animals cannot be dealt with as laid down in existing regulations, it is always possible to hasten the natural process of decay by merely ripping open the bellies of the animals. This was found in South Africa, where fuel was scarce, to reduce the offensive period of putrefaction from weeks to days.

Horse Dung.—With mounted troops collections of horse dung are a fruitful source of flies. Accumulations can generally be obviated by insisting on the manure being spread out daily for a short time to dry, and then burning it. This is generally feasible in ordinary weather, but it is difficult to enforce. The practice of collecting it in empty corn sacks and throwing it into depressions in the ground is very insanitary.

Refuse Water of Field Kitchens and Washing Places.—In camps occupied for more than 24 hours, the refuse water containing grease and soap should, previous to being drained away, be thrown over a collection of brambles, twigs, or coarse grass, &c., which intercepts fatty material. The intercepting material can be burned when necessary.

6.—RATIONS, CLOTHING, &c.

The biscuit ration was barely enough,* and when reduced, as it was several times to one half, it became starvation diet. Fortunately the troops never had a very long spell of such short commons, but the evil effects were noticeable for many days after the men had again come on full diet, they were much weakened, and could only do short marches with any ease. Any reduction in the meat ration was not nearly such a trial, perhaps because it was frequently very poor in quality, tough, and uninviting. The tinned beef in its different forms was very good at all times. The rum ration was much appreciated, and did nothing but good after some of the long and exhausting marches, especially during the cold months. Tea ought to be allowed in more liberal quantities, say half an ounce per man daily. The men would carry it willingly, and perhaps the knowledge of its refreshing qualities would help them to wait until the water was boiled and the tea added in their canteens. They are always keen cooks, and the increased issue would be a good thing and help to prevent illness. Coffee was always greatly valued by Officers and men, cheese would have been greatly appreciated,† sugar and jam, of which there was a most liberal allowance, were much liked, and were of great value as articles of food. No "fancy" biscuits ought to have been tried on the men; on some occasions rather daintily made biscuits flavoured with ginger were issued, they were most unsuitable and not satisfying as food.

Khaki drill is a distinctly dangerous clothing for many months of the year in South Africa, and serge should entirely take its place. The method of wearing puttees over ordinary trousers led to dragging at the knees and at the seat, consequently after a very short time the men's trousers were hopelessly torn at both places. Either peg-top trousers or knee breeches with double cloth at the knee and seat would be an improvement, they should be made of ample dimensions. Three or four pairs of socks are needed to allow of sufficient changing and washing.

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N. C. FERGUSON, Major, R.A.M.C.

R. J. C. COTTELL, Major, R.A.M.C.

* This was not the universal opinion.

† Cheese was allowed among the "equivalents" (see pp. 384, 386).

PART III.

FIELD MEDICAL UNITS.

1.—INTRODUCTORY.

In the general account of the medical arrangements, the work of the field medical units has been shown to have comprised, firstly, their legitimate use in the field, and secondly, their compulsory use as stationary hospitals.

During the early part of the campaign the work of these units in the field was conducted more or less on established lines, but their efficiency was impaired by want of transport. In the later stages the bearer companies and field hospitals were reorganised so as to form a large number of combined units, with a reduced personnel and equipment, to meet the requirements of the small mobile columns. In October, 1901, 84 field units were employed in various parts of the field, which were developed from sections of bearer companies and field hospitals. During this period the transport difficulty was lessened, and the chief ground of complaint was regarding the inferior quality of the draught animals supplied, while it happened on more than one occasion that animals which had been well looked after, and got into first-class condition by the Officer commanding the medical unit, were, through the exigencies of the service, taken from him and replaced by worn out animals, almost (if not quite) unfit for work. Though probably unavoidable, this is a course not calculated to encourage Officers to look after their transport animals.

2.—SCALES OF TRANSPORT.

The following statement shows the position with regard to the transport and field medical units during the late war.

In O/79/9706, dealing with the medical arrangements for South Africa, it was pointed out that the regulation transport arrangements had been considerably modified to meet local requirements in South Africa.

These modifications were published in the "Organisation and Details of Transport," Cape Town, 1899, which gave the following as the scale for medical units:—

Bearer company—Water cart	1	} With 1 conductor and 35 natives; mules, 139; oxen, 6.
Buckwagons	...	...	2
Ambulances	...	...	10
Ox cart	...	...	1

Field hospital, corps troops, and brigade—

Water carts	2	} With 20 natives, no conductor; mules, 64; oxen, 6.
Scotch cart	...	...	1
Buckwagons	...	...	4
Ox cart	...	...	1

Field hospital, infantry divisional troops, has one water cart less, and one buckwagon in addition.

It is specifically noted that "all units will draw and organise their own regimental transport."

Loads of vehicles—

Buckwagon	...	...	...	...	3,000 lbs.
Scotch cart	...	...	...	...	1,500 "
Ox cart	...	...	...	...	1,500 "

Ten per cent. of spare mules were authorised, with one Cape boy for every four mules or less ; also two Cape boys per vehicle, with 10 per cent. spare, and one conductor for every 10 vehicles.

Army Order No. 4, Cape Town, January 24th, 1900, announced the reorganisation of the transport ; " with certain exceptions, regimental transport will be withdrawn and become general transport." The exceptions are detailed in Army Order No. 2, of January 29th, 1900 : " the following vehicles will remain with units : all others will be available as general transport " :—

Bearer company—Water carts	...	...	2, to be muled by transport.
Ambulances	...	...	2, " "
Field hospital—Water carts	...	...	2, " "

By the scale of equipment and transport (Authority, Chief of Staff's telegram, No. M 87, dated Driefontein, Orange Free State, March 11th, 1900), the transport allowed for technical units is shown as follows :—

Bearer company—1 mule wagon and 1 Scotch cart per company.
Field hospital—2 mule wagons.

This is the scale with which the medical units left the Modder River.

On March 15th Lord Roberts directed that the transport of bearer companies and field hospitals be made up to establishment, and that the balance of transport for this purpose should be sent up as soon as opportunity offered.

This authority, however, was not published till April 30th, when the following appeared :—

Army Orders, South Africa,
Bloemfontein, April 30th, 1900.

* * * * *

7. *Medical*.—The following scale of transport for field hospitals and bearer companies is authorised, and will be supplied on demand by the senior transport Officer of the brigade or division concerned :—

4 buckwagons, 1 Scotch cart, 2 water carts, per field hospital.
2 buckwagons, 1 water cart, per bearer company.

One extra Scotch cart if available will be issued to each field hospital of the cavalry division, as these field hospitals are divided into two sections. If not available, General Officers Commanding will obtain suitable carts by requisition on the inhabitants of the country.

This is short of the original scale by one ox cart in the bearer companies and field hospitals other than those of the cavalry division.

There was, however, considerable difficulty and delay in the supply of this transport, which never again reached the scale originally sanctioned, and at times was short of the bare minimum requisite to maintain these units in a fit condition to take the field.

In Natal, on the contrary, the same trouble, owing to deficiencies of transport, did not occur.

This scale remained in force until January 1st, 1901, when the following was substituted (" Scale of Equipment and Transport ") :—

Field hospital—4 mule wagons, 1 Scotch cart or trolley.
Bearer company—2 mule wagons, 1 Scotch cart or trolley.

The first line transport was then—

Bearer company	} 2 water carts, 12 mules, ambulances as ordered ;
Field hospital		8 mules per ambulance.

The second line transport was as above, with—

Field hospital	...	...	...	46 mules.
Bearer company	...	...	...	26 "

(3959) L

This scale formed the basis on which the requirements were supplied till the end of the campaign. But there was considerable elasticity. The field medical units were not of a uniform size, but arranged in proportion to the strength of the columns with which they took the field, and the difference shown above as between bearer company and field hospital was really one depending on the size of the units.

The difficulties at this period were, as has been stated, not in the number of vehicles but in the condition of the draught animals.

The ambulance transport was also materially altered. No universal scale was adhered to but the necessities of individual units, varying with its strength and the country it was working in, were considered. Four ambulance wagons were generally supplied, with tongas while these were available, and later Cape carts in their stead. There is no doubt that the light two-wheeled cart is eminently suited for such work as was then necessary; probably a light four-wheeled vehicle would be better, but these were not available in any number, though some units were able to obtain the light "spider" of the country, which worked very well.

By this stage of the campaign Officers had a large practical experience of what was really needed in the field. This, of course, varied in individual cases: one Officer could get on equally well with a less elaborate equipment than another. But this was a matter which was left to the individual judgment of the man who had to do the work, and, therefore, the equipment actually taken into the field varied in each instance. The one condition incumbent in each case was, that the mobility of the unit should be increased as much as possible.

3.—REMARKS.

In order to make use of the practical experience of Officers in command of the field medical units, a Committee was formed of Officers who commanded field medical units during the campaign to consider all points bearing on the subject. Their report is included here, and thereto have been added notes on such points as seem to need qualification or elucidation.

The line on which the development of the field medical organisation should take place seems to be that the existing field hospital with its present equipment, neither calculated for sufficient mobility on the one hand, nor on the other for the continued treatment of sick and wounded, should be replaced by a more mobile field ambulance for the brigades and a more elaborate divisional field hospital, with a series of well-equipped line of communication hospitals as close to the fighting line as possible. The one possible objection from the medical point of view is, that such a field ambulance would not normally be suitable for the treatment of the sick and wounded from a small garrison at a detached post. For this the existing field hospital would be better suited. But even the existing field hospital is not sufficient for this; it requires additional equipment, and if the advanced line of communication hospitals are on the ground as early as they should be, it would not be necessary to utilise field hospitals of any description for this purpose during the early stages of the campaign, while later, in case of necessity, additional equipment can easily be obtained and supplied to them.

It only remains to add that of all the units which were in the field in South Africa, the bearer companies and field hospitals of the Royal Army Medical Corps have probably the most continuous record of work. Most of the regiments were in garrison or on the line of communications for a period from time to time as columns were broken up and dispositions changed, but the field medical units went from their brigades to a column, from one column to another until the campaign ended.

The work of their personnel, both Officers and men, was extremely good under any circumstances, and the way in which they maintained their interest and zeal deserves record.

4.—REPORT OF A COMMITTEE APPOINTED TO CONSIDER THE ORGANISATION AND EQUIPMENT OF FIELD MEDICAL UNITS.

The information at the disposal of the Committee has largely consisted of reports from numerous Officers lately commanding bearer companies and field hospitals during the South African campaign, and they desire to acknowledge the assistance which those reports have afforded them in the preparation of their joint Report.

The Committee have also had the benefit of advice and help from some Officers of high standing in the Army Medical Service, whose extensive experience with the working of medical units in the field has been of great assistance to them, and from others whose high professional attainments lend to their opinions a special value.

In preparing the Report, the Committee have endeavoured to follow as far as possible the headings in the Schedule furnished by Surgeon-General Sir W. D. Wilson, K.C.M.G., without limiting too closely the scope of their Report, which it was stated should embrace all points connected in any way with the organisation, equipment, and working of field hospitals and bearer companies. The Report has been, as far as possible, arranged under the following headings :—

Field Units.

(1) Number required per division, and—

- (a) The nature of a cavalry brigade unit.
- (b) The nature of a divisional hospital; whether it should be more fully equipped than the brigade field hospital, and whether a combined unit or not.

(2) The question of amalgamation into one combined unit, or their continued separate existence.

(3) How should these units be named and numbered?

(4) The personnel required, the division of their work, the degree of training necessary, and the question of transport of the whole or part of the personnel.

(5) The work of the units on the march, in and after action, especially considering cavalry brigade units.

(6) Equipment, ordnance, medical and surgical; its improvement by addition or omission.

(7) Transport: its amount, nature, and class, both general and ambulance; under the latter the description of ambulances required and recommended, and a description of the Canadian field ambulance.

(8) Stretchers, hand, wheeled; their improvement. Numbers needed, and carriage of these.

(9) Field cooking.

(10) Reception, care, and storage of arms and accoutrements.

(11) Reception and custody of valuables; whether the method adopted in the last part of the war, of handing moneys over to the Field Paymaster, was a satisfactory solution of the difficulty.

(12) Clerical work and returns. Special reference to para. 1727 King's Regulations and Army Form A.36.

(13) The question of reserves for the Medical Service in the field.

(14) General remarks on the proposed scale of equipment for a field ambulance of four sections, each section capable of accommodating 40 patients, and being in every way self-supporting, and capable of independent action (see Appendix XIV).

President.—R. W. FORD, Lieut.-Colonel, R.A.M.C.

Members { R. PORTER, Lieut.-Colonel, R.A.M.C.
R. H. S. SAWYER, Lieut.-Colonel, R.A.M.C.
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J. FALLON, Major, R.A.M.C.
J. KEARNEY, Major, R.A.M.C.

(1) *Number Required per Division.*

(i) The Committee consider there should be three medical units—one for each brigade of infantry, and a third, larger and more fully equipped in every way, to be described under (ii).

Each brigade of a division should have a field medical unit capable of treating temporarily 100 or 150 sick and wounded. It should be a combined unit, as lightly equipped as possible, and should consist of a bearer division and a tent division. Each of these field medical units should be divisible into four sections. Each section should be complete in itself, and have its own medical, surgical, and ordnance equipment, the panniers, &c., of each section bearing designating letters or numbers. Each section should also have its own personnel of bearer division and tent division, and be capable of independent action at short notice. The present field hospital is only imperfectly divisible into halves, yet during the recent campaign one frequently received orders from General Officers Commanding to send a "section" of the hospital with detached bodies of troops. The preparation of this "section" invariably caused great trouble and anxiety. We therefore consider the divisibility of the proposed new field medical unit into sections to be essential.

Each field medical unit should have eight or ten ambulances, each ambulance capable of carrying four lying-down cases, also the necessary store wagons, &c. The draught animals of these units should be mules, and none of their wagons should be so heavily laden as to prevent them easily keeping up with the advancing troops. The terms "hospital" and "bed" as applied to these field medical units of the brigades should be abolished as misnomers, and calculated to convey a false idea in the mind of the army generally. Some form of light tents should be carried, and it should be distinctly understood that these field medical units are not hospitals in the generally recognised sense of the term, but are devised to be as mobile as possible, and to give immediate, though only temporary, shelter and medical and surgical aid to the sick and wounded of the division. It is not in our opinion feasible to combine in a field medical unit great mobility and efficient treatment of sick and wounded for any length of time.

These field medical units with the brigades should evacuate their cases as soon as possible into the *third* field medical unit, *i.e.*, the field hospital.

(ii).—For this, the third field medical unit of a division, we would retain the name of field hospital.

This should be a much larger unit and much more elaborately equipped than the two field medical units of the brigades. In this unit the sick and wounded should be able to obtain more comfort than was possible in the field hospitals during the recent South African campaign. It should accommodate 200 sick and wounded on light stretcher beds. Its tents might be larger and heavier than those with the brigade field medical units, its wagons would be heavier and drawn by oxen (presuming a campaign like the recent one in South Africa), and it would follow the division more slowly. We suggest for this unit the "Hubert" pattern or tortoise tents, and stretcher beds like those of Major Fiaschi's Australian Field Hospital, which some of us had the privilege of inspecting at Paardeberg.

The field hospital should be divisible into four sections of 50 beds, each section complete in itself as regards tentage, stores, personnel, and transport. If this were done a section could be dropped or detached wherever desired.

The field hospital should be a combined unit in that it should possess a full complement of ambulance wagons or transport carts convertible into ambulances. Each section should have two ambulances allotted to it for evacuation purposes.

The field medical units with the brigades of the division would keep in constant touch by means of their ambulances with the larger and heavier field hospital following more slowly in the rear. They would constantly empty their sick and wounded into it, and the field hospital in its turn would evacuate by means of its ambulances into the nearest hospital on lines of communication or nearest stationary hospital. During the recent campaign the brigade field hospitals found great difficulty in coping with the demands of the Regimental Medical Officers for medicines, surgical materials and

medical comforts. They did not, and could not, carry a supply large enough for these constant requisitions, and the necessities of the Regimental Medical Officers were supplied direct from the lines of communication depôts.

The wagons of the field hospital should carry a large supply of medicines in tabloid form, surgical materials, and medical comforts, and the regimental units should fill up when necessary from this source.

(a) General Remarks on the nature of a Cavalry Brigade Unit.

The bearer company and field hospital arrangements for a brigade of cavalry are under present conditions precisely the same as for a brigade of infantry; that is to say, we attach a body of dismounted men to act with mounted, actively mobile troops. This impossible system was condemned as far back as 1882 by no less an authority than the late Major-General Sir Herbert Stewart, K.C.B., and an important minute by that Officer is to be found at p. 703, Appendix 39 of the "Report on the Hospitals in Egypt, 1882," by Lord Morley's Committee. It is called a "Report on the Hospital Requirements of Cavalry in the Field." Sir Herbert Stewart expresses the opinion most strongly that a "mounted bearer company" is needed to work with cavalry in the field. Subsequent experience has more than justified that opinion, yet still the "bearer company" for cavalry purposes is to-day no more mobile or capable of fulfilling its proper functions than it was 20 years ago.

The question of devising a really efficient and mobile ambulance unit for duty with mounted troops is one that presents some difficulties. One thing is clear, it must be a mounted unit in the sense that the personnel may be either mounted or carried—probably a unit with a judicious mixture of mounted and carried men will be found to be the best solution of the problem.

If all, or nearly all, are mounted, what will happen to the horses when the company dismount for work with the stretchers and ambulances? It would not be possible for each mounted man to have a batman to hold his horse. Again, when in camp, who is there to look after, groom, and feed a large number of horses? The Officers and men are required for duty with the sick and wounded, and could not do so, even if it were desirable to turn them into troopers. We think, therefore, that the majority of the personnel should be carried, some in light carts and others in the ambulances, the Officers and a few N.C. Officers being mounted.

It is suggested that the "mounted field ambulance" should be composed as in the field ambulance for infantry, of a bearer division and a small "tent division," the first to accompany the columns and transfer its cases rapidly to the second (see Appendix XVI).

The personnel should be carried chiefly in the ambulances, the Officers and some N.C. Officers riding. They should be sufficient in numbers to collect the wounded, and when necessary form an efficiently manned "collecting and dressing station," i.e., if the wounded were numerous enough to necessitate such a formation. It is a matter of experience, however, that the sick and wounded of infantry are always far more numerous than in the cavalry. Accompanying the "bearer division" should be a light "medicine supply wagon" for the equipment of a dressing station. A sufficiency of instruments and dressings, a small camp equipment, cooking pots, &c., blankets, stimulants, beef tea, brandy, &c.

[NOTE.—It seems to be absolutely necessary that in future the personnel of the cavalry brigade unit should be carried in some way or other. If not, they might as well be off the field.]

There should be nothing to correspond in any sense with a cumbersome field hospital in point of size and equipment. Any really heavy section of a mounted field ambulance would be out of place and defeat its own ends by moving too slowly. There should be tentage to provide shelter for not more than 50 patients, and a few additional N.C. Officers and men to look after them, and a reserve of camp kit, medical and surgical equipment, hospital utensils, and all the necessities on a small scale for the treatment of sick and wounded for a brief space of time. The bearers of the mounted field ambulance will not as in the infantry unit be able to afford much assistance as "tent

Bearer
division.

Tent
division.

division" orderlies, for they will be required to keep pace with the constantly moving cavalry brigade, so that it will be necessary for the tent division of the ambulance to remain behind with any accumulation of sick or wounded until they can evacuate them into the nearest infantry field ambulance or field hospital. It should be clearly laid down that it is the special privilege of mounted units so to dispose of their wounded, otherwise it will be impossible for them to maintain that high degree of mobility which is their first essential. The tent division having delivered the sick into the nearest infantry unit must follow up their brigade as quickly as possible. The bearer division will have already followed the brigade, and must make the best provision it can for wounded till the tents, &c., are brought up. It is impossible in war to make provision for every emergency. A good deal must always be left to the initiative and experience of individual Officers.

A unit constituted somewhat on these lines should be capable of easy division into two sections by having its equipment duplicated in almost every particular. Any smaller division would not be useful, but there is no reason why an extra mounted ambulance should not be attached to a cavalry division to meet emergencies, and be held in reserve, in the same way that under the present system there is a third field hospital to a division of infantry, and the Committee suggest that this be done.

[NOTE.—The necessity of this 3rd mounted ambulance is not apparent. The infantry field ambulances will always be more or less in touch with the cavalry at the time when the suggested 3rd ambulance alone could be utilised, and this is in conformity with the previous suggestions as to the evacuation from cavalry brigade units.]

Ambulances of a mounted unit to be of two kinds.

Two-wheeled tonga suggested by some officers.

Ambulance of the 2nd line.

So far as the ambulances of a mounted unit are concerned, it is felt that they should be of two kinds: a light four-wheeled ambulance with hood, equipped somewhat like the Indian tonga, capable of carrying two lying down cases and four sitting, and others of heavier pattern capable of holding four lying down cases and more sitting. The former to range widely on the flanks with advancing cavalry to search for and pick up single wounded men and bring them back to the heavier ambulances; the ambulances of the first line to act as feeders to the second. An Officer with experience, writing on this subject, says: "I would also suggest a lighter two-wheeled tonga, something after the pattern of Danjibhoys, only much lighter, and drawn by two mules. It often happens that one has to send out to bring in a single wounded man, and at present this entails sending a heavy wagon and 10 mules, when a light tonga and two mules would be quite sufficient for this purpose." Speaking generally, however, the Committee have not concluded that the tonga (two-wheeled) is a very serviceable vehicle to adopt. The reports upon them have not been very satisfactory, although in the Tirah campaign they were well spoken of. It is thought, therefore, that a light ambulance on four wheels is on the whole preferable to a two-wheeled one, but no reliable conclusion can be arrived at without further trial of equally well-constructed two and four-wheeled ambulances to meet the requirements here indicated.

As to the ambulances of the second line, the Committee recommend the adoption of a wagon built on the Canadian pattern, well reported upon by Lieut.-Colonel Worthington, lately commanding 10th Canadian Field Hospital. They are transport wagons convertible into ambulances. In a report to the "Montreal Medical Journal," written when serving with Kekewich's Column, Vaalbank, Transvaal, he says: "The transport wagons convertible into ambulances are somewhat similar in pattern to the Canadian prairie wagon. Strong but light running they carry four lying down cases and two sitting up, and have all necessary wagon accessories, a detachable galvanised-iron tank holding eight gallons of sterilised water, which can be placed on tripod over fire and boiled, or if fuel be scarce filled in camp from a Forbes' steriliser. The lightness of the wagons as compared with the English pattern can be realised from the fact that we frequently carry four lying down cases to Klerksdorp, 40 miles in 12 hours with two horses, and that in the four stretchers there is a saving of over 60 lbs."

An Officer, writing on the subject of cavalry brigade units, gives the following as his experience: "On the march to Kimberley and to Bloemfontein, and subsequently to Pretoria, via Kroonstadt and Johannesburg, our

men were the only dismounted ones in the Cavalry Division. As cavalry move very rapidly and cover longer distances than infantry, it was quite impossible for our men to keep up unless helped along in the ambulances and on the transport wagons, the latter variety of help being at the expense of the already over-burdened mules. On one occasion, from De Kiels Drift to Klip Drift on the Modder River (owing to the burning veldt) over 28 miles were covered. The mules were quite done up, and our men arrived in camp so tired out that it would have been a physical impossibility for them to have attended to sick or wounded if any had been waiting. It is not fair to expect men to be ready for work after a long and fatiguing march, and, I think, even in the case of infantry units it would be advisable to carry the men, carriage should be provided for in light brakes. If horses are allowed the men's time would be occupied in attending to them, and many are unable to ride."

There is no very useful guidance as to the best kind of field unit for duty with mounted troops to be obtained from the methods adopted in Continental armies. In the French army the wounded of cavalry are left to be collected by the stretcher bearers of the ambulance or nearest infantry or artillery unit, but it is the custom for each regiment of cavalry, in addition to the "voiture medicale," which carries medical and surgical equipment, to be accompanied by two-wheeled ambulance wagons, each of which carries a surgical pannier (panier regimentaire pour troupes à cheval), and the ordinary ambulances have, in addition to ambulance wagons, so many mules with cacolets and litters. It is not the province of this Committee to consider the sufficiency or otherwise of the regimental aid, but it is suggested that a small proportion of horses per squadron (say two) might, with a few mounted orderlies, be used in this way, or, at any rate, a trial made of the utility of cacolets with mounted troops.

Medical aid
for mounted
troops in
French
Army.

In the American army the following is laid down :—

"On the march each Medical Officer will be habitually attended by a mounted private of the hospital corps. Hospital stewards (corresponding to our senior N.C. Officers) and at least one private of the corps in each separate command, will be mounted when serving in the field, and all privates of the corps will be mounted when serving with mounted commands. Horses to be furnished from the Quartermaster's Department, and horse equipment by the Ordnance Department."

Mounted
hospital
corps
orderlies,
U.S. Army.

(b) Nature of a Divisional Field Hospital.

The Committee consider that the Divisional Field Hospital is an essential unit in every division. If, however, the field ambulance units of brigades be, as is suggested, enlarged so as to be capable of receiving 150 or more patients, this increase in accommodation would provide for the temporary treatment of the sick of the divisional troops, for which hitherto the divisional field hospital has been provided. It is considered, however, that while the ambulance units are equipped only for the temporary reception of sick and wounded, the field hospital should be specially organised for more permanent treatment of patients than has hitherto been the case, and that its special function shall be to act as an evacuation hospital for the field ambulance units.

Divisional
hospital to
act as an
evacuation
hospital for
ambulance
units.

As at present constituted the divisional field hospital does not meet the requirements above indicated, being itself only in the nature of an ambulance unit, equipped with the bare requisites for temporary treatment of 100 patients. It has no beds, is only supplied with eight stretchers, has no invalid clothing, and is provided only with bell tents, which the Committee think are not adapted for any prolonged treatment of sick.

It invariably happens during the advance of an army that one or other of the field hospitals has, for a time, to remain stationary, owing to the impossibility of evacuating directly into fixed hospitals.

In order to be able, in case of need, to remain in use for some time, it is considered desirable that the divisional field hospital should be more fully equipped than it is at present. There seems to be an absolute necessity for the presence with a division of a large and well-equipped field hospital, into which both field ambulance units can evacuate sick and wounded when necessary, so as to enable these two units to continue their uninterrupted advance with the army.

The
divisional
hospital a
mobile unit.

Transport
carts con-
vertible
into ambu-
lances.

The divisional field hospital should, however, be a mobile unit marching with the division to which it is attached, or following slowly after it. It is not considered necessary for it to be a combined unit in the sense of having a large number of bearers attached to it. The carts (or some of them at any rate) in which the equipment is packed should remain with the hospital, and be regarded as its wheeled transport, a number of these carts should be, as in the Canadian field hospital (to be hereafter alluded to), *convertible into ambulances*, and have all necessary wagon accessories. These convertible transport carts will form the *transport section*, so that, although for a time stationary, the hospital retains the necessary means of evacuating its sick and becoming again mobile.

[NOTE.—*Divisional Hospital.* This of course would not be a combined unit. It should be equipped with at least 100 stretchers, which would be available for the use of serious cases, and would also form a reserve to make up deficiencies in the units of the division. It should certainly be supplied with some clothing (flannel pyjamas and shirts), and with additional blankets, in fact, the whole equipment should be more complete than that of the brigade units, so that in case of necessity it might be employed as an advanced stationary hospital on the lines of communication with some probability of success. Such a hospital does not need a bearer section, but it requires control of a number of ambulances in addition to its convertible transport wagons; whether these should form part of its equipment, or be obtained from the supply recommended for the lines of communication, is a question to be settled. Probably the latter would be equally efficient, and it certainly would be more economical both in wagons and draught animals.]

Hospital
similar
to the
Canadian
pattern
suitable for
divisional
field
hospital.

After careful consideration the Committee recommend for this purpose a hospital equipped on practically the same lines as the 10th Canadian Field Hospital, lately serving in South Africa, which they consider in every way well adapted to fulfil all the requirements of an evacuation hospital for ambulance units; they recommend, however, that instead of accommodation 100 patients, it should be capable of expansion so as to be capable of receiving 200, or by the addition of personnel, tentage, and equipment, even a large number of sick.

The Canadian Field Hospital has been fully reported upon by a "Board of Officers," presided over by Lieut.-Colonel Porter, R.A.M.C., who inspected it in South Africa under circumstances that afforded them an excellent opportunity of observing its exceptional merits (*see* Appendix IV).

The chief features of this hospital will be only briefly alluded to here. Its most obvious advantages are as follows:—

Transport
wagons
convertible
into ambu-
lances.

"Hubert"
pattern
tent pre-
ferred for
field
hospitals.

Accommo-
dation of
the
"Hubert"
tent.

Medical
and sur-
gical equip-
ment as
supplied
to field
hospitals in
the U.S.
Army
recom-
mended.

1. Its transport wagons are convertible into ambulances, so that while stationary it still retains the means of evacuating its sick and becoming mobile.

2. It is provided with the "Hubert" pattern tent, upon which Colonel Porter reported as follows (*see* Appendix XI):—"The Board have formed a very high opinion of this tent, and consider it very suitable for both mobile work in the field and for stationary work. It is far superior to any pattern tent which they have seen in South Africa, and would strongly advise its introduction to our field equipment." They suggest, however, certain modifications (p. 334).

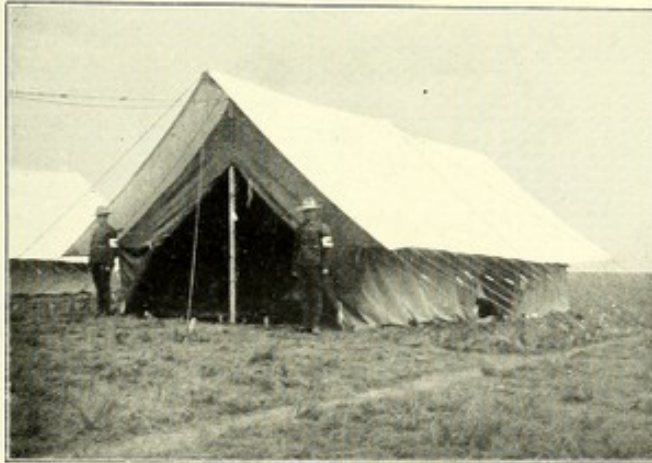
Accommodation.—It is capable of holding 10 patients comfortably on stretchers.

In case of emergency 20 on ground sheets.

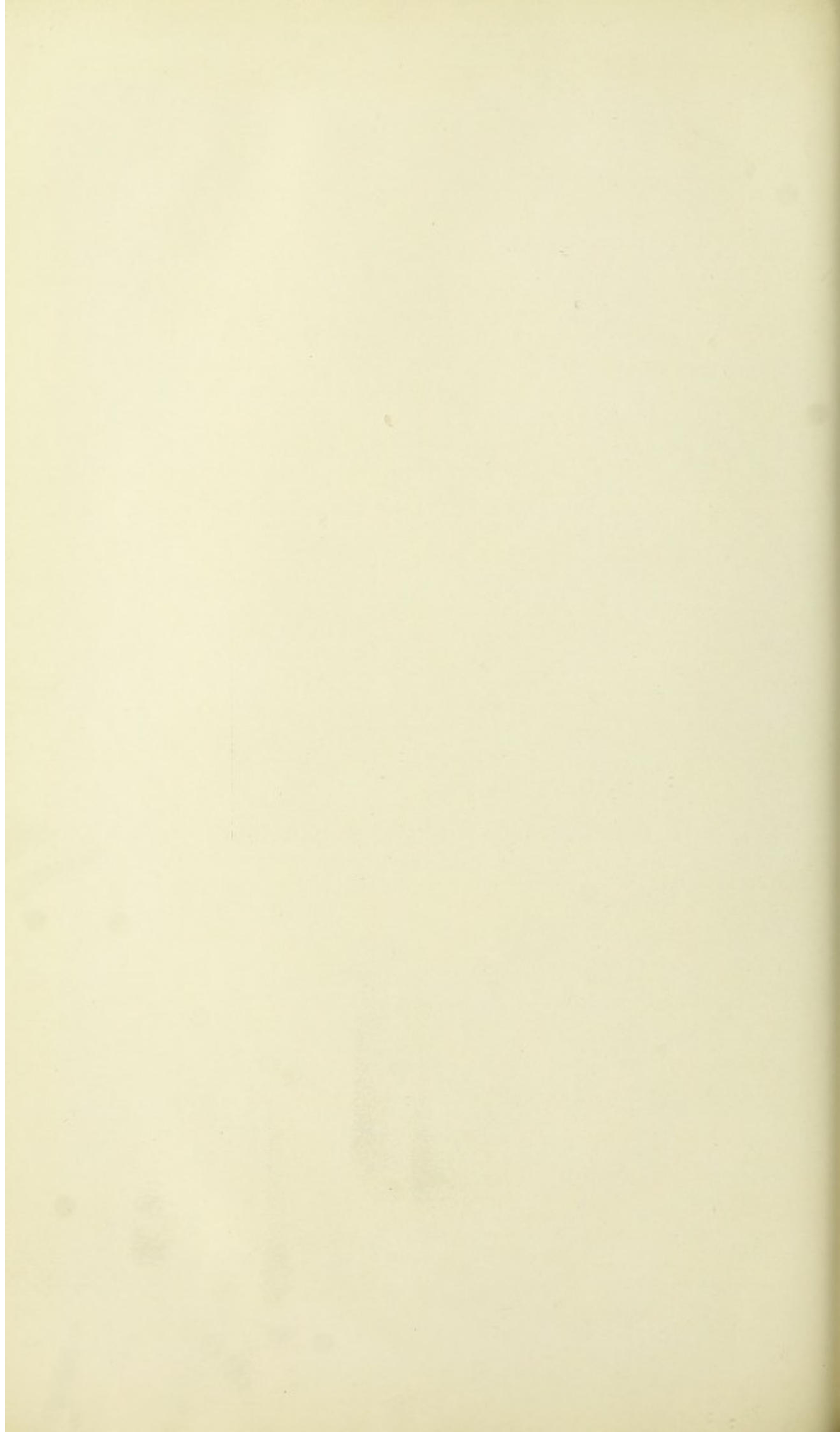
With beds of "Lawson Tait" pattern it holds seven patients easily.

3. The medical and surgical equipment, of the same pattern as that supplied to field hospitals in the United States army, is most complete, and in point of arrangement and general utility is certainly superior to ours. It includes a sterilising apparatus. The medical and surgical chests are made of oak, with brass corners and hasps, very strong and suitable for rough field work. Each chest has a canvas cover.

(To face p. 88.)



The "HUBERT" TENT.
(Used by the Canadian Field Hospital.)



4. It has an acetylene gas plant, from which tubing conveys the gas through the tents to lights of 30 candle-power. The Board considered "that the mode of lighting the 'Hubert' tent was the most important improvement which has yet been produced and adapted to hospitals in the Field" (see Appendix XII).

Acetylene gas plant.

5. *Plan of Encampment.*—This is given in the attached plan (see Appendix IV). Lieut.-Colonel Worthington, late Officer Commanding 10th Canadian Field Hospital, in a letter to the "Montreal Medical Journal," thus describes it: "The arrangement of tents according to the enclosed plan of encampment we have adopted and found most satisfactory and convenient. Arranged in the form of crosses, with flies meeting (except in the central compound, which is covered separately by rectangular fly suspended from pins of ridge poles) they comprise one cross, eight wards, capable of holding from 64 to 80 patients, according to use of beds or stretchers, and two smaller crosses of four wards each. This plan of encampment commends itself for adaptability and compactness, and is unique and picturesque. With doors rolled up one can see through the four wards at once, while from a convenient desk in the central compound the ward master can readily overlook the eight wards at a glance and superintend the work of the orderlies. In one corner of this compound is a Forbes steriliser, from which hot and cold sterilised water is at all times available. The plan of encampments in cross formation is readily changeable as regards the number of tents employed. In this plan the larger cross is available for medical or surgical cases, according to their respective predominance. With the eight tents available as surgical wards, one or more smaller crosses of four can be used for enteric and dysenteric cases. All are easy of access from the Officers' and ward section lines, the operating tent and the dispensary, and the horse lines are well out of the way."

Plan of encampment.

Medical and surgical cases accommodated in separate divisions.

"The dispensing and medical equipment is most excellent and compact. With a field hospital constructed on these lines the transport section can be utilised during and after an engagement for the same purpose as a bearer company, thus doing away with the latter."

To emphasise still more the utility of this hospital a further extract is made from Colonel Porter's Report: "On arrival at Klerksdorp from Durban by rail, a section of the hospital (roughly speaking, a quarter of the personnel and equipment) was detached from the main hospital and posted to "No. 1 Column" of General Kitchener's force, the remaining part became stationary on the Klerksdorp-Lichtenburg blockhouse line, taking in sick and wounded from the various columns operating in the district and any serious cases from the blockhouse line. From the above described arrangement, the Board have been enabled to form a good idea of the value of this hospital, both on the line of march as a true field hospital and as a stationary field hospital on the line of communication, and both of these during a time of great pressure, as the field hospital (as such) took part in the engagement of Boschbult, and the stationary unit took in the wounded from the engagement of Rooiwal."

The Canadian Field Hospital was fitted out in Canada, *especially as a field hospital having its own transport*, consisting of 10 wagons, nine of which were convertible into ambulances.

Field hospital with its own transport.

It is hardly possible to conceive a field hospital constructed on better lines than these, and the Committee strongly recommend its adoption.

The ambulances and water carts are all specially referred to in Appendix XVIII. Each has its distinctive advantages and all are recommended.

[NOTE.—The Canadian Field Hospital deserves all that is here said of its organisation and equipment.]

Lieut.-Colonel Sawyer was much impressed with the excellence of the tortoise tents, ambulances, and stretcher beds, used in Major Fiaschi's "Australian Field Hospital," which some members of the Committee remember at Paardeburg, and there is no doubt this field hospital merited the highest praise. The ambulances, too, were extremely good and superior to the English pattern. One of these ambulances was specially selected at the request of Lord Roberts to convey a wounded Officer from the 18th Brigade Field Hospital from Paardeburg to Kimberley, and Mr. Low, F.R.C.S. (civil surgeon), who accompanied the Officer in question, reported that he considered the ambulance a particularly good one. On the whole,

The tortoise tent of the Australian field hospital recommended by Lieut.-Colonel Sawyer.

however, opinion favours the adoption of the "Hubert" tent in preference to others for British field hospitals.

Tent equipment of U.S. Army recommended. In order to make the field hospitals more suitable for the possible retention of cases under treatment, the Committee think it might usefully be supplied with light pattern bed-cots (weight about 15 lbs.), and suggest that the plan adopted for the equipment of field hospitals in the United States Army be followed.

Tent unit system. The amount of "field furniture" and bedding required is estimated on the "tent unit system."

Thus a complete assortment of bedding, linen, &c., sufficient to furnish one hospital tent, accommodating six patients, is carried in the field in a single *canvas bedding case*, having the dimensions 16" x 22" x 30", as follows:—

The canvas bedding case.	Bed sacks	...	...	6	Pillow cases, cotton	...	6
	Blankets (grey)	...	...	12	Pillow sacks	...	6
	Blanket, rubber	...	...	1	Sheets, cotton	...	12
	Suits, convalescent	...	...	6	Shirts, cotton	...	6
	Towels, hand	...	...	6			

Under certain circumstances, mosquito bars* for bed-cots are supplied.

Folding field furniture tent unit.

Contents of *Folding Field Furniture Chest*, tent unit—

Chair	...	...	1	Table with interlocking	
Cots	...	...	6	arrangement	...
					1

Mosquito bar* frames.

Commode chest.

Contents of *Commode Chest*, tent unit—

Bed-pan, Agate ware	...	1	Spit-cup, Agate ware	...	1
Chamber-pot, Agate ware	...	1	Urinal, Agate ware	...	1
Paper, toilet, packages	...	6			

Food chest.

Both the above in iron-bound wooden chest, with two hasps and buttons. *Food Chest* of hospital stores, containing the usual medical comforts, outfitted for use of 25 patients.

Mess chest.

Mess Chest (small) outfitted for 25 patients, and containing all eating and cooking necessities.

Field Range (small) outfitted, to meet the needs of 25 patients.

Bath Tub Set.—Bath tub, folding rubbered duck, 6 feet, No. 1; ditto, 5½ feet, No. 1; in iron-bound wooden chest. One to every 25 patients.

Reserve of bedding, &c.

Reserve of bedding and clothing, in addition to the tent unit supply, for each 100 patients or 100 bedded hospital:—

Bed sacks	...	...	50	Shirts, cotton	...	...	110
Blankets	...	...	7	Socks, woollen	...	prs.	60
Pillows	...	...	12	Suits, convalescent	...	...	220
Pillow cases, cotton	...	...	110	Towels, bath	...	doz.	12
Pillow sacks	...	...	50	Towels, hand	...	..	50
Sheets, cotton	...	...	220				

Equipment to be packed in sections for 25 patients each.

It would be practically useful if equipment were packed in sections sufficient to outfit in every respect (except medicines) 25 patients, and a large quantity collected at the base to supplement, and, if necessary, speedily expand field hospitals if converted into stationary field hospitals. Calculation as to amount of equipment required for a field hospital of any number of beds can easily be made on this basis, and assortment simplified.

Field hospitals divisible into four sections.

Every field hospital should be divisible into four sections if a 200-bedded divisional hospital, as is suggested, for each division be adopted. Each section would accommodate 50 patients, and if this is decided upon, equipment should be packed in sections of 50 and sub-sections of 25.

It should be possible for a section to be dropped or detached if required, and the remainder follow the division.

If transport not available for bedding, &c.,

It might not, of course, be possible to provide transport for a large quantity of tent beds, bedding, &c., in the first instance—the carriage of these things is purely a question of transport; but light equipment of this kind

* Anglice, "curtains."

might be pushed forward by road or rail as opportunity offered: but in any case, even at the outset, a large number of light stretchers should be provided, even if only as a temporary measure, sufficient to accommodate, say, 70 per cent. of sick. Additional carriage would have to be provided for them.

Field hospitals should always be provided with an extra allowance of ward utensils; there will invariably be a large number of men suffering from bowel diseases, the inevitable accompaniment of an army in the field.

The field hospital sections should be packed and arranged in the same way as that proposed for field ambulance units, so that they can be readily detached and used separately if desired.

[NOTE.—As regards the suggested "tent equipment," if these proposals apply only to the "divisional" hospital, there appears to be everything in their favour. But as regards the field ambulance, everything which conduces to the retention of cases in the field, when they can be removed, should be avoided. Immediate evacuation should be the rule, and the equipment should be provided to meet probable, not possible, necessities. On the other hand, light bed-cots should invariably accompany the divisional and advanced line of communication hospitals.]

(2) *The Question of Amalgamation into one Combined Unit of the Bearer Company and Field Hospital.*

The consensus of opinion appears to be strongly in favour of a combined unit, to be called a *field ambulance*, for which the following advantages are claimed:—

1. The whole field ambulance being under one Commanding Officer, the system of a dual control in the brigade field units is abolished.

2. The personnel of each division of the field ambulance (which it is proposed should be called the *tent* and *bearer* divisions) can be utilised separately, as occasion requires.

3. In camp the bearers would be employed for camp work generally—pitching tents and assisting the nursing section, but leaving the attendance on patients chiefly to the latter.

4. Under one Commanding Officer the division of duties would be facilitated.

5. In action the bearers go forward with the ambulances and fulfil the legitimate functions of a bearer corps. Under the present system it often happens that the personnel of a bearer company is idle while that of the field hospital is overworked; yet the Commanding Officer of the latter has no power, on his own initiative, of employing Officers and men of the bearer companies in the work of the hospital. There is thus an obvious advantage in having the personnel of both units under the control and at the disposition of one Commanding Officer. [Para. 695 of the "Regulations A.M.S.," 1900, deals to some extent with this point.]

6. The term field ambulance is one in use by all foreign armies.

7. Although the equipment of a hospital is subject to the laws of war, an ambulance under the Geneva Convention retains its equipment if captured.

Major Kearney, R.A.M.C., in advocating the combination of the two units, says: "The Indian Field Hospital in South Africa may be taken as an illustration of the efficient working of a combined unit. In the Natal campaign at Talana, Elandslaagte, and Rietfontein all the field work was done by the Indian hospitals. During General Buller's advance to Lydenburg, the 2nd and 3rd Cavalry Brigades, and the 7th Infantry Brigade had Indian hospitals acting as bearer company and field hospital, and in every action the wounded were promptly attended to and no difficulty occurred."

Major Donegan, who commanded an Indian Field Hospital, says: "It can be divided into four sections at a moment's notice, and under me the Officers commanded their sections as companies, and I did not interfere. One Officer acted as adjutant, one as Sanitary Officer and one as Transport Officer. At Talana I left one section in camp to attend to the wounded who were sent back early, and later on in the day I relieved it with a section from the field."

stretchers to be carried as temporary substitute. Extra allowance of ward utensils.

Efficiency of the Indian field hospital which is a combined unit.

Extract from Major Donegan's report.

Extract
from Major
Faunce's
report.

On the subject of amalgamation Major Faunce says: "As an Officer who commanded a bearer company I am decided on the point. I had practical experience of working as one unit from March 26th to May 18th, 1900, during which time my bearer company fulfilled the function also of a field hospital. I had, however, only the equipment of the former, supplemented by four bell tents. I was therefore deficient in shelter for sick and wounded. Notwithstanding this I was able to deal with the wounded at two important engagements, besides minor ones. As at present organised in two units, and the Officer of each independent of the other, it is almost impossible to work together, however much the two Officers may desire to do so. One Officer alone can make the dispositions for succouring and receiving the wounded."

Field
hospitals to
be distinct
from
ambulance
units.

Having read a great deal of evidence on the subject the Committee consider it extremely desirable that the combined unit system should be adopted, *not of course to the exclusion of field hospitals*, for "divisional" use, but as forming the first unit in the field for collecting and succouring the wounded. The Indian Field Hospital being in their opinion a very satisfactory and efficient unit, it is thought that a good deal could be copied from it with advantage in field units of the Home Establishment, and chiefly in its three most prominent features, viz. :—

- (a) In its combination of bearer company and tentage accommodation for wounded.
- (b) In its easy divisibility into four sections.
- (c) In the allotment of a far larger number of bearers.

[NOTE.—There is a very decided opinion that the field unit of the future should fulfil both the functions of a field hospital and a bearer company.

This opinion is based on the proved convenience in the field of the field unit of the Indian establishment, which combines both features.

During the later stages of the war, when a large number of small columns (strength from 1,500 to 2,000 men) were employed in the field, the medical arrangements were always based on a combined unit, and the result was eminently satisfactory. This stage is, of course, not strictly comparable with the conditions obtaining during war of a more classical type, but it affords some considerable practical experience of the working of a combined unit.

Another argument, which is very frequently put forward, is based on the want of proportion between the work of the personnel of a field hospital and that of a bearer company, for whom, except during or immediately after an action, no definite duties are assigned. This appears to be a very strong point, as most certainly all the skilled assistance that can be obtained is absolutely necessary in the field hospitals.

As to the personnel of this combined unit, it is not probable that there will be any saving in the actual numbers. Indeed, the experience of the earlier part of the campaign points to the necessity of an increase in the personnel of the units of the field army, to allow for casualties and for convoy duty.]

(3) *Name and Numbering of Field Units.*

There is some diversity of opinion on this point, but most Officers seem fairly agreed that the proposed "Combined Unit" should be named simply a

Field Ambulance.

Title of
combined
unit.

The reasons advanced in favour of this title have already been given in this Report, and need not here be repeated.

An alternative suggestion has been made, viz., to call the Combined Unit an "Ambulance Company," and that any further description should follow in brackets thus—

No. 8 Ambulance Company (2nd Cavalry Brigade).

No. 15 Ambulance Company (1st Infantry Division 1st Brigade).

It seems a mistake to give any field medical unit a brigade, divisional, or cavalry title. Such terms are confusing, and have little meaning when the brigade and divisions, both infantry and cavalry, break up and disappear, but the "Field Ambulance" remains a Royal Army Medical Corps unit. It has no real unity with the brigade, and may any day be detached, it should preserve, therefore, its individuality.

All seem to concur in the view that field units should be designated by consecutive numbers from 1 upwards,* *e.g.*—

Field Ambulance No. 1, &c.

Sections whether of ambulance units or field hospitals should bear the name of the hospital or ambulance of which they form a part, and their section numbers as well, thus—

Field Ambulance No. 1.

Section No. 2.

Field Hospital No. 4.

Section No. 1.

Some Officers, however, are in favour of *lettering* the sections, viz., A, B, C, D. This is immaterial.

The attachment of a field ambulance to a brigade is in the nature of an appointment, for example: *Order*—"No. 16 Field Ambulance will act as Brigade Field Ambulance to No. 8 Brigade." In this sense only there is a double title. For instance, when a Field Company R.E. or a Company A.S.C. is attached to a brigade *no brigade title follows*, such as "7th Field Company R.E., 1st Brigade." There seems, therefore, no reason why it should not be the same with a field ambulance, the letters R.A.M.C. might follow in the same way as A.S.C. and R.E.

Cavalry Brigade Units.—Some Officers are in favour of the retention of the term "Cavalry," and would name field units thus—

No. Infantry Field Ambulance.

No. Cavalry Field Ambulance.

But, for reasons already given, others would not, and would prefer to call a unit working with mounted troops a

Mounted Field Ambulance (No. 1-2, &c.),

following the precedent "Mounted Infantry," the sections being indicated as before suggested. A mounted field ambulance is a Royal Army Medical Corps unit that can be attached to any body of mounted troops (not necessarily cavalry), possibly artillery, mounted infantry, or mounted irregular corps.

A further suggestion is made, instead of numbering ambulance units for cavalry or mounted duties, to letter them

A }
B } Field Ambulance.
C }

In numbering "Field Hospitals" it is a question whether they should bear an army corps number if there is a specific number allowed for each army corps, thus—

No. 3 Field Hospital, 3rd Army Corps.

It is thought that field hospitals should not be called by any divisional titles, but should be simply numbered consecutively, thus—

No. 1 Field Hospital (attached 2nd Division).

In the French Army and others the field hospitals are numbered and marked with the number of the army corps to which they belong. They are utilised wherever the Principal Medical Officer considers it desirable.

The Committee recommend the adoption of this principle on the ground that the field hospitals should be massed, or distributed, not according to brigades or divisions, but in that position where there is the greatest accumulation of wounded. The Committee consider there should be great elasticity in such matters.

Field ambulance to be a R.A.M.C. unit.

Consecutive numbers for field units.

Term mounted field ambulance.

Proposition to letter cavalry units.

Numbering field hospitals.

Field hospitals numbered according to army corps.

* This has been done.

(4) *The Personnel required for Field Units.*

- A. The division of their work.
- B. The degree of training necessary.
- C. The question of transport for the whole or part of the personnel.

Recom-
mended
increase in
stretcher
bearers.

Increase in
proportion
of ward
orderlies
for field
hospitals.

Increase of
personnel
for mounted
medical
units not
necessary.

Division of
work of
personnel.

The Committee consider that the personnel of field units should be increased, especially in the combined unit (which it is proposed should be called a "field ambulance"), and more particularly in the number of bearers, which hitherto has stood at 32 per bearer company. At least double that number are required to aid the regimental bearers for any really effective work in the field. Some Officers with experience, derived in the Natal campaign, consider the number should be increased up to 100 per infantry brigade, bearing in mind the large numbers of volunteers required and employed in this service up to and after the relief of Ladysmith, and when the extent of ground covered by a brigade in extended order is considered, there is no doubt that large numbers of bearers will in the future be required to collect wounded scattered so widely. Ideas differ as to the exact numbers which should be employed in field units, but there seems to be a general concurrence of opinion that it is neither desirable nor necessary for the highly-trained R.A.M.C. orderlies to be employed in bearer work, unless in the proportion of one per stretcher squad. The remaining bearers might be volunteers or St. John Ambulance men, and possibly the junior orderlies R.A.M.C. who have only been trained in "first aid" and "stretcher drill." The number of trained orderlies for duty in field hospitals as ward orderlies might with advantage be increased, so as to allow one R.A.M.C. man for nursing purposes to every three or four patients; at present the relative proportion stands lower than this (*see Appendix XV*).

For the cavalry or mounted field ambulance the personnel need not be increased—in fact, might be reduced. Light ambulances would do most of the carrying work, with a sufficient number of bearers to collect the wounded and place them in the ambulance carts (after applying first field dressing, &c.). The tent division would not need many orderlies either, as it would only provide a temporary accommodation for 50 sick, whose transfer to other units would be as speedily accomplished as possible. Although the actual numbers required in mounted field units need no increase, it is highly probable that a larger proportion of mounted medical units will in the future be required, to correspond with the general increase in the number of mounted troops employed in the field (*see Appendix XVI*).

The Division of their Work.—The personnel will, broadly, be divisible into two sections, the *nursing* and the *bearer* sections respectively. The former to consist of the senior and experienced Royal Army Medical Corps N.C. Officers and men whose duties have been chiefly confined to ward work in the military hospitals. The latter, composed largely of men from the Auxiliary Services and junior Royal Army Medical Corps men, must be employed in bearer and camp work generally.

[NOTE.—While the number probably must remain at least as great as at present, it is possible that the class of man employed in "bearer company" work might be altered in case of necessity to allow of the employment of a less highly trained orderly for these duties, reserving the more highly trained men of the Royal Army Medical Corps for hospital (nursing) duties in the field hospitals, where female nurses cannot go. There are numerous duties connected with the working of field hospital which could very well be performed by these less highly trained men, thus freeing the nursing orderly for his important duties. It is a question whether, under the circumstances under which "bearer company" work is done, there is any opportunity for the special training of a soldier nurse to show itself so sufficiently more valuable than that of the less highly trained man, to justify his employment in bearer company work, to the detriment of the attendance on the sick and wounded in the field hospital.

There is very little doubt that the immediate attendance on the wounded in the actual fighting line is becoming more difficult, one might almost say

less possible, and, on the other hand, the small-bore wound which is at all amenable to treatment does not appear to suffer by being left for a time. It appears to be sufficient that the bearer company man should be well instructed in the application of the first field dressing, and probably also in the arrest of hæmorrhage, though the cases in which this is important, and in which aid can be given, do not appear to be very numerous. For these reasons there does not appear to be any professional objection to the employment of partially trained men as bearers.

As a matter of history, untrained men had to be used both in Natal and Cape Colony in the earlier stages, and their employment, in the first instance a matter of necessity, was fully justified by results.]

The Degree of Training.—For the newly-enlisted Royal Army Medical Corps men and men of the Auxiliary Medical Services, instruction should embrace the following subjects :—

Stretcher drill, and the
Method of rendering first aid to the sick and wounded.

It seems advisable to train the N.C. Officers and men of the Royal Army Medical Corps more carefully than has been the case in field cookery and sanitation, especially the latter. A trained N.C. Officer of the Royal Army Medical Corps would be invaluable in camp and on the march as sanitary inspector, to report to the Sanitary Officer.

Special Training.—All N.C. Officers and men destined to serve with mounted units should learn to ride and go through a modified course for "Mounted Infantry," and a proportion of N.C. Officers and men selected to serve in field units should have a training in transport duties, and be attached for classes of instruction to the Army Service Corps companies at headquarter stations, and receive *elementary* teaching in horse management, feeding, watering, &c.

The above course might be followed out in the case of orderlies of Imperial Yeomanry and a proportion of the Auxiliary Medical Services generally.

It would be a practically useful thing to enlist a proportion of men for the Regular and Auxiliary Medical Services who in civil life had some knowledge as tailors, carpenters, farriers, saddlers, wheelwrights, &c. Such men are particularly useful in field units.

The Transport of the whole or part of Personnel.—It is considered that all the personnel of medical units serving with mounted troops should either ride or be carried in vehicles. It seems hardly feasible to do the same with medical units serving with infantry, and scarcely necessary, but a *proportion* of them might well be carried, and the men could take turns, they would then arrive in camp fairly fresh at a time when their special duties commence. A certain number of N.C. Officers might be allowed ponies to ride, viz., the sergeant cook, compounder, quartermaster-sergeant, and the sergeant detailed for conservancy duties in camp. The cooks might be allowed to ride on the supply cart, and a few stretcher bearers take it in turn (two or three at a time) to ride in the ambulances, provided their places are not required for sick. Stretchers should always be carried in ambulances and carts when the troops are on the march. Empty general service wagons can occasionally be lent for transport of the personnel of medical units, and when practicable this might be the rule (*see* Appendix XVI).

So far as riding horses for Royal Army Medical Corps units are concerned, there is always a large proportion of the former unfit for cavalry purposes, especially ponies, which would do quite well merely to carry men.

[NOTE.—As regards the personnel, there is little doubt that at least a portion of them should be mounted or carried in light carts. This is particularly necessary with a mobile force, and under any circumstances it is not to be expected that men who have been marching all day should be in the best condition for the important but laborious duty of attending on the sick.]

Degree of
training.

Special
training.

All per-
sonnel
mounted or
carried
when with
mounted
troops.

A propor-
tion of the
personnel
to be
carried in
infantry
medical
units.

(5) *Work of Units on the March in and after an Action. Work of Cavalry Brigade Units considered.*

A.—General Work of a Field Ambulance.

If it be considered desirable to have a combined unit divisible into sections, as the Committee think it is, then it should be capable of acting—(1) as a whole unit; (2) in detachments or sections.

Surgeon-General Evatt, C.B., speaking of the necessity of a unit easily divisible into sections, says:—"One of the first lessons of war teaches us the necessity and need of a unit to sub-divide and yet be efficient. Note the battery, Royal Artillery with its clear sub-division into three gun detachments."

Opinions seem on the whole to favour the sub-division of a field ambulance into four sections (there being four regiments to a brigade of infantry), each section being self-supporting, having its recognised personnel, equipment, and transport, capable at any moment of being detached for independent action. The division into sections should not, of course, prevent the unit acting or being used in its entirety, that is to say, the whole of the bearer division performing the functions of a bearer company, and the whole of the tent division acting as the receiving hospital to the former.

If so, when a section is detached for duty, it will perform on a smaller scale the functions of the larger unit.

When working as a whole unit the Commanding Officer of the ambulance would direct the movements generally of both divisions and make his own dispositions.

Field ambulance on the line of march.

If no immediate fighting is expected, and the ambulance is merely on the line of march, there seems no reason why it should not march in sections, like companies of a regiment and camp in the same way. If on the line of march the numbers of sick to be dealt with in the brigade be small, as they frequently are in healthy climates, the sections might take it in turn to form a small receiving hospital for the night, and erect a few tents, leaving the remaining sections packed and ready for marching on any sudden emergency. It will be advantageous too for the personnel to be split into sections for messing purposes, and the work of the unit decentralised in every way.

Position of field ambulance on line of march.

When the troops are simply advancing, without any expectation of an engagement, the field ambulance might march in one of two formations:—

First Formation for Line of March.

(1) The whole of the bearer company or bearer division, including ambulances, water carts, and technical equipment wagons, should be in *the first line of transport*.

(2) The tent division, with general service wagons, tents, reserve rations, blankets, kits, and heavy baggage generally, in *the second line of transport*.

The first line of medical transport immediately in rear of the ammunition column, the second line of medical transport in advance of all regimental, brigade, and divisional baggage, and when necessary the tent division should be sent into the first line of transport.

This formation would be used also when an action might be expected.

Second Formation for Line of March.

Marching in sections.

On occasion it might be desirable for the ambulance to move in sections thus:—

One section to follow the advance guard; the main body in rear of the ammunition column; and one section with the rear guard of the force to which it belongs.

[NOTE.—There is no doubt that the mobility of the field units must be increased, probably this can be most usefully done by dividing the stores into (i) those needed for the immediate treatment of the sick and wounded, and (ii) those necessary for their accommodation. That is, all the medical and surgical equipment, with some medical comforts and cooking pots, should be loaded on light wagons which could keep up with the column, while the tents and baggage generally should follow on behind with the baggage column, or at least need not be so closely in touch with the actual column.]

The work of units on the line of march will chiefly consist in attending to stragglers suffering from minor ailments, and providing for their immediate treatment; the contents of the surgical haversacks and a small supply of medical comforts will generally suffice for ordinary requirements. It will be of course necessary to prevent overcrowding of ambulances, the same men should not be carried longer than necessary. Some, who otherwise are capable of marching, may only need their arms and ammunition carried, but not in the ambulance wagons. Men temporarily sick, footsore, &c., but likely to be fit in a day or so, should be brought along in carts and wagons; those who are palpably unable to continue in the fighting line must be sent back to hospitals on the line of communication, probably in empty provision wagons, or to the line or rail; if any considerable distance has to be covered arrangements have to be made for provisioning them, and whenever practicable medical aid should be sent with them.

Work of unit on line of march.

The practice of attaching a light ambulance to regiments for the line of march is a useful one, and is adopted in some armies. [During the later stage of the war the Medical Officer with mounted troops had light vehicles at his disposal.]

In the event of a small body of troops being detached from the main force for any special purpose a section of the field ambulance should accompany it.

During an Action.—The bearer division should move in immediate rear of the troops, and the tent division be moved up into the first line of transport, the first line of medical aid being as at present carried on by the Regimental Medical Officers and bearers.

Work of unit during action.

It has been considered by some military surgeons, as a matter of personal experience, that groups of four bearers are sometimes too large and draw fire, and they suggest that two men should carry a light stretcher, and a third a surgical haversack and water-bottle; but generally speaking four bearers are not too many, especially with a heavy load to carry. If the fire is severe it will generally be extremely difficult, if not impossible, to remove wounded till it slackens, but from time to time it may be possible to mark down men for removal, and await a favourable moment for conveying them to some sheltered spot. It is pointed out too, that it is often to the interest of the wounded themselves that they should be allowed to remain for some time on the field, their immediate wants having been ministered to. It has frequently happened during the late war that stretcher bearers attracted the enemy's fire, and have been wounded in their efforts to render aid. On some occasions the patient himself has been hit a second time while on the stretcher, and in some instances killed. Major Stonham, C.M.G., of the Imperial Yeomanry Field Hospital, makes the following pertinent remarks on this subject: "No one (he says) would for one moment wish to keep the surgeons and bearers from the field, if necessity demanded their presence, but this is equally to be deprecated if non-essential, for it is not only useless but foolish to expose unarmed men to a fire against which they cannot defend themselves, and which may seriously reduce the ranks of those, already too few in number, whose object it is to succour their unfortunate comrades." And again, and this is a point of supreme importance, he says: "There is no doubt that in cases of wound of the abdomen and chest, with possible internal hæmorrhage, immediate movement is contrary to the patient's interests, which are best consulted by allowing him to remain undisturbed for some hours."

In certain cases desirable to leave wounded undisturbed for some time.

Under modern conditions of warfare the firing line is extended over a wide front. A brigade of infantry, in attack or defence, is extended over a front of some miles; scattered in this way it is obvious that they cannot be adequately served by the "collecting station," as laid down in Army Regulations, and it has been found necessary to diverge to some extent from the scheme proposed for rendering aid to wounded, as detailed in the "Manual for the Medical Service," which, as a matter of fact, was not carried out in South Africa.

Major Heuston, C.M.G., lately commanding the 9th Bearer Company in Natal, writing on the subject of the bearer company "collecting station," says: "During the whole campaign, owing to the mountainous nature of the country, it was found useless, and in fact impossible, to make use of a collecting station (as defined in the 'Manual'), consequently the 'dressing

station' was pushed up near the fighting line as far as expedient, and the wounded brought there direct. In some instances, notably at Pieter's Hill, we prepared nourishment for the wounded in a sheltered place near where they passed to the dressing station. This was necessary, as sometimes they had to be carried over two miles before reaching it. In very few cases were the ambulances able to proceed past the 'dressing station.'

Necessity
for increase
in number
of bearers.

This Officer also lays great stress on the necessity for an increase in the numbers of bearers, and says: "From experience I consider that a minimum of 100 bearers should be attached to each brigade, excluding those employed as wagon orderlies, at the dressing station, and as company cooks."

On the Natal side, the deficiency in bearers was made good by the employment prior to the relief of Ladysmith of the Natal Volunteer Ambulance Brigade, and subsequently by the Imperial Bearer Corps; both rendered admirable service, especially at Colenso on December 15th, 1899. "Without them (writes Major Heuston) we should have been utterly at a loss; as an instance, our brigade not being much in touch with the enemy, we assisted in removing the wounded of the 5th (Irish) Brigade, and on attempting to follow the brigade over the Little Tugela, our ambulances were unable to proceed, there being no drift, consequently the wounded (about 500) had to be carried about 1½ miles before they reached wheeled transport. Owing to the presence of the Natal Volunteer Ambulance Brigade, even with this obstacle in our way, all the wounded were removed to the hospital from that part of the field before 7 p.m., but without their assistance this task could not have been completed before the next morning with the small number of men at our disposal. The same applies to Spion Kop, Vaal Krantz, and the fighting round Pieter's Hill, although at the latter place we made use of trolleys on the railway line, and so saved a great deal of labour."

On the western side the want of bearers in great numbers was not felt, chiefly owing to the nature of the country allowing wheeled transport to be more extensively used, although for military reasons this had to be greatly reduced on the advance to Bloemfontein. During the fighting on this side at Paardeberg and Driefontein, the wounded were brought direct to field hospitals without intervention of dressing stations.

[NOTE.—On the western side during the latter part of the campaign there was on more than one occasion a difference of opinion between the military and medical authorities as to the strength of the medical unit to accompany the small columns into the field. For military reasons it was desirable to have the column as compact as possible, and free from the non-combatant element. On the other hand, the Medical Officers considered the units allotted could not be reduced with safety and so declined to take the responsibility.]

The Committee consider that the collecting station, with its personnel of sergeant and bugler, as at present laid down in Regulations, does not serve any useful or practical purpose.

The following appear to be the principal points at which during an action the wounded should receive attention (*see also* Appendix XIV):—

Principal
points
during an
action
where
wounded
should
receive
attention.

- (1) With the battalion under fire, wherever possible.
- (2) At the regimental aid stations, which should be established as near the fighting line as is consistent with safety, but where neither the wounded nor bearers should be unnecessarily exposed to fire.
- (3) At the ambulance station, i.e., at the spot where the ambulance rendezvous. These should be advanced as near to the front as they can with reasonable safety be taken, so as to relieve the bearers of their burdens as soon as possible; the ambulances should constantly ply between this advanced position and the dressing station in the rear.
- (4) At the dressing station. This should be established at some place of security in the rear, possibly in a building, otherwise the tent division of the field ambulance should be brought up, the whole of the wounded from the brigade collected and afforded temporary shelter, and all absolutely necessary operations performed. Experience has taught us that over a widely extended front sections of bearers must spread out in corresponding fashion, and the

ambulances must scatter in the same way. The latter should always be in charge of an Officer (preferably with some mounted men of the Medical Corps), they should be kept together as much as possible on the journey from the field to the dressing station, and return again under the direction of an Officer.

No very hard and fast line can well be laid down as to the respective sphere of work of the regimental and the ambulance bearers. In theory the former should not pass in rear of the regimental aid stations, and here the work of hand-carrying the wounded should be taken up by the ambulance bearer; as far as practicable this is desirable, otherwise the regimental bearers get too far behind the advancing troops. It is sometimes, however, difficult to prevent the regimental bearers from straggling to the rear. Many cases must be hand-carried all the way to the dressing station. Men gravely injured in abdomen, chest, or head should not be jolted in an ambulance, or, at any rate, must be taken out and carried over rough ground.

Work of
regimental
and ambu-
lance
bearers.

It is not till an action draws to a close that the real business of collecting the fallen commences, and then a systematic search must be made for them in all directions, especially in wooded country. It is a good thing to supply Officers and N.C. Officers of the Medical Corps with whistles (recommended by Surgeon-General Evatt, C.B.), so as to keep in touch with one another if night has come on. In the German Army it seems to be customary to use bugle calls for this purpose. There is a useful rule in the German Army that merits attention, namely, that slightly wounded men, after giving up their ammunition (with the exception of a few rounds), but retaining their arms, go to the rear alone, and that men who are not stretcher bearers only carry back wounded men when ordered to do so by an Officer; after depositing the wounded they immediately return to the fight.

Collecting
wounded at
conclusion
of the
fighting.

On the arrival of wounded, during and after an engagement at the field hospital* (which is the best dressing station), when practicable, they should be sorted by the Medical Officers and sent into the operating tent according to the severity of their wounds; others should be fed and stimulants administered.

Surgical
treatment
in the field.

"Ideal aseptic surgery cannot," says Major Stonham, "be carried out in the field," and every surgeon with practical experience will concur in that opinion. A good supply of boiled and filtered water is necessary for the cleansing of wounds. All operations that are imperative should be performed, and must be undertaken at the tent division of the ambulance or field hospital, but certain operations can be usefully deferred until the patient reaches a stationary field hospital or the base hospital.

[NOTE.—This should be put more strongly. No operation should be performed in the field ambulance which can, with due regard to the safety and comfort of the patient, be deferred until he reaches a line of communication hospital. The patient should be placed under the best conditions possible prior to operation; this can only be ensured in stationary hospitals. Further, the work of the field ambulance is too important to permit of time being taken up with things that are not obligatory.]

There is one class of injury that demands special attention, namely, the treatment of fractures in the field. On this subject Major Stonham makes the following observations: "The immediate treatment of compound fractures in the field is one of the most important matters which can occupy the attention of the surgeon. Much depends on the initial treatment, for not only does the future of the limb, but often the patient's life, depend on its efficacy. When transporting patients with bad fractures, it should be the practice to off-load the wagons at drifts and over bad ground, and have the wounded carried on stretchers. There is no form of apparatus—no build of wagon—which can altogether do away with the pain, and possible injury, of transport. Morphine is the means of saving much pain, but the damage which is occasioned by the movement of the shattered limb too frequently excites considerable inflammation, which may not only retard union, but cause still more serious trouble. It is these considerations as regards the transport of badly comminuted fractures which sometimes turn the scale against the limb

Treatment
of fracture
cases on the
field.

* The "tent division" of the field ambulance.

when the advisability of an attempt to save it, or of performing primary amputation, has to be considered, and hence it arises that amputation is sometimes performed in the field which would not be entertained at a stationary hospital." It is not always easy to decide the degree of a man's fitness to be transported, and, under any circumstances, it often happens that military exigencies have first to be considered, and it may be an absolute necessity to transport for long distances gravely wounded men for whom movement is specially prejudicial. If possible, this should be avoided, the field ambulance should retain the wounded and take care of them till all are collected.

Function
of a field
hospital.

After an engagement the function of a field hospital commences, and they should, when possible, be brought up and distributed at those places where the greatest number of wounded are accumulated; this seems a better plan than immediately transporting the wounded to the rear. It often happens, however, that field hospitals are pitched during an engagement, and in this case it will be possible for a number of wounded to be conveyed directly to it. Field hospitals continue and complete the work of the ambulance and enable the latter to advance or retire without hindrance. It is a great advantage when practicable for the wounded to be sent as soon as possible to a "stationary" field hospital, and every effort should be made to push well-organised stationary hospitals as close up behind the troops as possible. These might be called "evacuation hospitals," and one should invariably be established at the head of each line of communication. If sufficiently near the front, wounded might be transported to them direct, and the field hospitals of the army corps marching with the troops held in reserve till this plan of evacuating is no longer possible.

From the evacuation hospitals, at the head of each line of communication, sick and wounded must be arranged into convoys and sent by road, rail, or water towards the base.

[NOTE.—The phrase "head of each line of communication" is a little indefinite. These evacuation hospitals should be pushed up as close as possible behind the fighting line: technically no doubt they are on the lines of communication, but they should be so placed that immediate evacuation into them can take place. If this is done, the question of transport as affecting amputation or conservative treatment becomes of much less importance, and it is for this reason that the advancement of these hospitals is so highly desirable.]

The Work of Cavalry Brigade Units.

First line
of medical
aid with
cavalry.

It is thought that each squadron of cavalry or company of mounted infantry should be accompanied by two or more mounted orderlies, with field haversacks and water-bottles, and that each cavalry regiment should have two light wagons or tongas as part of their regimental medical equipment.

Each of these light vehicles to carry:—

- 2 Stretchers, outside.
- 4 Blankets strapped to seats.
- 1 Field companion.
- 1 Surgical haversack.
- 20 Field dressings.
- 2 Waterproof sheets.
- Medical comforts, such as brandy, bovril, tea.
- Lantern, candles, kettle, bucket, and a small axe.

The regimental medical officers with the suggested mounted orderlies and two light carts per regiment would form the first line of aid for mounted troops, and would be especially useful with small detached bodies of cavalry, &c.

Second line
of aid.
Work of
mounted
field
ambulance
on the line
of march

The second line of medical aid should be formed by the bearer division of the "mounted field ambulance" (Appendix XVI). Whether in action or on the line of march the position of the first line of light wheeled transport would be the same, namely, moving in immediate rear of the fighting line. The light ambulance carts, if attached to regiments, might be ordered out on the flanks, and those of the field ambulance directed to follow in a more central position,

but the position of all wheeled transport should be at the disposition and under the orders of the Officer commanding the mounted ambulance.

"The heavier ambulances would follow further in the rear, advancing as close to the scene of action as the nature of the ground would permit. The light carts would convey the wounded to the ambulances and again return to the fighting line. The ambulances would transport the wounded to the 'tent division' of the mounted field ambulance, which would have taken up a position still further to the rear." The above suggestions are taken from Lieut.-Colonel Sawyer's report.

The casualties of mounted troops are never so numerous as those of infantry, and it is considered that tent accommodation for about 50 sick and wounded (as a temporary measure) would be all that is ordinarily necessary.

The tent division of the ambulance would form, when necessary, the collecting and dressing station in any big cavalry engagement, and act as a receiving depôt for the sick of the cavalry brigade. These, however, must be transported as soon as possible to the nearest infantry field ambulance or field hospital, or to the line of communication, if feasible. For this purpose the heavier ambulances must be used temporarily to convey the worst cases, the less serious cases being sent back in empty supply carts adapted, as far as possible, for this purpose. Immediately the tent division has evacuated its sick it must follow up the bearer division.

Lieut.-Colonel Sawyer mentions that: "At Middelburg in July, 1901, the 'Special Scouts,' 450 strong, went out for six weeks with a medical unit composed of Cape carts and other light country vehicles drawn by four mules each. All the personnel were either mounted or carried, and these Cape carts went practically everywhere with the scouts, and proved a great success."

Lieut.-Colonel Porter writes as follows on the subject of carriage of the personnel of medical field units on active service: "In a field ambulance attached to cavalry, or, indeed, any mounted branch of the service, I am strongly of opinion that all the personnel should be carried, some on wagons and others mounted on ponies. These mounted men are extremely useful with mounted troops during an action or on the line of march. Being able to keep up with the troops they are able to render medical assistance when required. During the late stages of the South African War a considerable number of the personnel of the medical field units were mounted, and were often sent with small parties during reconnaissance work and night surprises. The work done by these mounted orderlies was, as a rule, very satisfactorily performed, and in future might be enlarged upon. During the later stages of the South African War provision was made for the carriage of the Royal Engineers on wagons, which seemed to work very satisfactorily. Similar provision should be made for a certain proportion of the infantry medical field units."

The small tent division of the mounted ambulance need not follow too closely the bearer division; it would probably march with the reserve ammunition column and supplies, and act as a small receiving unit. There seems to be very little use in attaching a field hospital to any body of mounted troops. It would move too slowly to keep in touch with them.

In the future it seems probable that medical aid for mounted troops must consist largely of light ambulance carts and mounted orderlies with first aid requisites, a minimum amount of tent equipage, medical and surgical necessities and medical comforts being carried as a reserve for certain occasions.

(6) *Equipment.*

Ordnance, Medical and Surgical; its Improvement by Addition or Omission, &c.

The ordnance equipment of a bearer company and field hospital, as laid down in Mobilization Store Table, A.F.G., 1098-41, has been thoroughly gone into, and many suggestions are now made both in the way of addition and omission (*see* Appendices V, VI, and VII).

1. The carriage of tents, blankets, and reserve rations is now only provided for under "Special Establishments." The Committee propose that

and in action.

Heavier ambulances in rear of light ones, the latter act as feeders to former.

Sick and wounded of cavalry brigade units to be transported to nearest infantry field unit.

All personnel of mounted field ambulance to be carried.

Work of tent division of mounted field artillery.

these articles should be considered necessary under "normal conditions" (see Appendix IX).

2. It is suggested and recommended that a re-arrangement of equipment be made, and the contents of the panniers arranged with more regard to the uses for which they are intended. With this desirable end in view, alterations have been made in the contents of various panniers, and in many instances articles have been added.

3. A large number of bed-pans, urinals, &c., are provided, zinc articles done away with and enamelled substituted, or agate ware if thought preferable.

4. Feeding utensils, viz., soup basins, knives, forks, spoons, are now provided for each patient.

5. The entrenching tools, formerly greatly in excess of ordinary requirements, have been reduced in number.

6. The filter F.H.P. was not satisfactory. It is recommended that the sterilising chest in use in the United States army be supplied to field units. This includes a "Berkefeld filter" and a "Forbes steriliser." Plenty of candles will be required for the filter, carefully packed.

7. Additions have been made to the medical comfort pannier, and it has been recommended also that each ambulance be supplied with a box of medical stores.

8. The cooking utensils were satisfactory, but it is thought that all these things be packed in a *mess chest*, so that the cooks will have all their utensils together instead of scattered in different panniers. Extra articles also have been added.

9. The stools close field hospitals were not satisfactory. It is recommended that the "Hubert" pattern commode be substituted, as used in the Canadian field hospital and highly recommended by Lieut.-Colonel Porter's Committee.

10. A lighter pattern stretcher is recommended, weighing about 15 lbs.

11. The lighting arrangements at present in use in the field hospital are bad. Lamps are not satisfactory. An acetylene case, as used in the United States army, is here recommended, and possibly acetylene hand lanterns, or marine pattern lamps (see Appendix XII).

12. The number of blankets and ground sheets has been materially increased, and a good supply of hospital clothing added. This is considered very essential.

13. It is proposed that blankets and clothing supplied for use of infectious cases (enteric, dysenteric) should be of a distinctive colour, and that when no longer required should be destroyed.

14. Mosquito netting is supplied; it is useful to keep flies off sick and wounded, and to cover over food.

15. Cases for mattresses and bolster, to fill with grass, are added.

16. A *lavatory pannier*, containing all necessities for washing patients, viz., basins, soap, towels, sponges, &c., is suggested.

17. Paper spit-cups, to be burnt after use (*vide* Equipment, United States Army).

18. Zinc basins are heavy. Enamelled ones are supplied.

19. The Hubert pattern tent is recommended (see Appendix XI). It is highly spoken of, and recommended by Lieut.-Colonel Porter's Committee on the Canadian Field Hospital. These tents hold 10 patients comfortably on stretchers; four are allowed to each section, also a few bell tents. Some Officers recommend a different assortment of tents for field units constantly moving—the smaller for the line of march, and the larger for reception of wounded, &c. This is a matter for consideration; there is certainly an advantage in a small tent quickly and easily pitched for daily use on the march. Major Stonham, C.M.G., speaks very highly of the square bell tent, which holds four patients comfortably.

The panniers are called "field ambulance," and are numbered consecutively, the contents being indicated in brackets, thus—

Field Ambulance Pannier, No. 6 (Medical Comforts).

Field Ambulance Panniers, No. 7 (Clothing).

Field
ambulance
panniers.

It is a good thing to label everything very distinctly, and each pannier might well bear its number and the name and section of the field ambulance to which it belongs, thus—

F.A. 3 Pannier 1.
 Section 3.

Pioneer Equipment.—No special allowance has been made under this heading, but it is desirable that provision should be made for conservancy work in camp.

Blankets.—A proportion of these should be of a distinctive colour (khaki suggested), and used only for enteric or dysenteric patients; they should be destroyed when no longer used by infective cases.

Sleeping Suits, Shirts, &c.—Some of these should also be distinctive in colour, used only for infective cases, and finally destroyed; the same suggestion applies to bedding used for enteric fever patients.

It may be possible in this way to limit infection by taking precautions against the general use of clothing, blankets, &c., provided for this special purpose.

General Remarks.

Surgical Haversacks.—The Committee consider the surgical haversack used by the Imperial Yeomanry Field Hospital more useful than our own, although more bulky. Major Stonham, C.M.G., considers the weight could have been much reduced by substituting aluminium for the tin cases. Each haversack contained the following articles:—

Triangular sal-alembroth bandages (nine). Roller sal-alembroth bandages (six, 2½ inches broad). (More bandages and wider are desirable.) Double cyanide gauze in waterproof bag. Double cyanide wool and salicylic wool. Adhesive plaster (three reels). Spatula; Hagedorn's needles; dissecting forceps. Clasp knife; scissors; probe and directors. Gooch's splinting (two pieces, each 1 foot square). Esmarch's tourniquets (two); Samway's tourniquets (two). Medicine case: sal volatile (2 ounces); carbolic acid (1 ounce). Hypodermic morphia solution; boric acid powder; double cyanide powder. Hypodermic syringe and tabloids; safety pins. Sterilised silk for ligatures; specification tallies. Candles and wax matches in box.	Contents of surgical haversack.
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Field Medical Companion.—It is considered that this article is somewhat out of date, and that it might be replaced by something in the nature of the "Congo case" * as used in the Ashanti Expedition of 1895-6. It does not seem necessary that this article should be fitted for shoulder carriage. The contents must be varied according to circumstances, and the nature of the country in which military operations are to be conducted.

Field Fracture Box.—The contents of the fracture box used by the Imperial Yeomanry Field Hospital are also preferred to the regulation pattern omitting the extension apparatus, as follows:—

2 pairs Cline's splints. 1 pair Carr's splints. 1 Liston's splint (jointed). 2 pieces Gooch's splinting. 8 strips of pine wood. 8 sheets perforated zinc. 2 sheets pasteboard. 6 18-inch webbing splint straps. 3 27-inch " " "	6 empty sand bags with tapes. Anvil and hammer. 1 gross copper rivets. 1 box tin tacks. 1 tenon saw. 50 Sal-alembroth bandages. 20 triangular bandages. 12 plaster bandages. 6 lbs. absorbent gauze and wool.
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Instruments.—These must be of the latest surgical (aseptic) pattern. In a paper by Mr. Warren Low, F.R.C.S., M.S. (London), lately attached to the

* Some of these were used during the later months of the campaign.

18th Brigade Field Hospital, South African Field Force, many valuable suggestions are made. He considers that "a more varied collection of instruments might be kept at the 'base stores' than those supplied, in order that individual Officers could requisition for any particular instrument they required: this principle need not be carried very far, but there might be more elasticity in the arrangements." Mr. Low suggests also the addition to the equipment of "some specially sealed tins, each containing sufficient sterilised gauze, towels, marine sponges, needles, silk, &c., for one abdominal section" for countries where there might be opportunities for abdominal work.

[NOTE.—Mr. Low's suggested improvement was actually carried out in the late war, and from the very beginning. Medical Officers obtained every form of instrument that they asked for, but, of course, no public department can supply patterns of instruments which differ only in some minor detail from those already in the possession of the hospitals.

A cutler is a necessity. One was employed in the late war in looking after the instruments].

Mechanic
for care and
repair of
instru-
ments.

It is further proposed by this surgeon that amongst the N.C. Officers and orderlies of a field unit there should be at least one mechanic who has received training in the repair and upkeep of surgical instruments—this seems a very valuable suggestion. "Such a man (he adds) as I have described is invariably attached to the operating theatre of every large civilian hospital and is usually recruited from amongst the employes of some large firm of surgical instrument makers." The addition of an aspirator and an apparatus for saline transfusion is recommended, and the omission of the curved trochar and cannula for puncture of the bladder through the rectum, and Petit's tourniquet.

Small field
operating
case.

There should be in addition to the large operating case, smaller ones for detached units in the field (*see* contents of "Field Operating Case, small," used in the United States army).

Contents of
medical and
surgical
chest
U.S. Army
recom-
mended.

As far as the medical and surgical outfit generally is concerned the Committee are impressed with the excellence of the equipment contained in the United States army medical and surgical chests—the "steriliser chest," and also the contents of the United States army "medical and surgical chest" for issue to battalions and *small organisations* for field use. They consider that the equipment for issue to our field units might with advantage be modelled on these lines (*see* "Manual for the Medical Department," United States, America, 1902).

The "supplementary dressing chest" adopted by Colonel Worthington, late Officer Commanding 10th Canadian Field Hospital, appears to contain a variety of very useful surgical appliances (*see* Appendix XIII).

Medicines.

Medicines.—Too great a variety of drugs is carried in the field. Medicines should be, as far as possible, in tabloid form, and the quantity supplied must be large. Some officers think that one kind of antiseptic dressing made up in small packets, and carried in dust-proof tin-lined boxes should be supplied to field units. The quantity carried should be greatly increased.

Antiseptic
dressings.

[NOTE.—One dressing only would be economical and advantageous if it can be decided what this is to be, which will meet the requirements of all operators.]

Antiseptic
powders.

Antiseptic Powders.—Major Stonham says he chiefly relied upon cyanide of zinc and mercury, and boracic acid. For making solutions he took absolute phenol, carbolic acid tabloids, mercuric chloride, mercuric biniodide, and chloride of zinc. This officer suggests for antiseptic solutions, instead of enamelled jugs and basins, "enamelled iron barrels such as are used (but of glass) in hospital theatres, with supply taps and tubing."

Operating
aprons.
List of
additional
instru-
ments.

Operating aprons are required for the surgeons. Jaconet aprons for isolating the area of operations. Attention is also directed to the list of *additional instruments* carried by the Yeomanry Field Hospital to be found in the report on that hospital by Major Stonham.

Cyanide
wool and
collodion.

Mr. Warren Low, F.R.C.S., mentions the utility of cyanide wool and collodion as an economical and excellent method of dressing wounds made by small bore bullets.

The proper anæsthetic for the field and the only one desirable in hot climates is chloroform.

[NOTE.—The following are the points most generally noted by Officers in charge of field medical units :—

Light Trestle Beds for Field Hospitals.—The addition of a small number of these to the equipment of field hospitals is recommended.

Lamps and lanterns are all condemned, especially the operating lamp.

Operating Table.—The field hospital pattern is not liked.

Tents.—The present pattern operating tent is recommended to replace the present bell tent, which is not suitable for sick.

Blankets, Hospital.—These should be distinctly marked "hospital," or be of a distinctive colour.

Clothing or Pyjamas.—A supply should form part of the equipment of a field hospital.

Additions to Equipment.—The most generally recommended are an ear speculum, an ear syringe, and a full supply of Liston's long splints. More graduated measures are asked for.

Modifications.—Feeding cups, urinals, and bed-pans to be of enamelled iron. Tourniquet (Petit's) to be replaced by newer pattern. Tooth instruments not quite satisfactory. The hypodermic syringes are condemned chiefly on account of the softness of the needles. The present system of packing the canteens is considered to give unnecessary trouble. Dressing trays (zinc) to be replaced by enamelled iron.]

(7) *Transport.*

It is only possible to refer in somewhat general terms to the question of transport for field units, and no hard and fast line can be laid down either as to the amount, nature, or class.

The requirements will vary according to the local conditions, chiefly the nature of the country, in which military operations are taking place.

The regulations lay down a scale of transport for :—

A. Normal establishment.

B. Special establishment.

C. A scale which is neither normal nor special, as defined in A and B.

Details of alterations under Scale C are issued at the time by army headquarters, and are governed by military requirements.

Under A. Normal Establishment.—No provision is made for carriage of tents (other than the "operating tent"), nor for blankets (except those for sick), nor for reserve rations for personnel.

Under B. Special Establishment.—Provision is made for these things by the addition of G.S. wagons. Two for a bearer company, three for a field hospital, and for the latter one water cart and one forage cart, but in the case of the bearer company a deduction of one forage cart is made.

Transport for a Field Ambulance.—For a field ambulance divisible into sections the transport of each section should be complete in itself, so that it is ready at all times to take the field without rearrangement.

The technical vehicles of each section should be :—

(1) Ambulances.

(2) Water cart.

(3) Medical equipment wagon or wagons.

(See Appendices VIII and IX.)

It is considered that the wagons for the medical and surgical equipment should be specially constructed so as to render every article immediately accessible. All panniers and boxes to be specially numbered with the field ambulance number and the section thus—

Each section of a field ambulance to have its own transport.

Special wagon for R.A.M.C. technical equipment.

F.A. 5

Sec. 4

O

Certain articles of camp equipment essential for the treatment of the sick (as hospital patients when the hospital becomes stationary) might also be packed in special wagons, which should be considered technical vehicles.

All these vehicles should bear the name and number of the field ambulance to which they belong.

G.S.
wagons
for non-
technical
equipment.

All other equipment, &c., should be carried in general service wagons, provided by the Army Service Corps, but in allotting transport for field ambulance units and field hospitals, a special allowance should be made for:—

R.A.M.C. kit and blankets.

Reserve rations for the unit and personnel, and forage.

Kits of men reporting sick.

Arms and
ammuni-
tion.

It is proposed that the arms and ammunition of sick and wounded shall be otherwise dealt with than at present.

Transport
wagons of
field
hospital
convertible
into ambu-
lances.

Transport wagons convertible into ambulances.

In order to provide for a reserve of ambulances, the Committee make the proposal that a proportion of the transport wagons for field hospital equipment should be constructed with a view to their being convertible when unloaded into ambulances, thus affording field hospitals a transport section for convoy work.

Transport
section of
field
hospitals
for convoy
work.

The transport wagons of the Canadian Field Hospital were considered too light for the double purpose for which they were designed, but this is purely a matter of construction. If this plan were adopted the wagons would have to be fitted with water tanks and other accessories.

Personnel
of transport
for field
units.

Personnel of Transport for Field Units.

Field Ambulance Units.—Each section would require one N.C. Officer, Army Service Corps, or conductor, and one driver to each vehicle.

Field Hospital.—One Warrant Officer, Army Service Corps, or conductor, and small proportion of N.C. Officers and men, one N.C. Officer to each section, and one driver for each vehicle.

The following regulations should be observed:—

Transport
of field
units not to
be taken
away.

A. Transport not to be reappropriated except by order of the General Officer Commanding.

B. All transport drivers and conductors to be under the absolute control of the Officer commanding the unit.

C. Transport for the field ambulance to be in the first line, and not be mixed up in the rear with brigade baggage, &c. (See page 96).

D. The field hospital need not be in the first line of transport, being a slowly moving unit and only brought into use under special conditions.

Position of
field units
on line of
march.

E. *In cavalry units* the light ambulances and equipment cart should follow and keep in touch with the regiments or squadrons, and should precede all vehicles that do not come into the fighting line.

F. The heavy section should move with the ammunition column ahead of all baggage and supplies.

Field Ambulance Units with Infantry.

It might be advantageous for these units to march in first and second lines.

First Line.—Ambulances.

Water cart.

Technical wagons.

Second Line.—Ahead of all baggage and supplies.

General service wagons, carrying tents, kits, baggage, reserve rations, and forage.

Technical
vehicles
stored in
Ordnance
Depart-
ment.

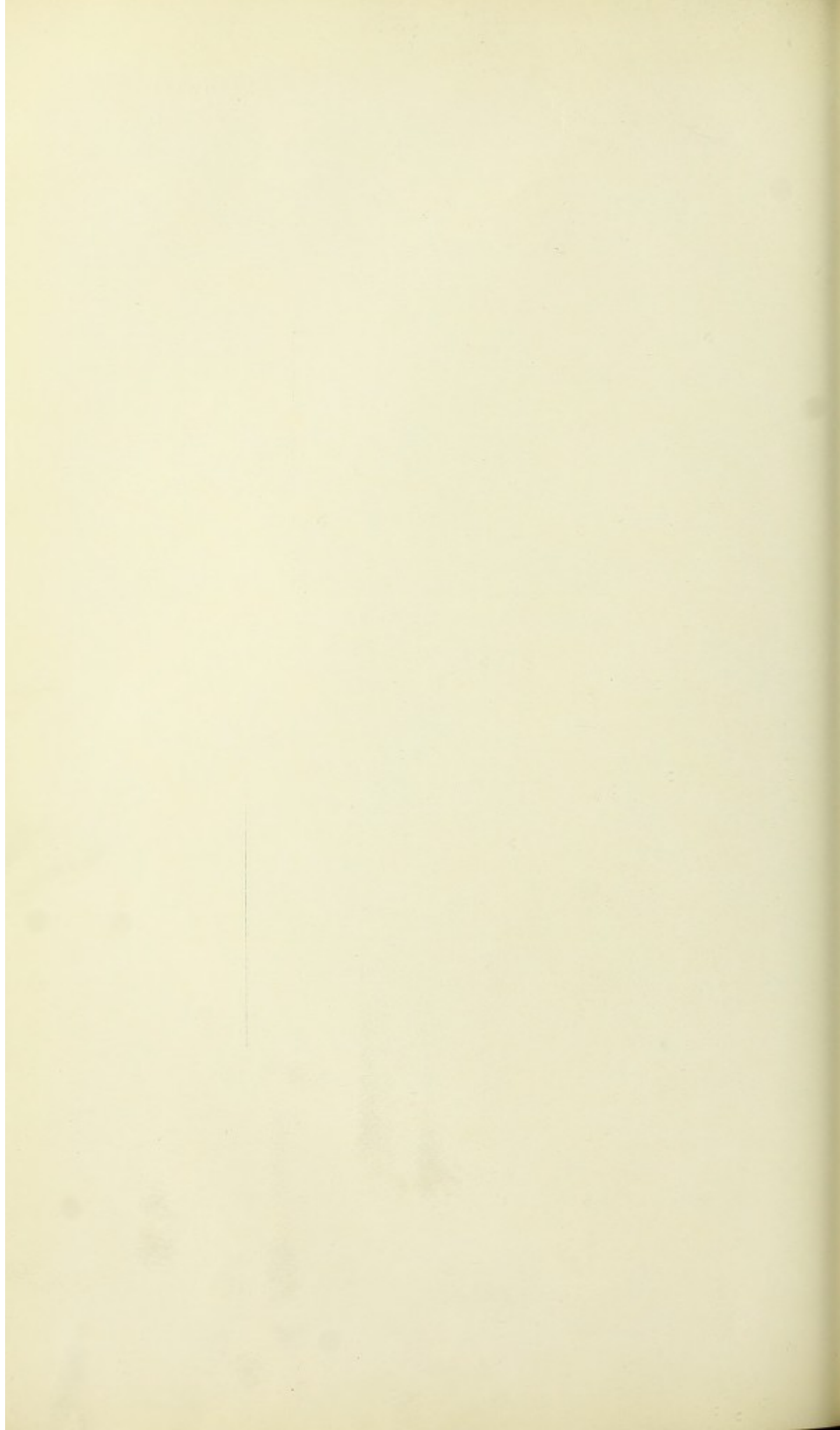
The technical vehicles Royal Army Medical Corps might be stored together by the Ordnance Department. All should be marked with the red cross.



CAPE CART, WITH HOOD, USED AS LIGHT AMBULANCE.



ARRIVAL OF CONVOY IN BULLOCK WAGONS. NO. 18 GENERAL HOSPITAL.



The question whether drivers for medical transport should be provided by specially enlisted men in the Royal Army Medical Corps or from the Auxiliary Medical Services so as to free the Army Service Corps from these duties must be considered.

R.A.M.C.
drivers for
medical
transport.

Transport Animals.—The ambulance wagons, water carts, and technical wagons (Royal Army Medical Corps) should be permanently horsed, and the draught animals (horses or mules) for them inalienable. The G.S. wagons should remain on permanent charge, to be horsed as required.

At present all transport for medical units is provided by the Army Service Corps, also transport for the food supply of sick and wounded. The question of the formation of medical service transport companies to carry on these duties is one for consideration. The custom of using Army Service Corps transport one day for munitions of war, and another for medical supplies, has not hitherto been dealt with under the Geneva Convention. It is impossible to say if a scheme for separate transport is desirable until it is ascertained whether medical transport companies would be protected under the Convention in the same way as an ambulance.

In this connection, Colonel Furse writes: "Transport is intimately connected with the medical department of an army, for the removal of the wounded from the battlefield, the necessary dispersion of the sick, and the provisions of medicaments and appliances, on which rest the saving of human lives, depend on transport entirely. It will be urged against a separate transport that the medical pressure for transport is occasional, where as with supplies it is constant, hence, endowing the medical department with special transport must be detrimental to the economical working of the general transport of the army, *yet the importance of a separate transport for this department cannot be underrated.* The description of transport needed is special, and as the time for sick convoys to move depends on certain considerations which only Medical Officers can estimate correctly, it is difficult to foretell when a pressure may arise; who is to guarantee when the necessity appears that the Commissariat Officers, who are interested parties in the transport, may not consider the needs of their own service far to outweigh those of the medical department, thus giving rise to a difficulty which could not occur were a distinct transport affected to this department."

Surgeon-General Sir T. Gallwey, on the other hand, says: "I am not in favour of any policy which by the provision of separate transport, &c., tends to relieve General Officers Commanding of the responsibility for their medical arrangement, which is as essential to their permanent success as supplies and ammunition."

Pack Transport.—The question of pack transport has not been considered, but it may be remarked that mules are most suitable for sick transport as pack animals, when specially trained; they are preferable to horses, being smaller, more sure-footed, and having a shorter step, and are less restive. They would only be employed in mountainous countries. Pack transport should never be used when there is any other kind of transport available.

In addition to wheeled transport it has been suggested that field ambulance units should have a certain number of pack mules with sets of pack saddlery to be used with the bearer detachment for carrying water, and possibly other things, as near the wounded as possible in positions where water carts could not go. This plan is adopted in Indian field hospitals. In these units eight pack mules are obligatory, whatever the other transport may be.

Pack mules
for carriage
of water in
the field.

(a) Description of Ambulances required and recommended.

It is obvious that no one type of ambulance will meet the varied requirements of active service, any more than one class of field gun will suffice for all purposes.

There is no doubt that the ambulance wagons lately in use in South Africa were, as the Royal Commission considered, extremely heavy, required a large number of mules to draw them, and, generally speaking, were jolty and uncomfortable.

Ambulance wagons, however, are still undergoing a process of evolution, and it is impossible to determine without full trial what sort of vehicles are best adapted for general service, and what for special service.

Ambulance
wagons still
undergoing
a process of
evolution.

Type of ambulance recommended for general service.

For general service and ordinary road work at home and on field service, the ambulance used by the bearer company of the Imperial Yeomanry was, for its class, probably the best in South Africa, and the Committee feel that they are justified in strongly recommending an ambulance built on these lines for general use. A full description of this wagon will be found in the report on the Imperial Yeomanry Bearer Company and Field Hospital, by Major Stonham, C.M.G. This ambulance carried four lying down cases and two sitting, two lying and eight sitting, or 14 sitting, that is to say, they accommodated twice as many lying down cases as the regulation pattern. Good as these wagons were it was considered that they could be still further improved upon, as the outcome of experience, in the following particulars (see Appendix XVII):—

Improvements considered desirable.

1. The carriage of the ambulance was 42 inches from the ground, and this over rough ground caused much lateral movement; it was thought, therefore, that the distance should be reduced—this necessitates a smaller wheel or a bent axle, the latter is preferable, small wheels get easily bogged in soft ground.
2. The inside beam was only 48 inches, divided by a centre board, this should be increased by 8 or 9 inches, and it is thought that this alteration will not only give more room but diminish jolting.
3. The centre board should be made movable, so as to give more room for men's legs when sitting.
4. Arm slings should be fitted to the centre board and to the side of the wagon for men on the lower stretchers. For those on the top stretchers a bed pulley should be fixed to the hoop stave in front and behind. The patient can, therefore, alter his position or steady himself when the wagon is going over rough ground.
5. Ambulances should be half or full locked, instead of quarter locked.
6. Position of water tanks to be in the rear, and not behind the fore-carriage, where in turning they are liable to injury.
7. Seats to double upwards, so as to be out of the way of the lower stretchers.
8. A curtain to be suspended from the top staves running fore and aft the wagon, so as to screen men on one side from those on the other. Major Stonham says: "We make this suggestion because on more than one occasion the death of a patient while on the march caused great distress to his opposite neighbour."
9. The side supports for the top stretchers were not strong enough, and it is suggested they should be fixed by three stays instead of one.
10. All stretchers should be placed on supports connected with strong spiral springs.

Type of ambulance recommended for work with mounted corps.

The light ambulance should, in the opinion of the Committee, be of a pattern similar to that used by the Canadian Field Hospital in South Africa, but a little longer in the body, and with stronger wheels. These can, if necessary, carry four lying-down cases. This wagon weighs 9 cwt., against which those of regulation pattern weigh 18½ cwt. or more (see Appendix XVIII).

The drawbacks to this wagon are—

- (1) There is no seating arrangement.
- (2) When four lying-down cases are being carried, there is no room for their kits.

It was, however, the opinion of a Board of Officers reporting on this wagon that one constructed upon similar principles, with wheels of a modified artillery pattern, with iron hub, and spokes closer together, would be suitable for general service work, but they should carry four lying-down cases and two sitting, with spare room for kits.

[NOTE.—These wagons appeared to be too high for comfort.]

Ambulance fitted with detachable metal tank.

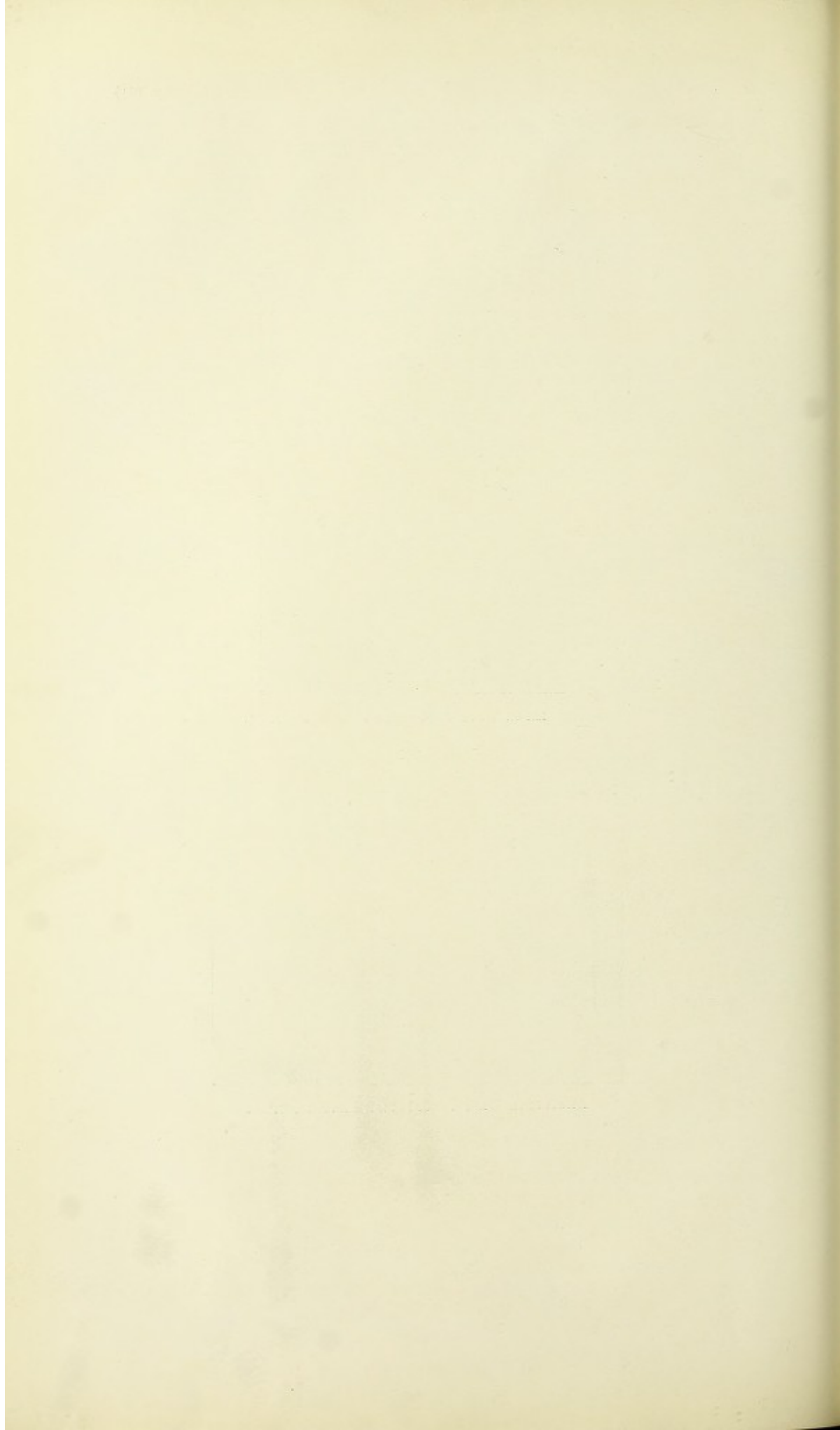
One great improvement on the English pattern is a small metal tank, holding 9 gallons of water, fitting under the floor at the tail end of the wagon. This tank can easily be removed *in toto*, the contents boiled, and tank replaced, thus ensuring a supply of sterile water for the day's march.



AMBULANCE WAGON. CANADIAN FIELD HOSPITAL.



AMBULANCE WAGON. CANADIAN FIELD HOSPITAL.



Lieut.-Colonel Worthington's opinion on these wagons has already been quoted. Canadian field ambulance.

The Australian contingent were also supplied with excellent wagons, well equipped and well horsed. Ambulances of Australian contingent.

The Committee, therefore, recommend for *heavy work* an ambulance after the pattern of the—

Imperial Yeomanry wagon, suitable for work with infantry units.

The Canadian ambulance, or a modification of it, for *light work*, chiefly with cavalry.

There are, however, a considerable number of Officers who strongly favour the introduction of light two-wheeled ambulances for duty with mounted units, working in conjunction with wagons of a heavier variety. The two-wheeled ambulance wagon to be constructed to carry two lying-down cases or one lying-down and three sitting (drawn by a pair of horses, ponies, or mules). Some Officers, but not a great number, recommend the *Indian tonga*, but suggest that it should be slightly longer and broader than the present pattern—48 inches wide, so as to take two stretchers. Two-wheeled ambulances.

Of course, two-wheeled ambulances are largely employed by foreign armies, but the balance of evidence appears to the Committee to be in favour of a light four-wheeled ambulance, rather than a two-wheeled one. Again, in whatever foreign country our army may be operating, the cart or wagon indigenous to the locality will generally have to be extensively used for sick transport, in the same way that the ox wagons of the Transvaal and Orange River Colony were utilised in South Africa. In the French and other continental armies, the large forage wagons are fitted with improvised apparatus for conveyance of patients, and various methods for carrying wounded in country wagons are described. It is possible that something in this way might be done with our G.S. wagons, but they are not invariably used on active service, and it is understood that they are of different patterns. The ambulances, whether of the heavy or light variety, should carry— G.S. wagons convertible into ambulances.

- A. A detachable water tank.
- B. An ambulance box of hospital stores.
- C. An ambulance box of surgical dressings.

The contents of B and C to be carried in a metal box, packed in rectangular water boiler, with lid, enclosed in iron firegrate, carried under the body of the ambulance.

The contents of ambulance box of hospital stores might be—

Arrowroot.	Condensed milk (unsweetened).	Ambulance box of hospital stores. <i>See Ambulance in the U.S. Army.</i>
Beef, soluble, liquid or extract.	Malted milk.	
Brandy.	Salt.	
Matches.	Tea.	
Sugar.	Can opener.	
Chocolate.		

Contents of ambulance box of surgical dressings—

Antiseptic dressings.	Gauze iodoform (sterilised in packets).	Ambulance box of surgical dressings. <i>See Ambulance in the U.S. Army.</i>
Bandages, plaster of Paris.	Gauze, plain, sterilised.	
Bandages, roll, sterilised gauze.	Morphine sulphas.	
Chloroform.	Hypodermic tablets.	
First aid packets.	Pins, safety.	
Plaster, adhesive.		

And in addition—

<i>Stretchers</i> , light Canadian pattern.	<i>Wrench</i> , monkey.
<i>Lamps</i> , ambulance, two.	<i>Hatchet</i> .
<i>Lanterns</i> , extra (one white, one red), carried under seat.	<i>Curry-comb</i> .
<i>Lantern</i> , extra wicks.	<i>Horse-brush</i> .
<i>Oil</i> , mineral, carried under seat.	<i>Bucket</i> , galvanised-iron.
	<i>Axle grease</i> .

The introduction of acetylene lamps for ambulances is desirable.

It is thought also that thigh splints (plain wooden) could be strapped to the roof, and a shallow locker constructed with door opening out to the air, to hold a bed-pan (Agate ware), often much needed while conveying patients seriously ill, also a urinal and disinfecting solids.

Trial of well-constructed two-wheeled ambulances recommended. Tongas for detached duty.

With regard to the two-wheeled tonga, or ambulance for two lying—or one lying and three sitting—the Committee recommend a trial of vehicles constructed on these lines, with a view to their adaptability for work with cavalry or other mounted units. The great difficulty seems to get them to balance well.

An Officer with Indian experience suggests that tongas should be extensively used with cavalry, and equipped, for detached duty, with *blankets* and *waterproof sheets*, a kettle, and a few *cooking pots*. There is a suggestion, too, that the riding horses with a mounted field ambulance should wear breast harness (light pattern) so that they could be hooked on in front when an ambulance had to go up hill or over heavy ground (spare traces being carried). The suggestion seems a practical one.

So far as transport animals for ambulance work are concerned, mules were invariably preferred in South Africa; but it does not follow that they would be elsewhere, and it is probable that, generally speaking, horses would be preferable for field units working with mounted troops.

With four-horsed ambulances with cavalry, the question arises whether any advantage would be derived if, instead of having drivers, they were postillioned.

[NOTE.—As to ambulances, there is an absolute necessity for some form of light, rapidly-moving vehicle in addition to the more commodious but heavier wagon. The proportion of these lighter vehicles would depend on the mobility of the force to which the unit was attached, a cavalry division, for instance, would require a larger proportion than an infantry division.

While it is recognised that it is not possible to design an ambulance wagon which will be most suitable under all conditions, there is a consensus of opinion that Mark V ambulance has done remarkably well, more particularly as regards strength and the small amount of repair necessary. The two chief faults which are pointed out are (1) the weakness of the fore-carriage, and (2) the fact that it carries only two patients lying down. It does not appear to be more uncomfortable than any of the other patterns which were used.

During the war Mark V ambulance was altered to carry four men lying down. This was done on several plans, and they all worked very well.]

(8) *Stretchers.*

The present regulation stretcher is far too heavy, weighing 34 lbs. They are, however, strong, and make good beds, but the traverses are said to cause annoyance to the sick.

The stretcher most in favour is one of American pattern, used in the Canadian Field Hospital. It weighs only 15 lbs., with iron stirrups instead of wheels, and lighter poles. With certain modifications it is highly recommended.

Every ambulance should carry four stretchers, but if tongas or very light ambulances are constructed, they would only carry two.

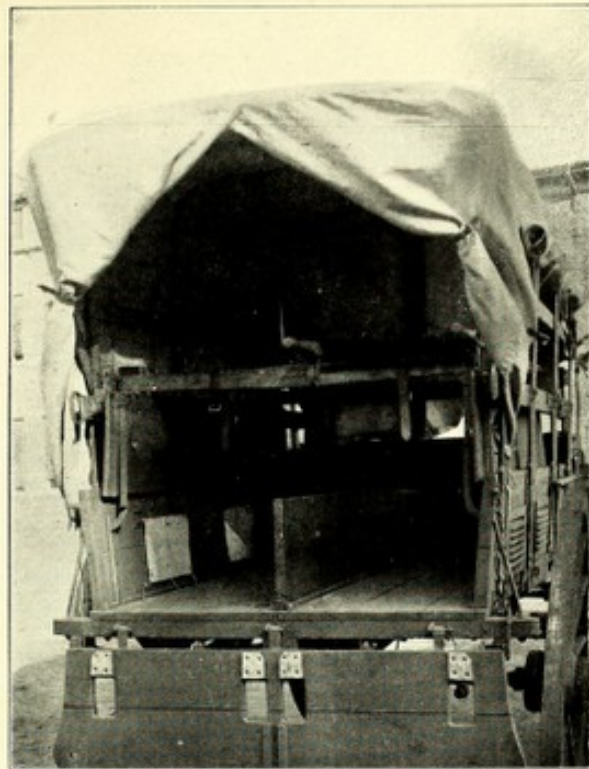
Increased number of stretchers required.

It is considered that the number carried for use of the brigade should be very materially increased.

In addition to those actually carried by the ambulance units and regimental bearers, at least 50 (light pattern) should be kept in reserve, and carried in wagons under the temporary charge of the Army Service Corps transport, or with the reserve ammunition column, to be at the disposal of the Principal Medical Officer of the division.

Reserve supply of stretchers.

This reserve supply of stretchers would be used to augment those of the field ambulance, and provide for a large number of sick and wounded who would otherwise have to lie on the ground in the ambulance tents, or, in the event of a severe engagement attended with heavy losses, these reserve



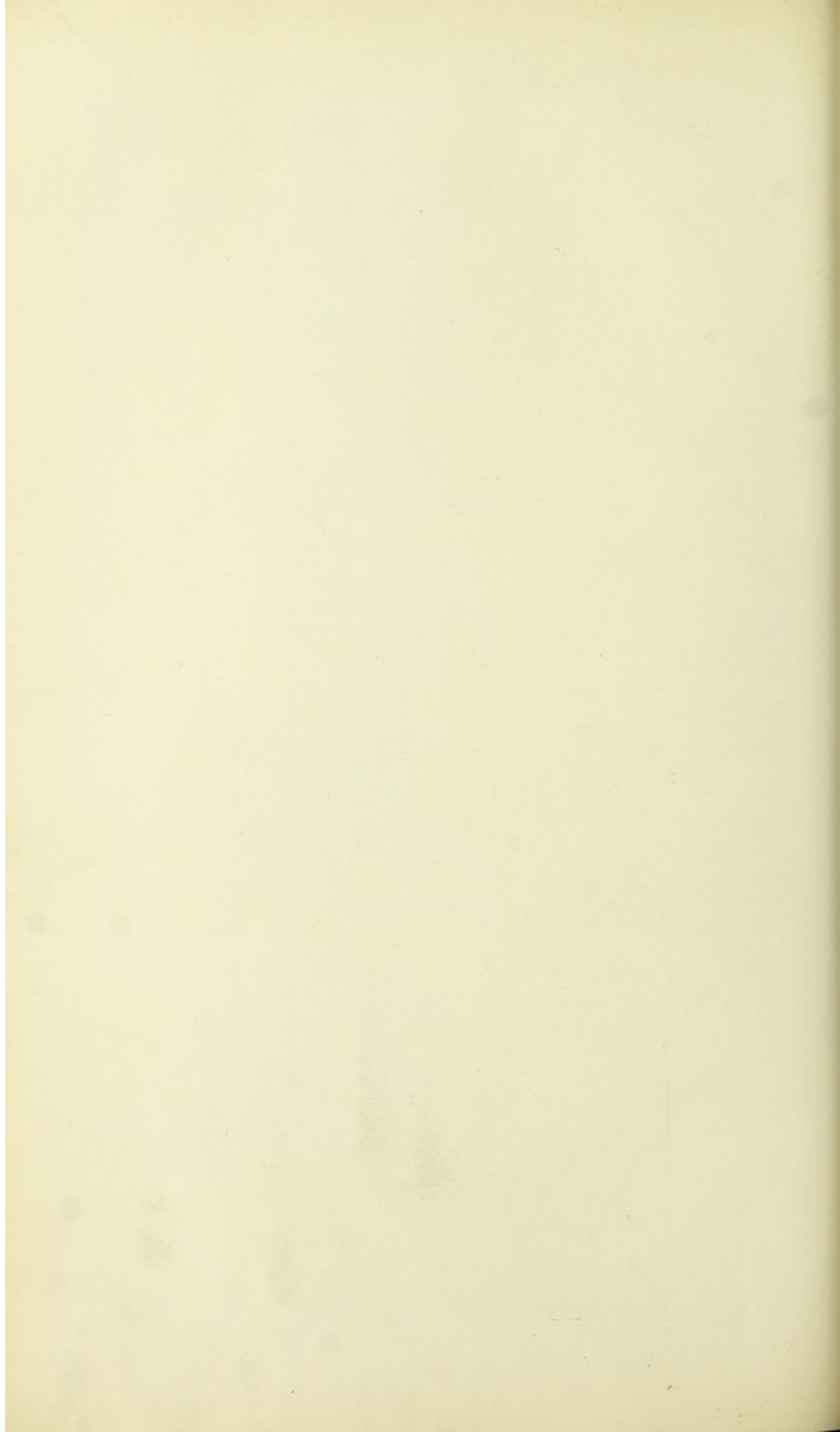
MARK V AMBULANCE.
(Converted to carry four cases. Captain Stammer's method.)



TONGA (IMPERIAL YEOMANRY PATTERN).



MANDER'S FLYING AMBULANCE.
That to the right carries three men lying down; that in the centre is for sitting-up cases only.)



stretchers could be used by disengaged troops to assist in the removal of the wounded from the field at the conclusion of the action. In the German army it is the duty of every body of troops without special orders to search the battlefield and its vicinity for wounded men.

In field hospitals, if camp beds are not carried, provision should be made for at least 50 per cent. of cases to be supplied with stretchers, and if possible a larger number. These will have to be carried in separate wagons, and extra transport provided for this purpose.

In field hospitals stretchers required for large percentage of patients.

The number of stretchers used in the field on the Natal side was enormous. Surgeon-General Sir T. Gallwey, K.C.M.G., says it was absolutely necessary, owing to the nature of the country, to have bearer ambulances, wheeled ambulances were impracticable, the bearer companies (*i.e.*, the ambulances) could not at times get within four miles of the army, and he adds: "Besides it is a very important thing to carry the men. . . . It is certainly the best means of carrying badly wounded cases."

Large number of stretchers used on Natal side. Importance of hand carriage for badly wounded men.

The stretchers used were a good deal lighter than the regulation ones, and were of different patterns. Sir Thomas Gallwey considered the old army pattern unnecessarily clumsy.

Great demands were made by this Officer on the Ordnance Department for stretchers. As many as 500 were ordered at one time. "I cannot," he said, "have too many, I want them in all the hospitals, and particularly in the field." It should not be necessary, for instance, for men with fractured legs to be taken off stretchers on arrival at a field hospital, but this might have to be done unless there was an ample supply. To give a further idea of the number of stretchers, which under certain circumstances might be required, it may be mentioned that prior to the relief of Ladysmith, no less than 1,400 of the Natal Volunteer Ambulance Corps assisted the bearer companies in hand-carrying the wounded, and 800 Indian coolies.

In cavalry brigade units spare stretchers should be carried with the heavy transport reserve ammunition or supply columns.

Wheeled Stretchers.—In some Continental armies wheeled stretchers folding flat for packing are used in the field. In the French army 16 can be taken to the front in one regulation transport wagon (*chariot de pare*).

The general opinion of British Medical Officers is, however, that they are not useful for field work, but that they might be used with advantage in general hospitals and in hospitals on the line of communication in transporting men from the trains to the hospital. It is a great economy to have wheeled carriage and relieves the orderlies. They should be provided with hoods. They were a good deal used for these purposes on the Natal side, and about 20 were allowed for a general hospital. Their use for purposes above mentioned is strongly recommended.

Wheeled stretchers suitable for general hospitals, &c.

A few Officers, however, suggest a few wheeled stretchers for the field ambulances; made so that the wheels would fold on the axle to permit them being carried flat, as mentioned above.

Description of the American Pattern Stretcher used by the Canadian Field Hospital. (Taken from Lieut.-Colonel Porter's Report on Canadian Field Hospital).

This stretcher is made of much lighter wood than our own—

Length of poles, 7 feet 8 inches.

Length of canvas, 6 feet.

Width, 21 inches.

Weight, 16 lbs.

Length of handles, 10 inches.

Shape of handle: with no special grip.

In lieu of wheels this stretcher is fitted with four galvanised iron stirrups $4\frac{1}{2}$ inches in diameter, which run along the floor of the ambulance like wheels.

The great advantage of this stretcher is its weight, which is half that of

the one in use with the British Army. The stirrup, too, is less likely to break than the wheel and is quite as useful.

The weak points about it are—

- (1) The handle has no grip.
- (2) The "traverses" are too weak, and so allow the poles to approximate themselves when a patient is on them. If these points were remedied the Committee are of opinion that it would be an improvement to the pattern now in use, and would be well adapted to carrying work in the field.

[NOTE.—*Stretchers*.—The existing pattern is universally condemned on account of its weight, otherwise it has done well. The number available with a brigade is reported as insufficient, after taking convoy work, and the use of stretchers as beds for serious cases in the field hospitals, into consideration.]

(9) *Field Cooking.*

The sergeant cook is specially trained in order to instruct men of the Royal Army Medical Corps in this most essential part of their duty.

Instruction
in camp
cooking
for the
auxiliary
medical
services.

It is considered very desirable that all soldiers should be systematically taught how to cook their rations in the field, especially men of Army Medical Service and the Auxiliary Medical Services.

In field hospitals soldiers' rations are supplemented by whatever medical comforts are available; as a matter of practice men reporting sick rarely, if ever, bring their rations with them; they generally come sick from the line of march, or from outpost duty, and have no opportunity of bringing their rations.

A considerable number of men reporting sick in the field are suffering from general nervous exhaustion, consequent on hard and continual marching, frequent outpost duty, want of sleep, and constant anxiety, with insufficient and badly-cooked food—with rest and a more stimulating diet they quickly recover and rejoin the ranks.

Wounded
not requiring
the adminis-
tration of
chloroform
to be fed on
coming to
the dressing
station.

Slightly-wounded cases coming to the field hospitals who do not need chloroform should be fed; men coming from the firing line are generally more or less exhausted, hence the necessity for beef tea, stimulants, &c., which must be prepared the moment a dressing station is established—the latter is frequently merged into the field hospital.

Small oil
stoves for
standing
camp.

In standing camp, small oil stoves are recommended for preparing small quantities of fluid food for patients. The plan adopted in the United States army of having a field range outfitted to meet the requirements of so many patients is a good one. The cooking utensils are packed in this range, and are supplemented by the contents of a "mess chest" outfitted for the requirements of a similar number—ranges for 25—100 patients are used.

Elaborate
field
kitchens
rarely used.

Field Kitchens.—Speaking generally, the elaborate plan for field kitchens mentioned in the Royal Army Medical Corps Manual is not carried out on service, nor is it required (except perhaps at home for purposes of instruction).

Cooking on
line of
march.

On the march, with brief halting periods, all that was done was to place the camp kettles in a circle round a wood fire, or in such a position as to catch the draught from whichever way the wind was blowing; cooking bars in the experience of most, were rarely used. The 18th Brigade Field Hospital left them behind at Modder River prior to the advance on Bloemfontein, and never felt the want of them; they have the disadvantage, too, of weighing a good deal.

Cooking in
standing
camps.

In standing camps the stove was used in addition to the camp kettles, and proved most useful.

As a matter of practical experience the large camp kettles were found very unsuitable for preparing food for men really sick, being far too large, the number of small saucepans provided was insufficient—nor could they be used very well with an ordinary camp fire—but were most useful when there was

time to utilise the stove. In the proposed "mess chest" for field units a nest of small cooking utensils is included.

The Committee attach great importance to the careful instruction of company cooks and soldiers generally in camp cooking, and consider that a good deal of bowel irritation is caused by half cooked or badly cooked rations on service. It seemed, in many instances, to be the rule that whatever time rations were issued, they were always supposed to be ready to eat at a given hour, irrespective of the proper allowance of time for the actual cooking. In standing camps there is no necessity for this.

Importance
of well-
cooked
rations on
service.

Extract from Report on Field Medical Units, South African War, by Major J. Kearney, R.A.M.C. Extract.

Field Cooking.—With properly trained cooks and supplies of good quality, all that will be necessary to ensure good cooking is a certain amount of supervision on the part of the Officer Commanding or the Quartermaster. If fresh meat is issued it should, if possible, be kept for some time, according to the season, before being cooked. As a rule on service the animals are killed in the afternoon or evening when the troops arrive in camp, and the meat cooked directly afterwards, the result being that it is quite tough and hard.

The baking of bread is a very important matter in the field. Men get tired of biscuits, and their teeth are very often injured by them, so that flour should be issued frequently, and field ovens constructed for the baking of bread. In the irregular corps in South Africa a large number of men baked their own bread during a halt or when an opportunity occurred. During the latter part of the war some of the Regulars learned to do the same, and flour was issued occasionally in some columns.

It would be a great advantage if a portable cooking apparatus on wheels could be issued to each unit or company (medical and other), so that soup, &c., could be prepared while on the march, and be ready for the men when they get into camp. This system is, I believe, carried out in some of the Continental armies.

An issue of covered enamelled iron buckets to field hospitals is much required for carrying milk, beef tea, &c., to the patients.

(10) *Reception and Storage of Arms and Accoutrements.*

The Committee consider that the custody of arms and ammunition by field units is extremely undesirable. The following suggestions have been made:—"That all arms and ammunition of men admitted to a field hospital might be handed over to a brigade quartermaster with rolls of men and corps to whom the arms, &c., belong, so that in the event of a man being returned to duty in a few days he could obtain his arms, &c., from this officer." The brigade quartermaster might be attached to the ammunition column, and charged with these special duties. It is considered necessary, however, that the arms, &c., of wounded should in the first place be brought from the field by the stretcher bearers, except in the case of men slightly injured who are able to carry their own, but that on arrival at the field ambulance or field hospital all arms and ammunition should be immediately handed over to a combatant unit.

Lieut.-Colonel Sawyer makes the following observations with which the Committee entirely concur:—"The arms, ammunition, and accoutrements of the sick and wounded have proved a source of great inconvenience to field medical units during the recent campaign. The arms deteriorate from not being looked after, and much of the ammunition gets lost. Recommended that either they be returned to the units to which the patients belong, or that a representative of the ordnance with the necessary transport accompany each brigade or column, and that the arms, &c., of the sick be received by him. All consignments of ordnance stores from the base could also be received and distributed by him to the various units in the field. A field medical unit has neither the means for the carriage nor for the safe custody of arms and accoutrements."

Arms, &c.,
to be
handed
over to a
representa-
tive of the
Ordnance
Service.

If, notwithstanding these objections, it were ruled that it was the duty of field units to take charge of arms, &c., of the wounded and fallen, then extra transport must be provided.

[NOTE.—Some remarks have been made on this subject in the section dealing with the lines of communication. The question really is one of arms only; there is never any difficulty in getting rid of ammunition, as any unit will take an expendible supply. If every man that went sick was lost to the field force it would be a much simpler question. But the man who is able to return must do so as quickly as possible, and must return armed. The suggestions made hardly seem to meet the difficulty, and apparently the hospitals must continue to receive the arms of patients admitted.]

(11) *Reception and Custody of Valuables.*

Field pay-
masters to
take charge
when
present.

It is considered that when possible all valuables should be handed over to the field paymasters; Officers commanding field medical units should not be made responsible for their safe custody, except to a limited and unavoidable extent. In cases where it is necessary for the Officer of a medical unit to take charge of such things as money and valuables, a small field safe might be issued for the purpose. On the transfer to the base, the valuables and money should be sent with the patient, in a sealed packet with the signature of the Officer commanding field unit written across it, and handed over to the Principal Medical Officer of the Base Hospital, who will return it to the man on his discharge or departure for England; if the man be unable to look after his valuables, the packet could be opened in his presence, any money paid into the local paymaster, and valuables sent by post to Netley for delivery to the man on his arrival, or in case of death to next of kin.

When no
field pay-
master is
present
with the
force.

Another suggestion is that money belonging to patients in field units too ill to look after it themselves, could be paid to the Supply Officer of the column, who would give credit to the man's regiment or corps for the amount received, with particulars in his imprest account, the man being given a receipt and informed how his money had been dealt with. In the case of Officers, money or valuables should be, when necessary only, handed over to a brother Officer or his Commanding Officer. Both Officers and men when able should take care of their own property. It seems desirable that neither Officers nor men should take anything valuable with them into the field, and that there might be some ruling on this subject.

[NOTE 1.—By South African Army Order No. 2 of 5.3.02, the Medical Officer in charge was relieved from the custody of sums of money over £5. These might be :—

- (a) Paid over to the man's unit for his credit.
- (b) „ „ sub-accountant Royal Army Medical Corps for disbursement.
- (c) „ „ nearest field or other paymaster.

This system worked well for the short time it was in use.]

[NOTE 2.—Many of the men, especially of the Imperial Yeomanry and Colonial forces, carried large sums of money on them, besides valuable watches and other trinkets. It is not fair to the Officer Commanding to make him responsible for sums which may easily (and did) amount to several hundred pounds. In many cases the patients retained their money and valuables, but here again they were exposing many of those with whom they come in contact to a temptation which should not have existed. Stringent orders should be issued with regard to this practice.]

(12) *Clerical Work and Returns.*

Clerical
work to be
reduced to
a minimum.

It is considered that the clerical work of field units should be reduced to a minimum, and that the present number of Army Books and Forms supplied to field hospitals and bearer companies should be very largely reduced.

The Committee recommend that the following be eliminated :—

- A.B. 156.—Casualty Book, in its present form. A book about the size of A.B. 136 being substituted.
 A.B. 291.—Register of Animals. MS. if required.
 A.F. A 9.—Proceedings of Regimental Court Martial. MS. if required.
 A.F. A 10.—Extract of Court Martial. To be completed by O.C. Base Details.
 A.F. A 12.—Court Martial Sheet. To be completed by O.C. Base Details.
 A.F. A 45.—Proceedings of Medical Board. Report in MS. if required.
 A.F. B 74, A.S.C.—State of Detachment. MS. Report to O.C., A.S.C., when required.
 A.F. B 76, A.S.C.—Return of Casualties. MS. Report to O.C., A.S.C., when required.
 A.F. B 83.—Horses Purchased, &c. MS. Return to Officer in Charge of Remounts, as required.
 A.F. B 116.—Application for Court Martial.
 A.F. B 121.—Defaulter Sheet, Company. To be kept by O.C. Base Details.
 A.F. B 135.—Disembarkation Returns. Obtained from Disembarking Officer.
 A.F. B 141.—Embarkation Returns. Obtained from Disembarking Officer.
 A.F. B 144.—Numbers for Embarkation. Obtained from Disembarking Officer.
 A.F. B 183.—Detailed Information, Mental Disease. Report in MS. if, and when, required.
 A.F. B 243.—Will Form No. 1. MS. if required.
 A.F. B 244.—Will Form No. 2. MS. if required.
 A.F. B 296.—Character and Particulars of Service of Prisoner. MS. if required.
 A.F. B 2069.—Crime and Offence Report. MS. if required.
 A.F. C 355.—Form to accompany Form of Commitment to Prison. MS. if required.
 A.F. C 385.—Order for Commitment to Prison. MS. if required.
 A.F. C. 388.—Order for Commitment to Prison by Commanding Officer. MS. if required.
 A.F. C 389.—Order for Discharge of Prisoner. MS. if required.
 A.F. C 396.—Order for Temporary Detention, Prison or Lock-up. MS. if required.
 A.F. F 736.—Hospital Diet Account. This was not required during the late war.
 A.F. I 1230.—Report of Deficient Medical Stores. MS. if required.
 A.F. O 1625.—Statement of Effects, Non-Effective Soldier. MS. if required.

Army Forms recommended for elimination.

(A "Specimen Book," containing one each of the forms to be rendered in MS., should be supplied.)

The information is found in A.F. F 735, which can be referred to if necessary. The fact that A.F. F 735 has been signed by the Medical Officer in charge should be a sufficient guarantee that the articles have been expended. A simple form of receipt and issue in bulk of medical comforts and extras might be substituted for the detail A.F. F 735 (see later note on A.F. F 735).

Remarks on A.F. F 736.

Army Forms, relative to pay, &c.

- N 1507.—Pay List.
 N 1509.—Schedule Non-Effective Account.
 O 1616.—Deferred Pay Voucher.
 O 1645.—Extra Duty Pay Voucher.
 O 1727.—Requisition Family Remittance.
 O 1811.—Statement of Soldiers' Account.

Procedure recommended for pay forms generally.

With regard to the above, it is thought that all pay duties for field units should be done by the clerical staff of the Officer Commanding base

details, Officers Commanding field units notifying casualties as they occur direct to that Officer. Soldiers to be paid on last pay certificates similar to that adopted for civilian conductors in the late war.

(This would save much delay and complication, and should certainly be carried out. See Lines of Communication Report).

Further forms for elimination :—

A.F. O 1761.—Seamen Sick in Hospital. MS. when required.

A.F. O 1785.—Horses Lost. Certificate from C.O. to Officer in Charge of Remounts through the Transport Officer.

A.F. O 1786.—Horses Destroyed. Certificate of O.C. or Veterinary Officer to Officer in Charge of Remounts.

A.F. O 1789.—Necessaries Destroyed. Certificate of C.O.

A.F. P 1949.—Return of Men not Rationed. Omit, not required.

A.F. P 1950.—Return of Men Drawing Rations. Omit, not required.

A.F. A 36.
para. 1727.
"K. R."

Book form.

A.F. A 36, with special reference to para. 1727 K.R.

It is considered that the quantity of this form should be greatly increased, and that they might usefully be supplied in *book form*, so that carbon paper might be used, enabling three copies to be prepared at once. It is necessary that great care be taken in the rendering of this return.

It might be utilised for the purpose of giving information as to transfers, &c. Column 6 being wider and used for this purpose, it would be very useful for reference (*see under "Invaliding"*).

Equipment ledger, A.B. 248, Special for Field Units. Not half the present book is used with a field unit.

More single sheets of foolscap should be included in the case, and a supply of small memorandum forms.

A.F. C 335
useful.

A.F. C 335 might usefully be included, also a few more diary and prescription books; the latter when carefully kept show expenditure of medical comforts and medicines, and is a good check on expenditure.

Will forms are hardly needed.

Brown paper is not wanted.

Record
office at
base.

It is recommended that a R.A.M.C. record office be established at the base, the staff to consist of two officers and a number of clerks. As far as possible *all* clerical work should be carried out at this office. In this way the return of sick and wounded would be carefully kept, corps returns and pay list properly kept up from a rough *précis* sent from field units. For example, a special admission and discharge book could be designed with alternate fixed and perforated pages, a duplicate copy of all entries being made by means of carbon paper. At the end of each week or month, the perforated pages to be torn out, and sent to the record office at the base. The necessary information with regard to strength, &c., to be obtained by the record office through army headquarters, from the returns published weekly by the G.O.C.

Pay lists and corps returns to be worked out on similar lines (*see Lines of Communication Report*).

Further
suggestions.

Further suggestions by Major Fallon are as follows :—

The pay list should be kept at a central bureau (one or several), possibly one per army corps, and only a cash book kept by mobile units. A certified summary of the latter to be sent in every month. When a man leaves the unit, sick or on transfer, he should be furnished with a certified statement of *all* his cash transactions whilst with the unit, a duplicate being forwarded to the central bureau.

All returns for field work should be in book form, with carbon papers. This would save much labour when duplicate and triplicate returns (with office copies) are required.

A.F. A 36, para. 1727, K.R. For field units one copy of A 36 sent weekly to the man's Commanding Officer should be sufficient. All other returns based on it to be a regimental arrangement.

The same course to be followed in case of men transferred to other hospitals.

A consolidated return, giving numbers of each corps only, to be sent weekly and on transfer to the general or other Officer commanding the force.

A.F. 735. This form is far too intricate. It is thought that it might also be done away with in field ambulance units if the diary and prescription book (A.B. 39) were completed daily, giving the *totals* of all articles of diet and extras issued, signed by the Officer in charge; the books to be kept as records.

List of Army Books and Forms which it would be advisable to retain with a Field Medical Unit.

				Books.
Letter Book (manifold writer with carbon paper).				
Field Service Voucher and Issue Journal ...	A.B.	8		
Ready Reckoner, Field Rations ...	"	14		
Hospital Admission and Discharge ...	"	27A		
Hospital Diary and Prescription Book ...	"	39		
Requisition for Rations ...	"	55		
Cash Book ...	"	69		
Plain ruled demy (4-quire), with index ..	"	122		
Plain ruled foolscap (2-quire) ...	"	129		
Memo. Book (1-quire) ...	"	136		
Day and Order Book ...	"	138		
Field Letter Book, with carbon paper ...	"	153		
A.F. Medical Certificate Book ...	"	172		
Hospital Pack Store Check Book ...	"	182		
Equipment Ledger (special for Field Ambulance)	"			
				Forms.
Nominal List of Wounded in Action ...	A.F. A	6		
Nominal Roll of Admission and Transfers...	" A	36		
R.A.M.C. Monthly Corps Return ...	" B	62		
Field State ...	" B	239		
Death Report ...	" B	2090		
Hospital Diet Account, monthly (special for Field Ambulance) ...				
Application for E.D. pay for men, R.A.M.C. ...	" I	1228		
Application for E.D. pay, other corps ...	" I	1229		
List of Casualties affecting Pay ...	" O	1601		
Expense Voucher, G.S. ...	" P	1925		

The Committee suggest that "information slips," such as are used in the medical service of the U.S.A., be largely employed in the field for ordinary correspondence and returns.

Arms and Equipment, R.A.M.C.—It is recommended that in future all arms and unnecessary articles of equipment of R.A.M.C. should be left in England, thereby saving a great deal of worry through these articles going astray and becoming damaged.

The Committee are indebted for suggestions under this heading to Sergeant-Major Soule, R.A.M.C., and Corporal R. B. Johnson (late R.A.M.C.), both of whom have had much experience with field returns.

(13) *The Question of Reserves for the Medical Service in the Field.*

Surgeon-General Evatt, C.B., in writing on this subject, says:—"We must learn to see field hospitals standing ready and idle, but waiting to be employed, just as we see batteries of artillery idle, waiting for use."

In addition to the three field units included in each infantry division, viz., two field ambulance units and one field hospital, the former attached to brigades and the latter to the division, there should be mobilised in addition and as a reserve, at least a tent section of a field ambulance, that is to say tentage for 150 wounded with the necessary personnel and equipment, for each division in the field.

This "field ambulance" should be located and kept in readiness immediately in rear of the field of military operations. If a stationary field hospital be established at the head of each line of communication the reserve

Reserve of one field ambulance for each division.

field ambulance for a division might rendezvous at that place, provided it be sufficiently near the front.

[NOTE.—Reserve field ambulances are certainly necessary, but they should not be detailed for the divisions; they should be entirely at the disposal of the Principal Medical Officer, Field Force, who can then send them where they are really needed, without any semblance of a reduction of the divisional medical arrangements. It is always possible that new brigades may be formed from lines of communication troops, and field ambulances are needed for these. To attach these reserve units to the existing divisions would to some extent defeat the object with which their provision is recommended.]

Reserve of
trained
orderlies
and bearers.

Medical
service
depôt at
base.

Proportion
of trained
orderlies
and bearers
to be
preserved.

Reserve Medical Personnel.—During the late war it was stated by the commission that "the difficulty of supplying orderlies accustomed to and fit for hospital work was much greater than the difficulty of finding civil surgeons, and, in fact, was never overcome"; and again, "a good orderly must be trained, and the training takes time, and clearly ought not to be at the expense of patients in a crowded hospital." Allowing that the numbers for field units will at the start be adequate, there must be an *ample reserve* of trained orderlies and bearers, as the personnel of both, especially of the former, will certainly be inadequate before the close of operations. It seems, therefore, imperative that in addition to all complete units for the field there should be mobilised at home and sent to the seat of war, a "reserve" of men belonging to the regular and auxiliary medical services organised into a "medical service depôt" and sent to the base overseas to prepare drafts for the medical services at the front.* There should be a nucleus of a sufficient number of men to allow for considerable wastage of trained orderlies and bearers per division, and the depôt must be continuously filled up from England; the constant demands of units can be supplied only in this way.

The medical personnel held in reserve should, however, always include a proportion of the highly trained nursing class of orderly, so as to preserve throughout the campaign a proper proportion between this class of man and the less highly trained bearer.

[NOTE.—In addition to the reserve units, reserve personnel to replace casualties must be available. The wastage begins at once, and indeed it seems that the proportional wastage is greater then than at later periods, so that the field units have their full establishment only for a very short time. Under the present system the N.C. Officers and men of the Army Reserve are, as in the case of the other branches of the service, employed to make up the peace establishment to the war strength. The result is that (except when Section D is mobilised) the completion of the medical units to their war strength exhausts the trained reserve, and the further drafts that are required must be composed of recently enlisted and partially trained men. By passing more men through the ranks a larger reserve might be formed sufficient to make the units up to war strength, and yet leave a surplus for further requirements.]

Convoy
work.
Wounded
transport
columns.

There is a further field medical unit that has hitherto not found its way into our organisation, viz., what in other armies is sometimes called a "military sanitary convoy," mobilised for the transport of sick and wounded from the battlefield to the rear. In the Russian service they are disposed as required by the staff of the army. The establishment of each consists of so many medical officers, hospital attendants, cooks, &c., and the necessary transport, viz. :—

Ambulances.
A horsed kitchen wagon.
Store wagon.
Medical store cart.

It is certainly desirable that every division should have an organisation of this sort with a reserve of ambulances for the purpose. In the Austrian

* Theoretically the "first reinforcements" (about 10 per cent. of the strength) should embark and be held in reserve at the base for this purpose. This was not the case in the late war.

army they are called "wounded transport columns," and one is attached to each field hospital. The personnel is furnished from one or other of the "red cross societies," and in our army it might well be a Volunteer aid. During the advance on the western side to Pretoria in the late campaign such organisations would have been extremely useful with our sick convoys.

[NOTE.—This question has been referred to in the section dealing with evacuation on the line of communication.

In operations of any magnitude an organisation of this kind would be of the greatest assistance, but in any case it should form part of the line of communication system. The transport that can be provided to accompany a division in the field will always be limited, and there seems to be little doubt that the tendency in the future will be to cut this down as far as possible. The difficulty is this, that such a "sanitary convoy" is an encumbrance when the force is advancing, that its draught animals are drawing empty wagons. On the other hand, the supply wagons work in advancing and return empty. There is an obvious advantage, from the point of view of the Transport Officer, in utilising these on the return journey for the carriage of sick and wounded, in place of having to provide additional animals for the "sanitary convoy."

Limited as the conditions must be by the transport that can be made available, it would seem on the whole better to ensure that the field ambulances and the divisional hospital are well forward with the divisions, and that the advanced line of communication hospitals are pushed as far forward as they can go. This indeed seems to be the true solution of the transport difficulty, to make the distance from the field to the advanced hospital shorter than is at present contemplated.

The sphere of probable operations of our army, as compared with those of the Continental Powers, is so different that the argument from one to the other hardly seems valid.]

Volunteer Brigade Field Units.

Each brigade should have a combined unit, viz., a "field ambulance," ready for active service.

The Yeomanry should also be provided with an organised medical service and be prepared to place in the field so many lightly equipped mobile *mounted* ambulance units for work with mounted troops only.

The field units lately sent on service with the colonial forces in South Africa have earned for themselves a well-merited reputation, as also the field hospital and bearer company of the Imperial Yeomanry.

The essential feature of Volunteer and colonial medical aid, both in regard to personnel and equipped field units, is that it should be sufficiently expansive to ensure provision being made for the medical care and treatment of the large numbers of auxiliary forces, both from home and the colonies, which in the event of a great war would form part of the field army.

[NOTE.—All auxiliary forces when brigaded should be *complete in themselves* for the field. Whether they should provide stationary and general hospitals is a matter to be settled, but they undoubtedly should have their own field medical units on the same pattern and to the same scale as the regular forces.]

PART IV.

GENERAL AND STATIONARY HOSPITALS.

1.—INTRODUCTORY.

During the South African War there were 22 general hospitals and 41 stationary hospitals established, besides a large number of smaller temporary hospitals.

General Hospitals, 22.

Of the general hospitals, Nos. 1 to 11, Nos. 13 and 14 were sent out from England; the remaining nine were formed in South Africa, as shown below :—

- (1) By the expansion of a stationary hospital—

No. 2 Stationary Hospital	became	No. 16 General Hospital.
No. 4 " " "		No. 17 " "
No. 1 " " "		No. 18 " "
- (2) By the expansion of a section of a general hospital—

Section No. 3 at Springfontein became No. 12 General Hospital.
- (3) By taking over previously existing hospitals—

Imperial Yeomanry Hospital, Deelfontein, became No. 21 General Hospital.

Imperial Yeomanry Hospital, Pretoria, became No. 22 General Hospital.
- (4) Entirely organised in South Africa—

No. 15 General Hospital,	Howick.
No. 19 " "	Pretoria.
No. 20 " "	Elandsfontein.

In addition to these numbered hospitals, a general hospital was formed at Maritzburg during the early months of the war from the existing hospital, plus accommodation in various buildings in the town.

Those under (4) required a complete staff and the entire equipment provided.

Under (3) No. 22 General required a new staff and much additional equipment to replace that removed before the hospital was taken over by us. No. 21 required a new staff.

The hospitals under (2) and (1) required much additional personnel and equipment in proportion to their development.

The general hospitals sent out from England required both personnel and equipment as they were enlarged to meet the necessities of the campaign.

The following general hospitals were established originally on one site, and later transferred to another :—

No. 2,	established at Wynberg,	transferred to Pretoria.
No. 3	" Rondebosch	" { Kroonstadt.
		" { Springfontein (Section).
No. 6	" Naauwpoort	" Johannesburg.
No. 7	" Estcourt	" Pretoria.

Except in the case of No. 7, which was able to bring up its accessory buildings from Natal to Pretoria, complete arrangements for water, drainage, and all accessories had to be made at both stations where the hospitals were erected.

Stationary Hospitals, 41.

Of these, five were sent out from England. The remainder were formed in South Africa, as follows :—

(1) By taking over previously existing hospitals—

No. 13, Pinetown	...	formerly	Princess Christian Hospital.
No. 14, Maritzburg	...	"	General Hospital there.
No. 20, Waterval Onder	...	"	Railway Hospital.
No. 32, Klerksdorp	..	"	Civil Hospital.
No. 36, Barberton	..	"	Civil Hospital.

Of these, the last three required material additions both in equipment and personnel to make them suitable.

(2) By the development of a field hospital—

No. 15, Heidelberg	}	Required additional personnel and equipment.
No. 18, Krugersdorp		
No. 35, Potchefstroom		

The remaining thirty-three were completely organised in South Africa, both as regards matériel and personnel, though in several cases a small detachment from a field unit, with some equipment, formed the nucleus of the hospital.

In addition to the stationary hospitals (41) alluded to above, there were a large number of smaller hospitals scattered over the whole area of operations, many along the railway line, others pushed out into the districts. These were of less importance than the numbered stationary hospitals. As a rule they were smaller, but the criterion which distinguished them from those which were regarded as on the permanent establishment (and therefore numbered for convenience of reference) was that their existence or importance depended entirely on the local conditions, and therefore varied from time to time as the tide of operations ebbed and flowed. The best examples of this class are those at Orange and Modder Rivers, which were used only in the opening period of the campaign, Vrede during the middle period, and Vryburg during the last month of the war. Many of these originated by the detachment of personnel from field units, to make the best local arrangements they could until the conditions allowed of help being sent to them from the lines of communication.

The tables at the end of this section show the dates of opening and closing of the general and stationary hospitals, and of the more important of the temporary hospitals. The total number of beds equipped varied from time to time according to circumstances, the maximum was in June, 1901, when 21,000 beds were equipped (excluding the field hospitals) with provision to increase this number if necessary. This was largely in excess of the total numbers for whom accommodation was needed, and a surplus of total accommodation over total needs was maintained until the end of the war, as it was absolutely impossible to say when accommodation might be required in any one district.

2.—GENERAL REMARKS.

(a) *Accommodation and Equipment.*

The general hospitals as established in South Africa differed very considerably from the general hospital as constituted by regulation, especially in the matter of accommodation and equipment.

The regulation equipment of a general hospital provides 520 beds (20 of which are for Officers) in hospital marquees, while all operating rooms, stores, and offices are also under canvas; kitchens and latrines are in the open. With the exception of No. 1 General Hospital at Wynberg (where the hut barracks were converted for hospital use) and the General Hospital at Maritzburg, the accommodation for sick in all the general hospitals was at first under canvas. Later, in many of the hospitals, huts were erected for the patients in lieu of tents. In most cases the barrack huts sent out for the troops were used and did very well; in others locally made huts did equally well, and were earlier obtainable.

The number of beds equipped was also largely increased in nearly every hospital.

In every case (except No. 1 at Wynberg, where it was not necessary as buildings existed) wood and iron buildings were erected, operating and X-ray rooms, stores, kitchen, latrines, and in most cases offices also.

(b) Operating Room.

The size and finish of these varied considerably in the different hospitals, but the general principle was the same, viz., a room easily kept clean and well lighted from the roof and by side windows, and in most hospitals by electricity at night. That of No. 1 General Hospital was somewhat more elaborate than the rest. The floor was marble, and the walls and roof were lined with sheet zinc and painted with enamel. It was lighted by skylight and by south windows. Electric light was laid on, also hot and cold water. The hot water was provided from small boiler house outside the operating room. At Wynberg there was a second operating room set apart for Officers' hospital. It was also well fitted; here a receiving room 16 feet by 16 feet by 12 feet was attached.

The operating rooms in the other general hospitals were not so costly, and the floors were either concrete or covered with linoleum. All were well lighted by skylights and by side windows by day, and by electric light (as a rule) by night. Where material was not very difficult to procure the size usually ran to 20 feet by 16 feet by 10 feet or 12 feet.

The X-ray room was an annex to the operating room and was suitably constructed for X-ray and photographic work.

(c) Stores.

In the absence of any permanent building these were plain corrugated iron huts, provided with shelves along the sides, and racks and shelves down the centre, with a counter at one end to facilitate the issue of clothing. The size of these huts varied very much with the accommodation of the hospital.

As regards the pack store, each kit on an average requires about 6 cubic feet of space. During the late campaign the size of the men's kits varied very much. Those on the lines of communication were generally very large and contained a collection of articles of clothing received from various sources, while the men off the columns arrived in the clothes they stood in, and had to be, as a rule, entirely refitted in the hospitals.

The storage and cleaning of the men's rifles is a matter that demands more attention. The rifles invariably arrive in hospital in a dirty condition and require immediate attention. During the campaign convalescents or regimental orderlies cleaned and oiled the arms, and everything was done in the hospitals for the care and safe-keeping of the men's rifles, but it appears that a better plan would be to attach to every large hospital two men of the Ordnance Department to clean and do any small repairs.

(d) Kitchens.

These varied very much among the hospitals. In places where there were pre-existing buildings these were utilised, but on the veldt where there were no such houses, plain corrugated iron huts were erected. There was no standard plan. Each hut was made in accordance with local requirements, and the dimensions were very much governed by the size and quantity of wood and corrugated iron available. In Natal, for instance, there was no scarcity, the hut of No. 4 General Hospital measured 60 feet by 16 feet by 10 feet. In the Transvaal and in the Orange River Colony the huts were of smaller dimensions, and may roughly be put down as 30 feet or 40 feet by 20 feet by 10 feet. A scullery and storeroom was usually placed at either end of the kitchen.

Smaller kitchens were provided for sick Officers, Medical Officers, Nursing Sisters, and for remainder of personnel.

The sick Officers' kitchens were presided over by a chef, assisted by Royal Army Medical Corps cooks.

(e) Latrines.

These consisted of long sheds made of corrugated iron or light wooden frames. The side walls did not reach up to the eaves but stopped short, leaving a space of about 18 inches between the top of side walls and roof. There were usually four latrines for the sick, and these were so distributed as not to be at a great distance from any tent. The number of seats varied, but may be put down as 70 to 90. There was also similar but smaller latrine accommodation for sick Officers, Staff, Nursing Sisters, and N.C. Officers and men of the hospital staff.

The bucket system was used with dry earth, and disinfectants. As the patients never would use the dry earth it was found necessary to detail a Kaffir to go round the latrines and throw the dry earth into every bucket.

(f) *Lavatories.*

Were usually long corrugated iron huts with concrete floors. Down the centre of each was a bench on which were the basins, and above the basins ran the water pipe with numerous taps. Drainage was provided for. At both ends of the huts were bathrooms, usually four baths in each lavatory. Hot as well as cold water was laid on whenever possible.

(g) *Report of Committee.*

In order to utilise the experience of those Officers who were actually in charge of or employed in general hospitals in South Africa, a Committee was convened, with Lieut.-Colonel Large as president, and the following members—Lieut.-Colonel O. Todd, Lieut.-Colonel G. E. Twiss, and Major A. P. Blenkinsop, all of whom had the necessary personal experience. These Officers have furnished a very full report, which has been condensed and freely used in the following pages.

3.—PERSONNEL.

In all the general hospitals that came out a large proportion of the medical staff was composed of civilian surgeons, and, except at the very beginning of the war, in none was the subordinate personnel composed entirely of the trained men of the Royal Army Medical Corps. As the campaign progressed the proportion in all ranks of the trained to the untrained personnel steadily decreased, and at the same time, too, the accommodation of the individual hospitals was largely increased. The result was much difficulty in carrying on the work. The emergency personnel, consisting of recruits of the Royal Army Medical Corps, specially enlisted Royal Army Medical Corps, Militia and Volunteers, the St. John Ambulance Brigade men, and those of the Cape Medical Staff Corps, and similar bodies, were, as a rule, willing and anxious to do their best; but for want of training their efficiency was far short of what was necessary, and the duty of instructing these men in the ordinary work of a military hospital fell on the Officers and N.C. Officers of the permanent establishment. That the results were as good as they proved to be says much for the zeal, energy, and efficiency of that permanent establishment. It was only by constant supervision and unceasing attention that this result was obtained.

The opinion of all Officers who have a practical knowledge of the working of a general hospital is unanimous, that the present subordinate establishment should be considerably increased; what the actual personnel should be is, however, not so easily determined, but it is possible to fix a minimum establishment which will meet most ordinary requirements, a good deal, of course, depends on local conditions, whether native labour can be obtained for certain duties or not.

The first thing to be decided is the size of the hospital. There is a consensus of opinion that no single hospital should exceed 600 beds. This is as much as one man can satisfactorily administer, and though in South Africa some of the hospitals were enlarged to considerably over this limit, this was the result of necessity and should be avoided as far as possible in future.

Administrative Officers.—The Officer in charge need not be of the rank of colonel, probably in most cases a lieutenant-colonel would be more suitable. He should, if possible, have had some previous experience of general hospital work, and should be a good business man as well as well qualified in professional knowledge. He must be active and energetic.

The Officer in charge should not, in future, be called the "Principal Medical Officer" of the general hospital.

The secretary and registrar to bear the same relation to the Officer in charge that an adjutant bears to the Officer commanding a regiment. This Officer in theory should relieve the Officer in charge of all details of administration, allowing him to devote his attention chiefly to the management of his unit as a hospital as distinguished from its military aspect. Probably the

exact relation between these two Officers must always vary with their personalities, their respective duties should, therefore, not be too closely defined. The Officer in charge is, of course, ultimately responsible for everything connected with his unit.

The divisional officers should, of course, be selected for their special knowledge of the duties allotted to them.

The Committee make the following general remarks regarding the personnel of a general hospital :—

“As frequent changes in the personnel of a general hospital cause great difficulties in administration, as well as complications in pay accounts, we are of opinion and strongly recommend that the administrative Officers and personnel, viz :—Principal Medical Officer, the Registrar (or Adjutant), Divisional Officers, Quartermasters, Principal Matron and Matrons, the Sergeants-Major, Steward, all clerks in both the Principal Medical Officer's and Registrar's offices, the X-ray and bacteriological specialists and their assistants, should not be removed from a general hospital during the time it is mobilised unless in case of great emergency. In fact, we are of opinion that none of the personnel should, if possible, be removed. We consider it ought to be a recognised rule that when once the unit has been mobilised it should remain as such till demobilised.”

This is a course which is obviously beneficial where it can be followed, but it is not probable that in practice it can ever be strictly adhered to.

Specialist Appointments.—The Committee recommend the following :—

“An X-ray specialist who should be required to perform the duties of anaesthetist, and, in addition, be qualified to perform any analytical work that may be necessary. We suggest these additions to the work of the X-ray specialist, as his duties, as such, during the South African campaign, were not sufficient to warrant only that speciality for the future, for this reason also we do not advise the appointment of a non-professional man for X-ray work alone. A pathologist and bacteriologist who should also act as sanitary officer. Each of these Officers to have an N.C. Officer as assistant in his special work, with, in addition, an N.C. Officer as sanitary inspector.”

[NOTE.—It would seem a better arrangement to put the analytical work in the hands of the pathologist and bacteriologist. Whatever their nature these analyses must fall under one or other of the divisions of his work.]

The Committee state :—

“The specialists' appointments need not necessarily be held by Royal Army Medical Corps Medical Officers, though we recommend and think it advisable that they should be. They should devote all their time to these particular important branches.”

“We would also recommend that a *civilian dental surgeon* be appointed to every general hospital on active service. His duties should include stoppings, extractions, and mending of plates, but not to supply new sets of artificial teeth. Much of the inefficiency during the recent campaign was caused by officers and men being unable to masticate their food owing to dental caries, thereby rendering them unfit for field service.

“*Ophthalmologist.*—We do not consider that sufficient work is likely to arise to warrant the employment of this specialist in a general hospital on active service, but we advise that one of the Medical Officers appointed for duty with these hospitals should possess a knowledge of this branch of the profession.

“The rest of the Medical Officers (executive)* doing duty in the hospital should be appointed at the rate of 2 per cent. to the number of beds equipped, of whom one half at least ought to be Royal Army Medical Corps Officers, the other half may be civil surgeons.”

[NOTE.—The proportion of Royal Army Medical Corps Officers should not fall below half of the total strength. This would ensure two Officers of the Royal Army Medical Corps being always employed in each division, which is absolutely necessary.]

* That is in addition to the Officer in charge: Officers in charge of divisions, registrar, and the two specialists.

Quartermasters.—In a hospital of 520 beds the work is rather heavy for one quartermaster; where the accommodation is increased to 600 beds two, as recommended by the Committee, are required. The division of their duties would probably best be made as follows :—

(1) *Senior Quartermaster*—

General supervision.
Steward's store.
Rations.
Kitchens.
Milk depôt.
Medical and surgical supplies and charge of operating room and dispensary.
Red Cross stores and supplies. "Gifts."

(2) *Second Quartermaster*—

Control of sanitary and conservancy staff, disinfection, &c.
Equipment, hospital and patients.
Linen store.
Clothing store : patients' and detachment.
Pack store and patients' valuables.
Rifle store.
Control of workshops, carpenter, tailor, shoemaker, and sail-maker.
Hospital transport.
Hospital lighting.

The duties of the second quartermaster would be almost entirely in the hospital camp. Those of the senior quartermaster involve much going about to the supply depôts and elsewhere, and for this reason he should be provided with a horse. The recommendations of the Committee are mainly in accordance with the above scheme.

Nursing Establishment.—The Committee recommend :—

"The nursing establishment of a general hospital should consist of one principal matron. Three matrons, one for each hospital division.

"*Nursing Sisters*, at the rate of $2\frac{1}{2}$ per cent., and staff nurses at the rate of $2\frac{1}{2}$ per cent. to the total number of beds equipped, ought to be appointed for general nursing duties.

"This would give an average of 40 patients (ordinary cases) to each Sister, assisted by one staff nurse (and four Royal Army Medical Corps orderlies, mentioned further on in report).

"This percentage is arrived at, having made allowance for both day and night duties, Operating Theatre Sister, extra nursing in severe cases, leave, sickness, &c. In addition to above number we recommend that a trained housekeeper be appointed to cater, and look after their mess and quarters. Experience proved in the late South African War that a considerable portion of the Superintending Sister's valuable time was occupied in household cares and housekeeping.

"Also a cook and two maids; a second maid is necessary with this increase of staff.

"The principal matron, divisional matrons, and half the Sisters should belong to the "Queen Alexandra's Imperial Military Nursing Service," half the Sisters and all the staff nurses may belong to Army Nursing Service Reserve (if military Sisters are not available).

"They should be selected, if possible, from hospitals and not from private nursing institutions (the former being more experienced in hospital duties than the latter), and not under 30 years of age."

[NOTE.—This establishment of Sisters at 5 per cent. is probably sufficient for the needs of any individual hospital; it was on this basis that the hospitals in South Africa were staffed, but a reserve of Sisters is required in addition to the numbers allotted to the formed units, in order (a) to replace casualties and (b) provide for new hospitals. These should remain at the base until their services are required.]

The Committee further say :—

"It is considered advisable that the operation theatre should be under the direct charge of a Nursing Sister, specially trained for this duty, as they are much neater, cleaner, and tidier in their methods and habits, especially in the handling and care of surgical instruments and appliances. She should have an attendant as assistant for rough work, scrubbing floors, &c., and cleaning utensils and instruments, to act under her orders. Nursing Sisters held these appointments in many general hospitals during the South African Campaign with satisfaction to all concerned and credit to themselves."

Masseur.—"The appointment of trained masseurs to general hospitals during active service would be advisable, their services being most useful. Nursing Sisters or nurses with masseur training and qualifications might be appointed for this special duty."

A masseur and masseuse were employed at Wynberg with good results.

With regard to the subordinate personnel the Committee say :—

"In the selection of personnel for general and stationary hospitals the following should be taken into consideration :

"*The senior clerks* detailed for duty should belong to clerk section and thereby have had previous instruction in clerical work, hospital returns, pay and corps duties. Much inconvenience and unnecessary work was thrown on administrative Officers in having to instruct their own clerks in these duties during the South African War when other work was pressing.

"*The two senior cooks* (superintending) should have special training in advanced cooking. If this is done chefs would not be required, and we do not recommend their employment on account of their extravagance in articles for cooking. [For large Officers' hospital a chef is certainly most useful.]

"All senior cooks employed should be qualified cooks in military hospitals.

"*Militia and Volunteer Royal Army Medical Corps; St. John Ambulance Brigade.*—The N.C. Officers and men of these medical corps were only very superficially, if trained at all, in hospital duties and nursing. They would be better employed in field units than in general or stationary hospitals, where they are only fitted for the less responsible duties. They improved in nursing duties, after prolonged instruction, especially the Volunteer corps, who are recruited from a higher and more intelligent class.

"They will no doubt form a valuable help in time, but everything should be done to improve their hospital training and bring them on an equality with the Royal Army Medical Corps. The term of engagement for those who came out first was far too short, as when they commenced to know their work they returned home; it should have been for 12 months or longer as the State required."

Regimental N.C. Officers and Men.—The Committee lay stress on the uselessness of untrained N.C. Officers and men for technical hospital duties, but with regard to supplementing the trained staff by such additional personnel, they say "the proposition to obtain men when rejected as unfit for active service is a good one, but men so obtained, being entirely ignorant of hospital ward duties and nursing, can never take the place of trained Royal Army Medical Corps orderlies. They, however, might be made useful as sanitary assistants, servants, batmen, fatiguesmen, police, assistants in pack, stewards, linen, and other stores."

The following is the opinion of the Committee regarding the personnel necessary and their distribution :—

"We are of opinion that an experienced carpenter should be attached to every general hospital for putting together and making bedside tables, mending tables, forms, tent poles, and the like, and particularly splints, extension apparatus, and similar articles.

"Also that an experienced tailor (military) be included in the personnel for both mending and altering the uniforms of the personnel as well as hospital clothing, &c., and for making sandbags and other things required for the treatment of the patients.

"That an experienced sailmaker be attached for the purpose of repairing hospital canvas generally. Many marquees and tents would have lasted much longer during the South African Campaign if they had been repaired early.

"That a shoemaker also be included in the personnel for repairing hospital slippers as well as boots and ward shoes of personnel.

"That an electrician be appointed to look after electric lighting, telephone, and electric fittings. This man should have temporary sergeant's rank and be included in personnel. (This is an engineer service, but it saves delay to have an artificer on the establishment, who could also look after the X-ray plant.)

"All should be attached to the Quartermaster's department, and under his supervision; and, of course, tents or accessory buildings must be provided for their accommodation.

"*Warrant Officers.*—These, as heretofore, should be two in number—one for general disciplinary control and Sergeant-Major of the Royal Army Medical Corps Company and details attached, also office duties, &c.; the other to act as chief wardmaster.

"*1st Class Staff Sergeants.*—These should be two in number—one for duty as Principal Medical Officer's clerk, the other to act as hospital steward.

"*2nd Class Staff Sergeants.*—Should be seven in number—

- 4 as divisional wardmasters (Officers, medical, surgical, infectious).
- 1 clerk to Registrar.
- 1 superintending cook.
- 1 senior compounder.

"*Sergeants.*—Should be 12 in number, detailed for duty as follows—

- 1 in charge of linen stores (clean and foul).
- 1 company pay clerk.
- 1 in charge of hospital clothing store.
- 1 compounder.
- 1 in charge of pack store.
- 1 assistant cook in hospital kitchen.
- 1 cook to Officer's hospital.
- 1 assistant to X-ray specialist. (This N.C. Officer must be a practical photographer.)
- 1 assistant to pathologist and bacteriologist.

(These last two N.C. Officers, who may (as an alternative) be corporals, should have special training for these important posts, consequently we recommend that special classes for instruction in these subjects be established for training N.C. Officers. This should form a special branch for advancement in the corps, carrying with it a qualifying certificate and extra duty pay. It would also tend to their readily obtaining good appointments on leaving the army.)

- 1 in charge of general sanitary duties in connection with hospital and Royal Army Medical Corps camps.

(This N.C. Officer should have a corporal (who will be responsible for the proper working of the sterilisers and incinerators, also the disinfection of linen and clothing) and six privates under his immediate charge. Besides these, in a country where natives are available, a staff of natives, as circumstances permit, should be given to perform the menial duties, which they are more capable of performing.)

- 1 as sergeant in charge of the Medical Officer's mess.
- 1 as electrician.

"*Corporals.*—The number of corporals for duty should be as follows—

- 6 as assistant wardmasters in sections of divisions.
- 1 assistant cook in hospital kitchen.
- 1 clerk to Principal Medical Officer.
- 1 clerk to Registrar.
- 1 compounder of medicines.
- 2 Quartermaster's clerks.
- 1 assistant steward.

- 1 postman.
- 1 assistant for sanitary duties, in charge of disinfecting, sterilising, and incinerating work solely.
- 1 company cook.
- 1 cook to Medical Officer's mess.
- 2 for general duty and supernumeraries in case of sickness, leave, &c.

" *Orderlies.*—The allowance of ward orderlies (trained) for nursing duties alone should be at the rate of 10 per cent. to the beds equipped. This number allows for day and night duties, but not for casualties as sickness, prisoners, leave, &c., which should be calculated at another 3 per cent. of beds equipped.

" Besides this number, six 1st class orderlies should be allowed for duty in Officers' hospital. This would give a total of 84 ward orderlies, of which 30, at least, should be 1st class.

" A trained Royal Army Medical Corps orderly is capable of looking after 10 patients under the direction of a Sister, and in conjunction with a staff nurse.

" Militia, Volunteers, St. John Ambulance Brigade, and other allied corps, as experienced in South Africa, should be graded as 3rd class orderlies of the Royal Army Medical Corps on joining till they are recommended as competent for advancement.

" *Buglers.*—Two.

" *Untrained Hospital Attendants.*—The following are considered necessary—

- 26 batmen—1 for each Officer.
- 2 for Nursing Sisters.
- 2 for sergeant-majors.
- 6 cooks—4 as assistant cooks in hospital kitchen.
- 1 in Officer's hospital kitchen as sculleryman.
- 1 in sergeant's and company cook-house.
- 2 assistants in steward's store.
- 2 assistants in the pack store.
- 1 assistant in linen store.
- 1 assistant clerk to Principal Medical Officer.
- 1 assistant clerk to the Registrar.
- 6 for sanitary duties.
- 1 as tailor.
- 1 as sailmaker.
- 1 as barber.
- 1 as carpenter.
- 1 as shoemaker.
- 10 as general duty and supernumeraries, which would include hospital police, filter men, church and reading room orderlies, sick Officers' hospital, mess waiters, messengers, &c.
- 1 in dispensary as assistant.
- 1 assistant in clothing store.

" This would give a grand total of 150.

" Many of these appointments could be filled by either Militia, Volunteer Royal Army Medical Corps, or St. John Ambulance Brigade, which would leave the Royal Army Medical Corps trained orderlies solely for hospital duties.

" A tabulated statement of the whole personnel is attached.

The recommendations of the Committee as given above are the result of much practical experience. With regard to the nursing duties in hospitals at the base, it may be possible to have the whole of the nursing done by Sisters and staff nurses, and at certain hospitals on the lines of communication it might also be possible to put this more into the hands of Sisters than is contemplated by the Committee. This is, however, a question which must depend very largely on the special conditions in each campaign. It is, of course, obvious that the personnel of an advanced general hospital in savage warfare must differ from that possible under better conditions, such as the late South African War.

Personnel of a General Hospital (Equipped for 600 Beds).

	Officers.						Nursing Establishment.				Warrant and N.C.O.'s and Men, R.A.M.C.						Remarks.					
	Colonels.*	Lieut.-Colonels.	Majors.	Captains or Lieutenants.	Quartermasters.	X-Ray and Anæsthetic.	Pathologist and Bacteriologist.	Principal Matron.	Matrons.	Sisters.	Staff Nurses.	Warrant Officers.	1st Class Staff Sergeants.	2nd Class Staff Sergeants.	Sergeants.	Corporals.		Trained Hospital Attendants.			Buglers.	Untrained Hospital Attendants.
Officer in Charge and Clerks..	1																	1st Class Orderlies.	2nd Class Orderlies.	3rd Class Orderlies.		1 as servant.
Registrar (or Adjutant and Clerks)..																					1 as servant.	
Divisional Officers ..																					Servant.	
General Duty Officers..																					"	
Quartermasters and Clerks ..																					"	
X-Ray Specialist ..																					"	
Pathologist ..																					"	
Female Nursing Staff..																					"	
Senior Warrant Officer ..																					"	
Sergeant-Major ..																					"	
Divisional and Section Wardmasters																					"	
Steward ..																					"	
Electrician ..																					"	
Hospital Kitchen ..																					"	
Sergeant's Mess and Company Kitchen																					"	
Officers' Hospital Cook ..																					"	
Compounders ..																					"	
Linen Store ..																					"	
Pack Store ..																					"	
Clothing Store..																					"	
Operating Theatre Assistant..																					"	
Postman ..																					"	
Sanitation ..																					"	
Medical Officers' Mess ..																					"	
General Duty and Supernumeraries																					"	
Ward Orderlies ..																					"	
Tailor ..																					"	
Sailmaker ..																					"	
Barber ..																					"	
Shoemaker ..																					"	
Carpenters ..																					"	
Buglers..																					"	
Totals ..	1	4	5	8	2	1	1	1	3	15	15	2	2	7	12	19	38	25	23	2	62	

* This should not necessarily be a Colonel's appointment.

† Half can be civilians.

‡ Civilians, if necessary.

4.—EQUIPMENT.

The details of the equipment have been very carefully considered by the Committee appointed, and extracts from their Report are included here.

The surgical instruments supplied to the Army Corps and Cavalry Division with the general and stationary hospitals detailed to accompany the force, as well as those afterwards sent out, were of the newer or 1898 pattern. This had been brought up to modern requirements in the type of instrument supplied; all the "handled" instruments were entirely of metal, and capable of being sterilised without damage. The instruments on charge in the existing hospitals of the country were, however, of the old pattern, and some of the field equipment in the country was also old.

The schedule on which the instruments were supplied, especially to the general and stationary hospitals, was not sufficiently comprehensive; consequently, as soon as the hospitals arrived in South Africa the Officer in charge of each put in large demands for additional instruments. These demands were met without delay or hesitation. Large purchases were at once made in South Africa, and the medical depôts sent large orders to England. Every instrument that was required was supplied. The following instruments were most generally asked for:—Esmarch's bandages, chloroform drop bottles, Murphy's buttons, bone chisels, bone drills, drill stock, drills and guard, double elevators; Lion, Sequestrum, Sime's, Hoffman's gouge and necrosis forceps; mouth gags, double retractors, Gooch's splinting, Jones's elbow splints, Mason's iron splints, Volkman's spoons, and Esmarch's tourniquets.

In addition to the above, every general hospital should be supplied with a microscope, chemical cabinet, and bacteriological outfit.

Dressings and drugs were of good quality, and abundant. These lists might be revised, as many drugs on the list were seldom used, and at the same time there was a great run on others. Tabloids were extensively used, and were most convenient.

Much has been said of the advisability of supplying only one form of dressing. The convenience is obvious, but till it is possible to fix on a dressing which will fulfil, not the requirements of modern surgery, but the wants of the individual surgeon, this question will always be difficult. Till then the limitation gives opportunities of complaint, which many people would no doubt consider well founded, and therefore blame those responsible for the supplies.

(i) *Ordnance Equipment (see Appendix XXI).*(a) *Tents.*

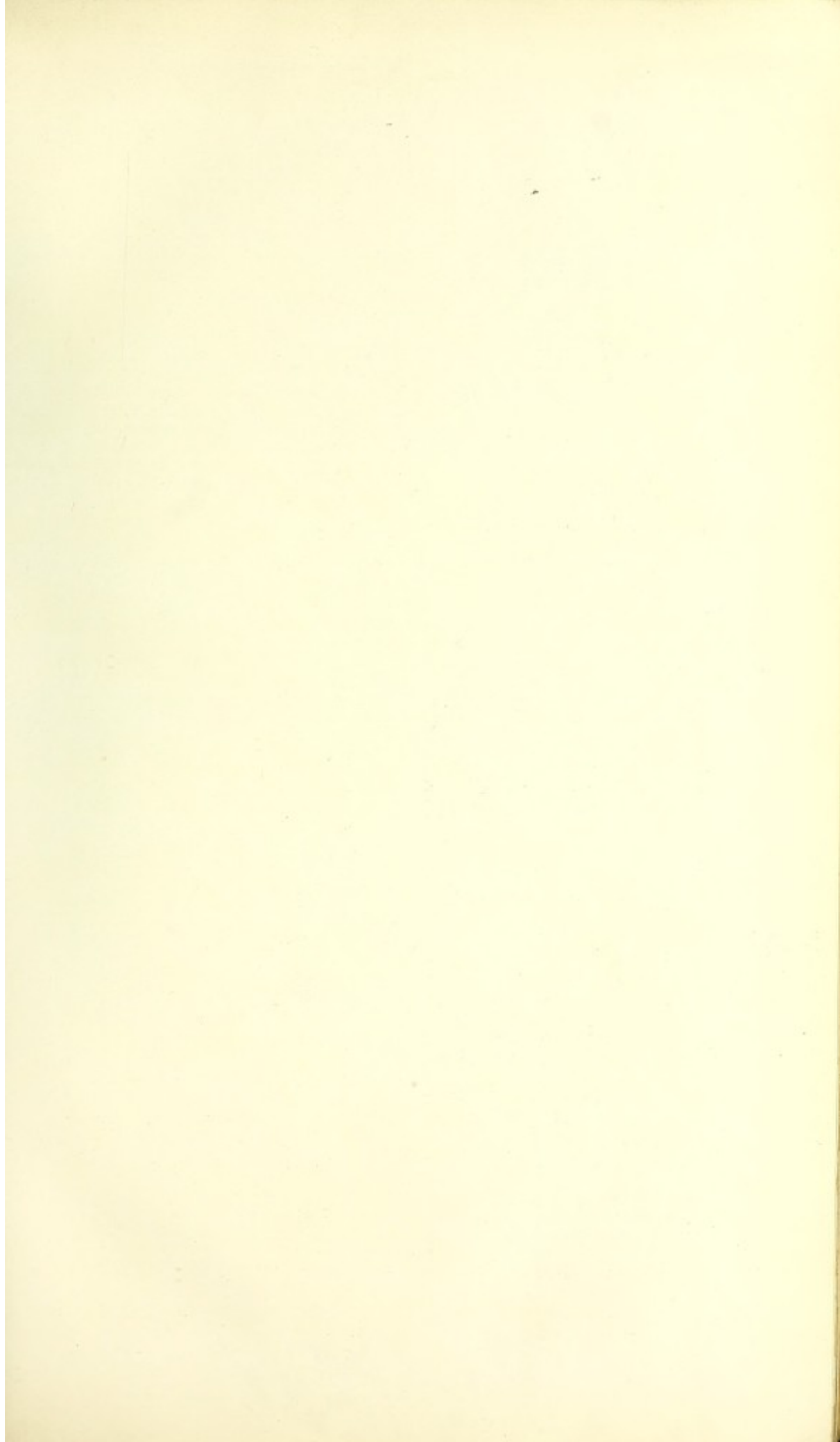
The authorised scale of 86 marquees and 40 single circular is not sufficient for a hospital of 520 beds. A marquee will only comfortably accommodate six sick in the present pattern iron bedstead, or 516 patients, thus leaving no margin for necessary isolation tents, or accommodation for stores and offices, &c. In South Africa this number of tents was largely exceeded, and in addition a large number of accessory buildings were found necessary, as previously mentioned.

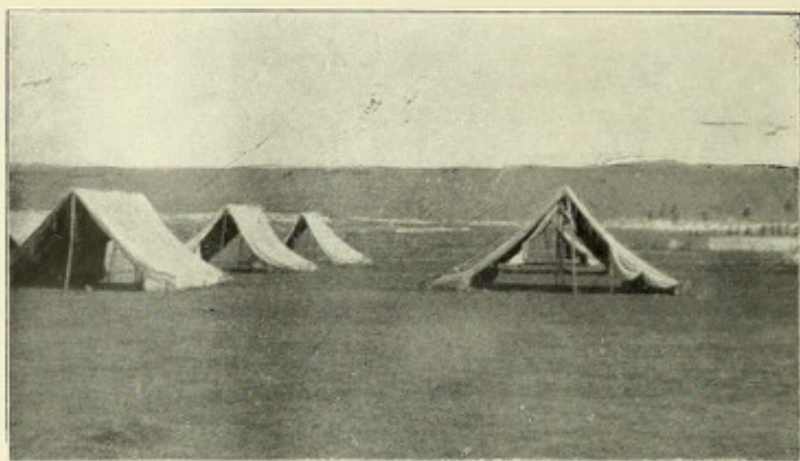
The Committee report as follows:—

"There is an universally expressed opinion by the Officers who were in charge of general hospitals, as well as by those Officers who did work in them and in other military hospitals in the late South African War, that 'European private, Indian pattern' tent (E.P.I.P.) is a superior tent for hospital wards and use compared with the present 'hospital marquee.'

"The advantages are:—Their rectangular shape, which allows a better and more economical arrangement of beds. The material they, as well as their supporting ropes, are made of being cotton, the tents are practically unshrinkable when wet, and consequently stand the strain of wind and rain storms much better than marquees, which frequently come down owing to the pegs drawing, from canvas and rope contractions. Their poles of bamboo are lighter, and do not break so easily. They are warmer in cool weather, cooler in hot, and more easily erected than marquees.

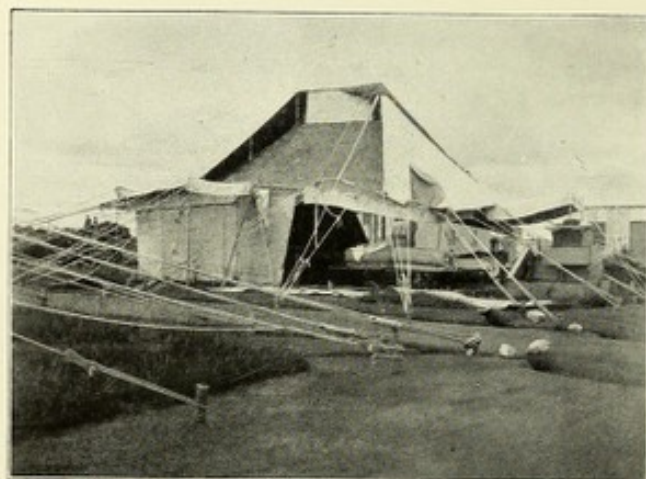
"They have, however, one disadvantage, which is their weight, being



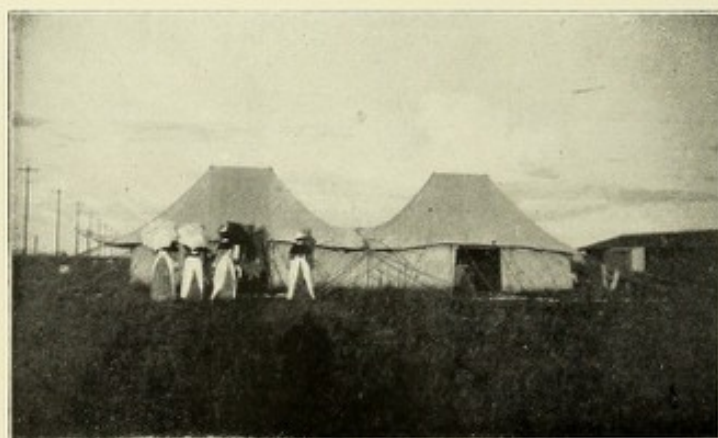


L.P. TENT.

(Used in convalescent camps. This view shows part of the Isolation Camp, Pretoria.)



E.P.L.P. TENT WRECKED BY A GALE. NO. 18 GENERAL HOSPITAL.



METHOD OF LACING E.P.L.P. TENTS TOGETHER. NO. 20 GENERAL HOSPITAL.

about 600 lbs. (in comparison to marquees, which weigh 512 lbs.), and one failing—no roof or ridge ventilation. This could very easily be remedied by placing a window 18 inches square in inner roof at each side, and two small ridge ventilators about 9 inches in diameter on outer wall at either side of ridge pole.

Special Size for Hospital Wards.—We are of opinion that if these E.P.I.P. tents were made for a general hospital pattern ward, 25 feet long and 18 feet wide internal capacity, to allow 10 patients per tent (beds being 2 feet 9 inches wide); they would be far more useful, serviceable, comparatively lighter than the present tents (calculating per patient), and be economical both in nursing duties, and in personnel, which would then be approximately, one Royal Army Medical Corps orderly to each 10 patients (one tent), and one Sister and two staff nurses to four tents or 40 patients. (Lieut.-Colonel Twiss suggests they be made twice the size of present E.P.I.P. tents, to accommodate 12 patients.) We therefore recommend this special size being supplied to all general and stationary hospitals for ward use.

Store Tents.—Of large tents the store tent has also been very useful, especially when placed in sheltered situations, for the treatment principally of enteric cases. They hold 18 patients comfortably; they are best suited to warm climates, their single roof, however, is a disadvantage, offering as it does slight protection from the sun's heat. This, however, could be easily remedied by the Ordnance supplying each tent with an internal canopy curtain made of light duck, to be suspended on light copper wire ropes from the ridge poles, the other end being attached by hooks to the edge of roof all round at its circumference. This was carried out in one or two hospitals with success. Their great advantage is their size, holding so many patients, which lessens labour in nursing; also their sides can be rolled up in hot days, allowing the patients free air and a view all round. This was found to have a very beneficial effect in the treatment of a depressing fever like enteric. They are also easily erected, and, judging them from every point, they are a very serviceable tent."

[NOTE.—These store tents were exceedingly useful, and four or five should be added to the equipment of every general hospital.]

"We, however, prefer the E.P.I.P. shaped tent as a hospital ward tent, as it is suitable to all climates and weather. The number of these (large sized) required for a general hospital of 600 beds would be, allowing for 10 patients in each tent, 70, which allows four for Officers' hospital and one for sick Nursing Sisters, say, with five spare for emergencies. Besides these 30 of the smaller size (E.P.I.P. tents) would be necessary for stores, divisional and other offices, sick Officers' mess and sitting room, Medical Officers' mess, Nursing Sisters' mess and sitting room, sergeants' mess and duty tent, &c.

"The tarpaulin flooring provided for hospital marquees has been satisfactory in every respect, except that it wears out much faster than the tents, so that a reserve should be kept at the base. We prefer them to wooden floors (the expense of providing these we consider unnecessary), which diminish internal ward space, hamper a hospital movement, and are easily broken, besides this dust and damp are apt to accumulate underneath unless they are taken up frequently, cleaned, aired, and disinfected.

"*Double Bell Tent (C.D.L.)*.—This tent has been useful, principally for isolation cases. Its advantage over the single bell is in the double roof, though the superficial area is consequently somewhat diminished. This tent should be the only one of this class issued to fixed hospitals. The number required would be, if hospital personnel are not accommodated in E.P.I.P. tents, 54, which allows five privates, three corporals, and two sergeants to each tent; also 10 for isolation cases and wear and tear.

"*Single Bell Tents (C.S.L.)*.—These tents ought to be removed from the equipment of hospitals as unsuitable on account of the small amount of protection they afford, either in hot or cold weather; they also wear badly when put to any severe strain of climate. They were only used for personnel, and complaints were general as to their unsuitability."

[NOTE.—Tents, single circular, are hardly suitable for a fixed camp, and ought to be replaced by the Indian field service double fly, for it must be

remembered that night duty men cannot possibly sleep in a single fly tent in the daytime. In fact it was found necessary to make special arrangements for the accommodation of night duty men during the campaign.]

"Indian Field Officers' Tents.—We recommend this tent, measuring 9 feet long by 8 feet wide, with bathroom attached, for use of Officers, Nursing Sisters, and Warrant Officers, instead of bell tents, as being more roomy and adaptable to comfort. Their respective weights are practically the same, and the square shape of the former renders it more suitable for a living tent. The number required for this use would be, allowing as above, and two for wear and tear, 62 tents."

[NOTE.—The objection to these tents is that only one cot can be placed in them, hence the number needed, which is excessive.]

"It would be advisable to define all hospital ward tents by having the Geneva red cross painted in large size, say, 6 feet in diameter, on both sides of roof. This would be visible from long distances and thereby tend to prevent hostile firing."

[NOTE.—The necessity is not obvious in the case of general and stationary hospitals, but the marking of hospital tents would prevent their misuse.]

The Committee, in addition to the recommendations given above, have expressed their opinion that the subordinate personnel of the hospital should be accommodated in European privates' tents. This appears to be a counsel of perfection. It is perfectly true that the work of a hospital involves a strain on the staff of a different kind, but certainly not less than that undergone by the men in the field, and even in the camp hospitals the confinement and the nature of the duties depreciated the health of those employed in it, and for this reason the whole staff should be made as comfortable as circumstances will allow. But the E.P. tent is a weighty and cumbrous article, and a sufficient number of these for use as wards is probably the most that can be managed. On the other hand, the single fly tent should not be issued for the use of the personnel of a hospital.

(b) Huts and Accessory Buildings.

Where a hospital is likely to be more or less permanent, as in the case of those at the base and at certain fixed points on the line of communication, it is an undoubted advantage to replace the tents by huts, and to add more satisfactory accommodation for stores and other necessities than can be provided under canvas. The following pages, therefore, include a description of the type of huts for ward use, and of the various accessories which were found useful in the late war. All the buildings described were in use in one or other of the general hospitals during the campaign, though all may not have existed in one hospital.

It is, of course, not proposed that all these buildings should be invariably provided. As the Committee points out, this is largely dependent on the probable time during which the hospital will be in use, and probably in some cases existing buildings will be available for conversion to hospital purposes, as in the case of No. 1 General Hospital at Wynberg. But where suitable buildings do not exist it certainly adds to the efficiency of the unit, and to ease in its working when buildings are provided. The following pages should, therefore, be taken as describing the ideal to which the development of the hospital should tend, and not as a statement of the necessities from the outset.

These semi-permanent structures may be divided into the following classes :—

(1) *Those which are necessary from the very first—*

- (a) Latrines and disinfecting apparatus.
- (b) Lavatories, surface drains.
- (c) Water supply.
- (d) Kitchens, sculleries, milk stores, and the like.
- (e) Operating room.

(2) *Those which should be provided as soon as possible—*

Storage accommodation for steward's store, pack, linen, clothing and quartermaster's store.

(3) *Those which are desirable, but not urgent—*

Offices.

Dining or mess-rooms, canteen, and the like.

(4) *Those which depend on local considerations—*

Huts for use as wards.

Tents, especially the E.P. tent, do very well under most conditions, and the erection of huts is in most cases not a necessity for wards.

Huts.—The Committee report :—

"Huts make very suitable and convenient hospital wards for general hospitals situated at the base of operations. They are more convenient for nursing duties, and the nurses having cupboards in each hut, can keep their necessaries, medicines, and dressings in them. They are more comfortable for the patients, especially in cold or wet weather.

"Portable huts are more desirable for active service than those permanently fixed, they are easier of transport, more rapidly erected and removed for re-erection for further use. Those used in the early months of the late war for hospital wards were too narrow, being only 17 feet 7 inches wide; the windows swinging on a central pivot, and the eave ventilation arrangements were primitive and unsatisfactory, allowing free entrance of dust and causing draughts. The windows would be better made in halves (casement pattern), each half hinged to the side frames, so that either side could be opened and closed as desired, and the ventilators arranged by sliding panels over perforated zinc openings, one below and above each window. This would keep dust out, and the ingress and egress of air could be easily regulated. There should also be ample ridge ventilation, well protected from entrance of rain."

The Committee have recommended a standard pattern hospital hut for use as a ward on the following plan :—

Outside dimensions—

Length, 84 feet.

Width, 21 feet.

Height—to eaves, 8 feet ; to ridge, 15 feet.

To have at one end two small rooms, 9 feet by 6 feet, leaving the length for ward use, 78 feet.

Verandah at one end, 21 feet by 12 feet.

It should have five windows at each side, each made in two halves (casement principle, and fastened on sill with bar fasteners), measuring 4 feet by 3 feet. These should be so placed as to allow room for two bedsteads between each two windows, as per attached plan No. 1. The doorways should be 3 feet wide. To be used as follows :—

(1) *Ward for 20 patients*, giving per patient, superficial area, 80 square feet ; cubic space, 1,030 cubic feet.

One small room at the end for Sisters' linen store room and pantry, &c., with a linen press 8 feet high by 4 feet wide for spare hospital linen (ward and personnel), &c., also a fixed perforated zinc safe 2 feet wide by 6 feet high, to keep nourishment in, free from dust, flies, and other impurities. A small refrigerator, 2½ feet by 1½ feet, should also be supplied for this. The other small room for ward necessities, cleaning articles, &c., under charge of the ward orderly, with a suitable locker with shelves (6 feet by 3 feet by 1½ feet) for keeping bed-pans, urinals, chambers, spit-cups, other ward utensils and cleaning articles in.

(The number of ward huts that would be, therefore, necessary for a 600 bedded hospital would be 30 for Warrant, N.C. Officers, and men.)

(2) *Ward for 18 Officers*, subdivided by partitions into three smaller wards, holding six beds each. Other arrangements as in (1).

(3) *Ward for special cases*, or for senior Officers, subdivided into the small rooms, 15 feet by 9 feet by 8 feet, five on each side, separated by a central passage (3 feet). Other arrangements as in (1).

(4) *Sick Officers' dining and sitting room*, subdivided by one partition, giving two rooms, 39 feet by 21 feet by 8 feet. Small rooms at the end to be used, one as a pantry with sink, cupboards, and shelves, the other for serving meals from.

Two 6 feet by 4 feet by 1½ feet cupboards to be fitted in the dining room.

Furniture for these rooms to be included in the ordnance equipment of the hospital.

The Committee state—

“(c) General Remarks on Huts and Tents.

“We are of opinion that huts should be used for general and stationary hospitals at the base, for wards and other hospital accommodation, also, when practicable, at the advanced base or other positions where the lines of communication are secure, especially if there is prospect of a prolonged campaign, as we consider them more serviceable than tents, the life of which can only be calculated at six months. They should be constructed of wood and galvanised iron with wooden lining to walls and roof and wooden floors, the boards being well laid with grooved and tongued junctions, the under surface of which should be tarred or creosoted, with free air spaces underneath. The ground beneath should be concreted if possible.

“In all other positions and circumstances than those described above, we consider that tents should form the ordnance equipment of general hospitals.

“As a similarity in size and simplicity of shape tends to expedite and facilitate erection we recommend that most, or as many as possible, be of same design and construction as per plans attached. In malarious and tropical climates they should be raised off the ground on masonry pillars 3 feet high. The hut wards should be warmed in cold weather by some form of ventilating stove, and lighted by electricity. The E.P.I.P. hospital tents should be lined with a chrome yellow-coloured material. The huts inside might with advantage be washed with this colour also, as it is cleanly in appearance and disliked by mosquitos.”

There is little to add to these remarks of the Committee. The Doecker hut was used by the Scottish National Red Cross Hospital in South Africa. These are good huts, and easily erected. They do not, however, appear to wear well in heavy weather. One was blown down at Kroonstadt, and the others suffered considerably from the storms.

The locally made huts used in the early stage were narrow. This was due to the difficulty of getting wood sufficiently long to enable them to be made wider. They had this positive advantage, that as they were built in sections they were easily erected and as easily taken to pieces for removal and re-erection elsewhere. The huts used later were those sent out for the troops; they answered very well.

Not all the general hospitals were hutted. The huts for the troops became available at various dates in different places, and the rule followed was that those hospitals which were likely to remain established after the cessation of hostilities should be hutted. The others remained under canvas. A few of the hospitals were partially hutted (under local arrangements) from the first; this of course took place only at stations not far from the base.

Accessory Buildings.—The following are recommended by the Committee:—

“The accessory buildings necessary for a general hospital at the base, should be constructed of wooden frames, and galvanised iron walls and roof, with matchboarding lining, ample ridge and side wall ventilation being provided.

A list is appended with a short description of each :

- | | | |
|--|---|----------------------------|
| (1) Hospital clean linen store | } | in one hut. |
| (2) " foul linen store | | |
| (3) Steward's provision store | } | in one hut. |
| (4) Utensil store | | |
| (5) Quartermaster's office (for two) | } | |
| (6) Pack store and rifle room. | | |
| (7) Hospital kitchen | } | in one hut with accessory. |
| (8) " milk kitchen, sterilising | | |
| (9) " scullery | | |
| (10) Shed for Soyer's stoves (8) | | |
| (11) Meat larder | } | |
| (12) Coal store | | |
| (13) Patients' bath house; 12 baths. | | |
| (14) Lavatories (3). | | |
| (15) Latrines (7) | | |
| (16) Operating theatre with, in annexe, X-ray, photo room, and sterilising room. | | |
| (17) Pathological laboratory | } | in one hut. |
| (18) Surgery | | |
| (19) Nursing Sister's duty room | } | in one hut. |
| (20) P.M.O.'s office | | |
| (21) Registrar's office | | |
| (22) Post office | | |
| (23) Orderly Medical Officer's room | | |
| (24) Medical Officer's kitchen. | | |
| (25) Nursing Sister's mess hut. | | |
| (26) Disinfecting sheds, including steriliser and incinerator. | | |
| (27) Oil and lamp storeroom. | | |
| (28) Reading room and chapel. | | |
| (29) Clothing store { for supply to patients in hospital } | } | in one hut. |
| (30) Red Cross store { for patients leaving hospital } | | |
| (31) Canteen. | | |
| (32) Fowl run and hen coop. | | |
| (33) Ashpits. | | |

"The hospital *clean linen store* (size 50 feet by 21 feet by 10 feet) and the *foul linen store* (14 feet by 21 feet by 10 feet) are placed in one hut with partition to the roof. The clean linen store should have three 2-feet wide shelves all round and a double-rack standard shelving down the centre, with a wooden floor; also a serving counter 12 feet by 2 feet by 3 feet, about 6 feet from doorway (*see Plan 5*). The *foul linen store* requires no shelving, its floor should be of concrete (*see Plan 5*).

"The *steward's store* (size 34 feet by 21 feet by 10 feet), the *utensil store* (size 20 feet by 21 feet by 10 feet), and the *quartermaster's office* (size 10 feet by 21 feet by 10 feet) are placed in one hut (size 64 feet by 21 feet by 10 feet), divided by wooden partitions into three compartments.

"The *steward's store* should also be separated into two by a wooden partition, one part for a store, the other for an issuing department, with communicating doorway between. It should have a concrete floor. The issuing department fitted with three rows of 1½-feet shelving round three sides, and a serving counter 12 feet by 2 feet by 3 feet high, about 6 feet from doorway, also two specially constructed strong cupboards which should be fixtures for safe custody of wines and spirits (*see Plan 6*).

"The *utensil store* should also have 2-feet shelving fitted all round and a concrete floor.

"The *quartermaster's office*, situated at end of hut, should have three short shelves and two cupboards for safe preservation of documents and books. Its floor ought to be of wood (*see Plan 6*).

"The *pack store* (size 56 feet by 21 feet by 10 feet) and rifle room (8 feet by 21 feet by 10 feet) are placed in one hut (64 feet by 21 feet by 10 feet), divided by a wooden partition. The former should be fitted with three rows

of 2 feet wide shelving (2 feet apart) all round, except at windows and doors; and two standard double racks, with four rows of shelving, 2 feet wide, down the centre, with a passage between, 3 feet wide. This will give ample accommodation for 600 kits (*see Plan 7*).

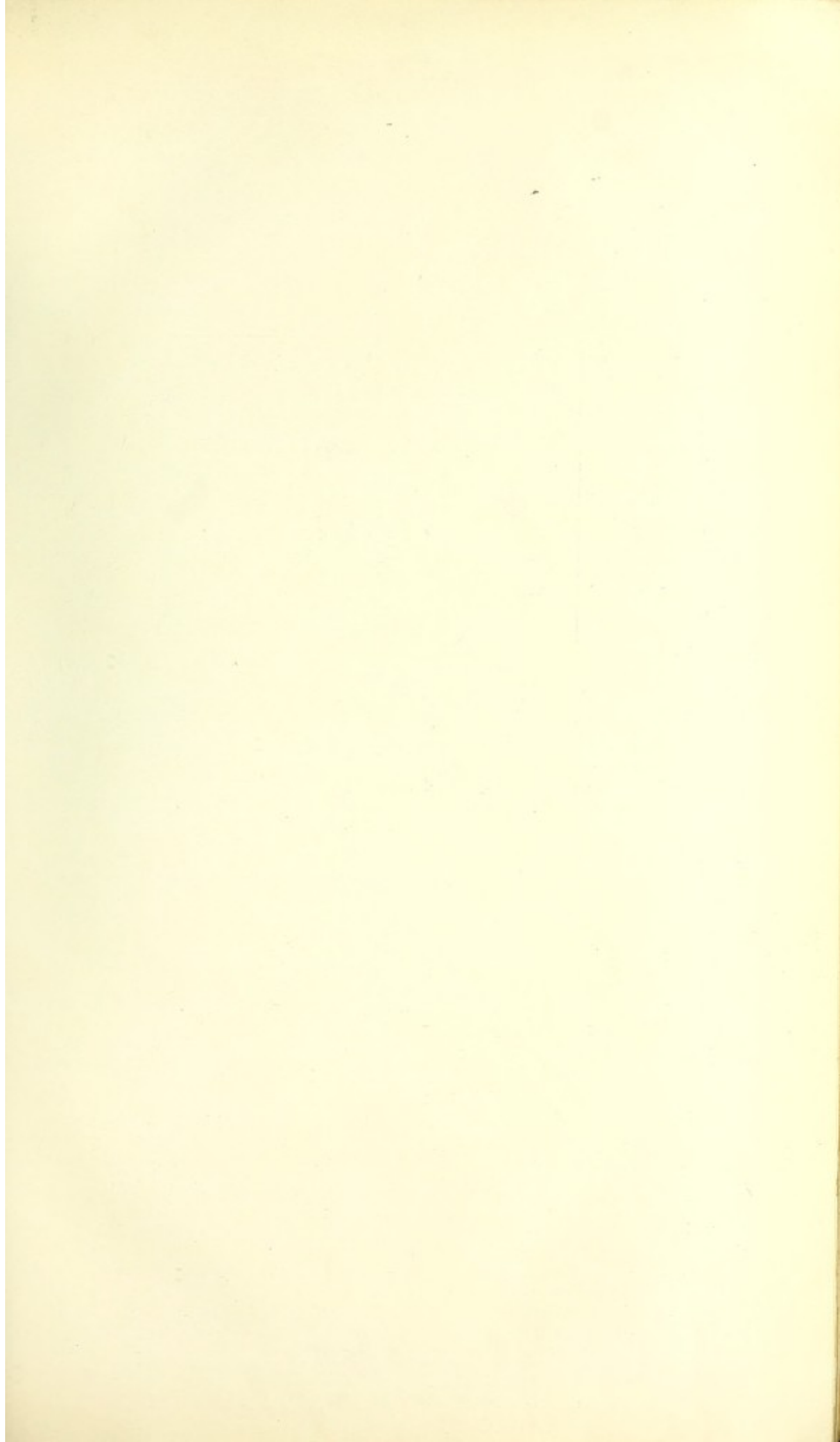
"The *rifle room* should have stands for a double row of rifles all round, both on walls and floor, and a window at each side. It would be better if each stand was lettered and numbered; ample light and ventilation should be provided by four windows, size 4 feet by 3 feet; the floor should be concrete, both in pack and rifle stores, to allow of their being washed out with disinfectants frequently (*see Plan 7*).

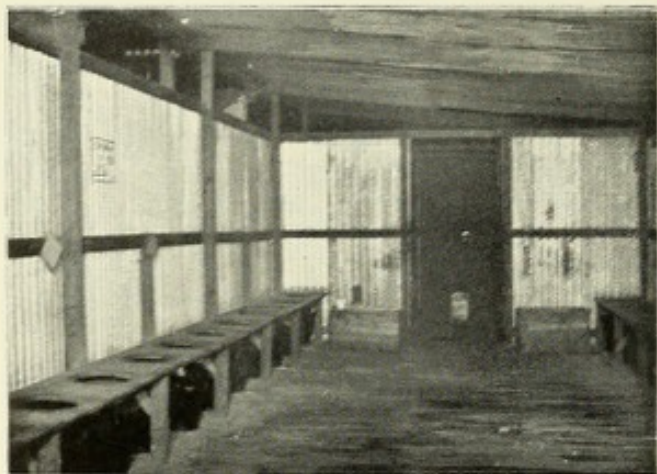
"The *kitchen*, situated behind medical and surgical divisions, and equidistant from all, should occupy a central position. It, however, should be sufficiently remote, say 50 yards from them, to render danger from fire impossible. In this position it is easily accessible for supply carts, &c., and sufficiently distant from hospital wards for a drainage system from scullery to be established. It should consist of one hut, 64 feet by 21 feet by 10 feet, divided into general kitchen, 52 feet by 21 feet by 10 feet, and milk (dairy and sterilising) kitchen, 12 feet by 21 feet by 10 feet, the former fitted with four large ranges, situated in the centre of the kitchen (back to back is the best arrangement for them), with a central chimney. We think that four large ranges should prove sufficient; but, if not, two more can be easily added, one at each end, crosswise. Hot water boilers should be attached to each range, and accumulation circulatory cylinders for the supply of hot water to scullery, and 12 baths. A hot plate for 500 diets should be fitted at one end, and cupboard lockers and drawers fixed for storing cooking necessities, &c., the top of which would form kitchen tables. The floor should be of concrete. Sliding counters should be attached to two windows for serving dinners through. Four windows, 4 feet by 6 feet, three in front wall and one in end wall, should give ample light. The entrance door should be divided horizontally about 3 feet from ground, for entrance of more air and light if necessary. An annexe, constructed as a lean-to hut against the posterior wall of kitchen, inside wall 10 feet high, outside wall 9 feet. Size 64 feet by 10 feet by 9 feet, divided as follows:—A meat store (larder), 12 feet by 10 feet by 9 feet; a scullery, 20 feet by 10 feet by 9 feet; a Soyer's stove shed, 20 feet by 10 feet by 9 feet; a coal store, 12 feet by 10 feet by 9 feet. The larder should have one door, 3 feet wide, opening from outside, and two large perforated zinc windows, 4 feet by 3 feet, to allow of free admission of cool air, but no flies. It should be fitted with a butcher's bench and strong hooks for hanging carcasses on. In this store all the meat is cut up before brought into kitchen for cooking. The floor should be of concrete, and frequently washed out with disinfectants, and the inside of the walls frequently whitewashed (*see Plan 8*).

"The *milk kitchen* is situated at end of hospital kitchen. It measures 12 feet by 21 feet by 10 feet, has room for six to eight sterilisers if necessary, and should be fitted with stone shelves for standing milk on to cool. It is lighted by a window, size 6 feet by 4 feet, situated in gable wall. The entrance door should be divided horizontally to allow of more air and light if necessary; also to act as an issuing counter. The floor ought to be of concrete (*see Plan 8*).

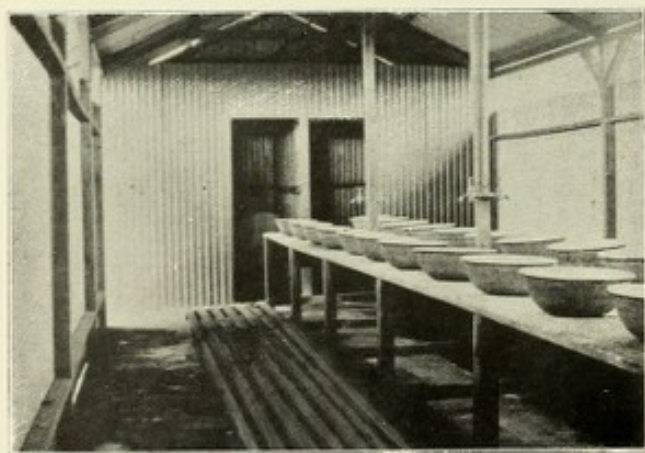
"The *scullery*, 20 feet by 10 feet by 9 feet, should have a long (porcelain or metal) washing trough down the centre or one side, for washing plates, pots, saucepans, &c., and a double row of shelves along one side and two ends for keeping them on when clean. Its supply of hot water should come from the kitchen accumulator. Its floor should be concreted. There should be a communicating door between kitchen and scullery; also one opening outside (*see Plan 8*).

"The *annexe for Soyer's stoves* (or, better still, agricultural or cattle food boilers) should have a communicating door to kitchen. Its size has been planned to hold eight of the latter, which proved far more serviceable after prolonged use than the ordinary Soyer's stoves for boiling vegetables, meat, water, &c. We suggest that those fixed on wheels as better for movement. The floors ought to be concreted; there should also be a door opening outside. The chimneys from boilers can pass direct through roof (*see Plan 8*).





LATRINES. NO. 20 GENERAL HOSPITAL.



LAVATORY. NO. 20 GENERAL HOSPITAL.
(The doors at the back lead into bath-rooms.)

" *The coal store*, size 12 feet by 10 feet, ought only to have one door of entrance, and that from outside, and no communication between it and kitchen on account of ingress of coal dust, and no windows. It is capable of holding four tons of coal; this is the main coal supply for the whole hospital. Its floor ought to be of concrete (*see Plan 8*).

" *The baths*, 12 in number, which is considered sufficient, are situated in a hut, adjacent to the kitchen for hot water supply, near centre of hospital for convenience of patients, and in cross roads, being adjacent to drainage scheme. A doubled span hut 30 feet by 21 feet by 8 feet at eaves, with a double row of six baths, arranged in cubicle partitions 8 feet high, containing a 7-foot bath and seat in each. The hot water supply should be laid on by pipes from kitchen, fitted with tap to each bath. By this arrangement there is a constant supply of hot water, day and night, which could not be if they were situated elsewhere in the camp, unless a specially designed boiler house was erected in connection with baths. A cold water supply also to be laid on by pipes—one tap to each bath. The branch drain pipes from scullery and bath house should lead direct into the main drain, being properly trapped. The floors of bath rooms and passages should be of concrete, slightly sloping outwards, where a surface drain should take the surplus water and washings from floor, which should be carried out daily; scrupulous cleanliness should be observed in all other respects (*see Plan 8A*).

" *The lavatories*, three in number, two for patients and one for detachment Royal Army Medical Corps; size, each 40 feet by 15 feet by 8 feet. Those for the patients should be situated, one at outer side of both the surgical and medical divisions, about 50 yards distant, and in a line with the latrines, having one door for admission and four windows, two at each side, a washing stand table with a 1-inch edging all round to prevent overflow, constructed of wood and covered with zinc, size 30 feet by 5 feet, and 3 feet high, sloping slightly from the sides to the centre, which is hollowed to form a drain, which carries the water to one end, then down a 2-inch discharge pipe to the branch drain (leading to the main), which should be properly trapped outside the hut. The water supply is arranged by a pipe passing from one end of table to the other, about its centre. This is fitted with 30 branch taps, 15 at each side, arranged alternately. A concrete floor, 4 inches thick, is necessary; also a strong wooden trellis, 1 yard wide, for standing on placed round the wash tables. Each wash house ought to have 30 zinc or enamelled iron washing basins.

" *The Latrines*, seven in number, as follows:—

- 3 for patients.
- 1 for Officers' hospital.
- 1 for detachment Royal Army Medical Corps.
- 1 for Medical Officers' camp.
- 1 for Nursing Sisters' camp.

"The patients' latrines, three in number, two being 45 feet by 18 feet in size, consist of a galvanised iron screen down the centre, on one side of which accommodation for a single row of 20 seats is provided, being roofed only over the seats to allow free circulation of air. A protection wall, which is included in measurements, surrounds the whole except for the entrance doorways at both ends.

"The opening in posterior wall is for conservancy men to come and go, a space 6 feet wide being allowed inside this wall for spare buckets and others for emptying bed-pans, urinals, and slops from wards into. In this space is also kept the supply of disinfectants necessary for use, the conservancy being done from the back of the seats, over the openings for which hinged doors should hang to prevent draught and blowing about of latrine paper. The whole floor should be of concrete 4 inches thick to allow of daily washing and disinfection. Two seats should be partitioned off and marked 'For venereal patients' use only.' Boxes as fixtures for latrine paper are necessary (*see Plan 9*).

"The third patients' latrine, intended only for convalescent enteric fever patients (placed about 50 yards from the side of that division and containing only six seats), is designed and constructed like the other latrines; all the excreta and liquid slops brought from wards to this latrine are disinfected.

The three small latrines (size 12 feet by 12 feet) for sick Officers, Medical Officers, and nursing Sisters' use consist of three seats each, and are of same design, except with partitions between each seat and doorways for privacy. A urine tub stands in the corner of the two former. We have allowed an average of 20 seats for each division of 200 beds (10 patients per seat) (except for the enteric division, for which latrine accommodation for 60 convalescents, i.e., about one-third of the beds, has been provided).

"The latrine for detachment Royal Army Medical Corps should be the same in design as that for the patients, only that four seats should be partitioned off for N.C. Officers. Its position should be about 50 yards from inner flank of their camp, behind patients' latrine. Boxes of dry earth and scoops should be placed in each.

"*Urinals*.—Four soil buckets are placed in each front corner of latrine enclosure. These are partitioned off for privacy. These would, of course, be unnecessary if a system of drainage was laid down which for prolonged occupation is considered advisable. The dry-earth system is the one advocated. A small shed should be supplied for storing the dry earth in; removal of the pails to take place morning and evening. The strictest attention to cleanliness is necessary, floors and seats should be washed down with disinfectant solutions; pine wood sawdust or carbolic powder, and dry sand sprinkled over the floor daily, the inside walls being limewashed at frequent intervals."

[NOTE.—The drainage system is not very clearly defined. It should certainly be a surface system only. Pipe drains are troublesome and dangerous unless well and carefully laid, and it is not probable that this could be satisfactorily done in a service hospital.]

"*Operating Theatre*.—This should also be constructed of a wooden frame with galvanised iron roof and sides, and matchboard lining to same. Size 25 feet by 25 feet by 10 feet walls. It should have two roof lights 6 feet by 4 feet, with green-coloured drawn blinds, three sides having two windows each, 6 feet by 4 feet, the fourth side has the X-ray photographic and sterilising room attached as annexe.

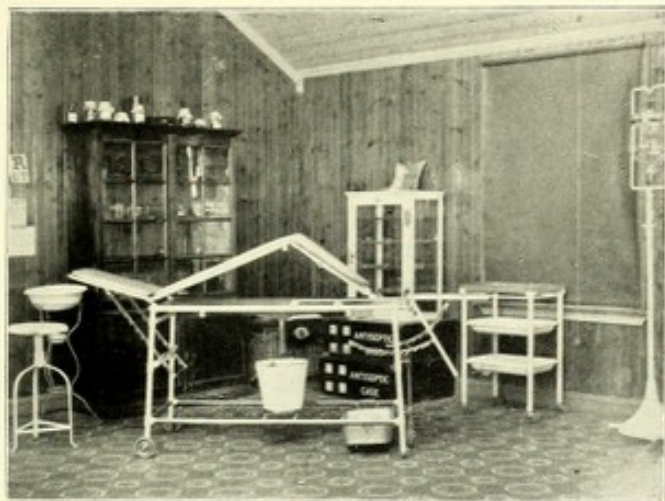
"The walls should be covered with white enamel paint, two coats, to prevent absorption, and to enable them to be washed with disinfectants when necessary. The white colour also tends to lighten the room. The floor should be covered with thick linoleum all over to prevent absorption, as also to allow of its being washed with disinfectants. Green roller blinds should be fixed in all the windows, the lower sashes of which ought to have dulled glass. The entrance door, as well as that to the X-ray room, should be 4 feet wide, to allow ample room for stretchers with attendants. Four ventilators, sliding panels over perforated zinc, should be placed in the walls. Two powerful hanging kerosene oil lamps, of 100 candle power (if electric light is not procurable), are required for night work, also two small hand lamps with reflectors, for throwing light on the patient. In several of the general hospitals in South Africa portable electric lamps of 20 candle power were used for this purpose with very good effect. The regulation fittings for operating theatre supplied during the later portion of the war were suitable, only the glass case for instruments is not large enough; two of the same size would be preferable to one of larger size.

"It is advisable that all surgical instruments should be kept in operating theatre in glass cases under immediate eye of nursing Sister in charge, and for immediate use when necessary. An ample supply of hot and cold water should be laid on, with taps over sink and hand basins. These should discharge into a portable cistern outside, which could be emptied as required.

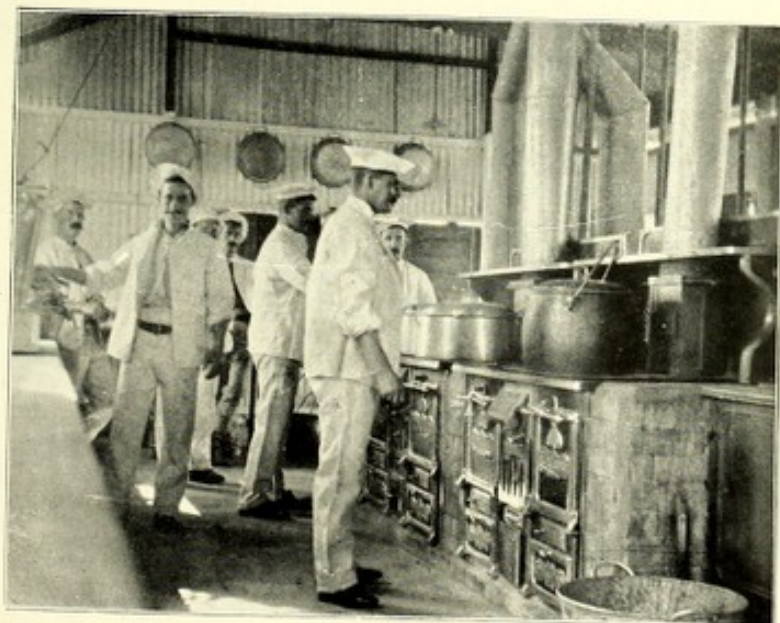
"*The X-ray and photographic room*, if not under the same roof, should form, with sterilising room, an annexe to the operating theatre, having a door of communication between; their size 20 feet by 15 feet, with a partition dividing 5 feet by 15 feet off, to form the dark room for photography. The dark room requires a red glass window $1\frac{1}{2}$ feet square, also a sink and three rows of shelving all round.

"The X-ray room, in which there is ample space, should also be used for administering anaesthetics to patients."

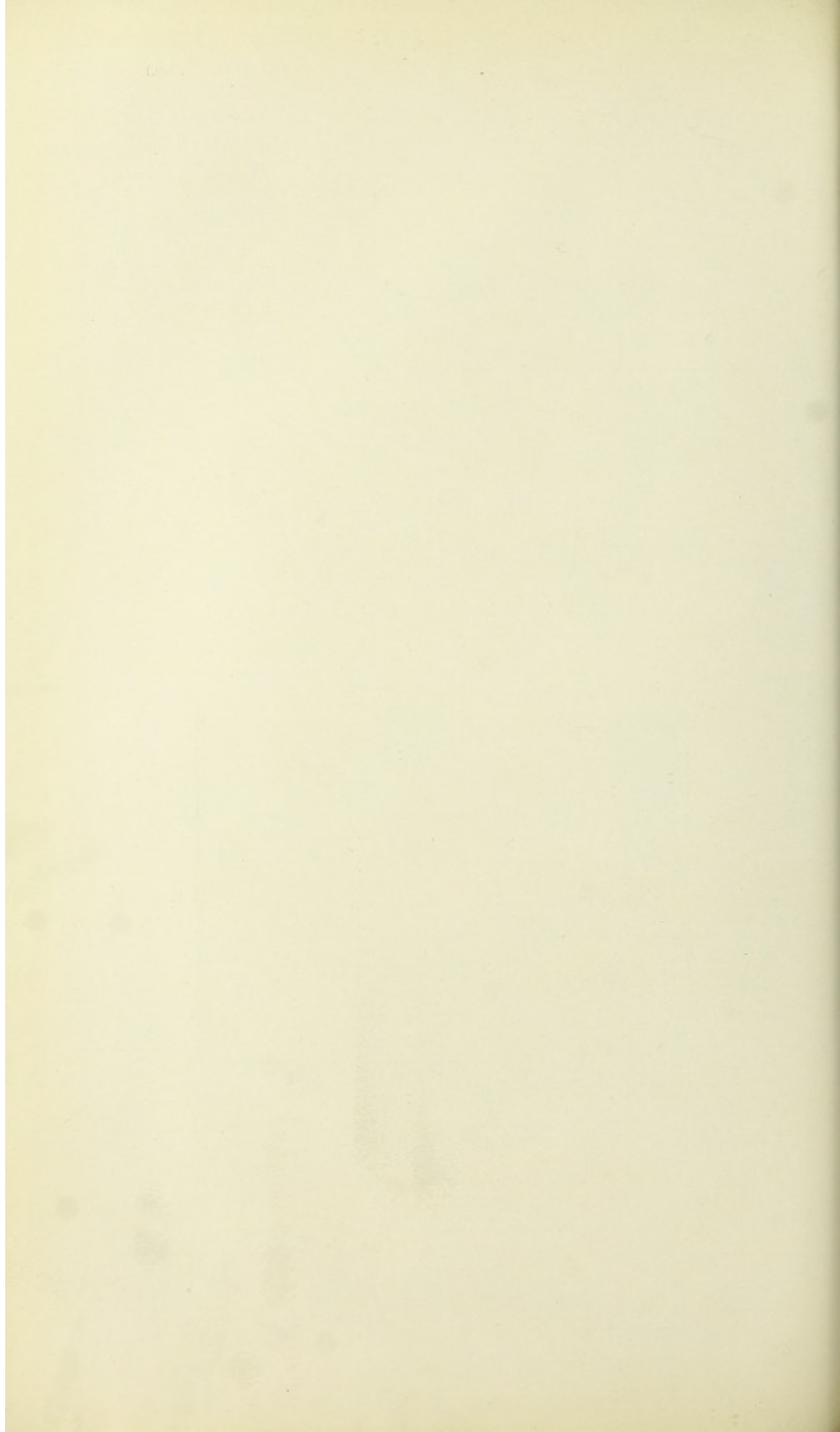
[NOTE.—It is better to have a separate room for this purpose.]

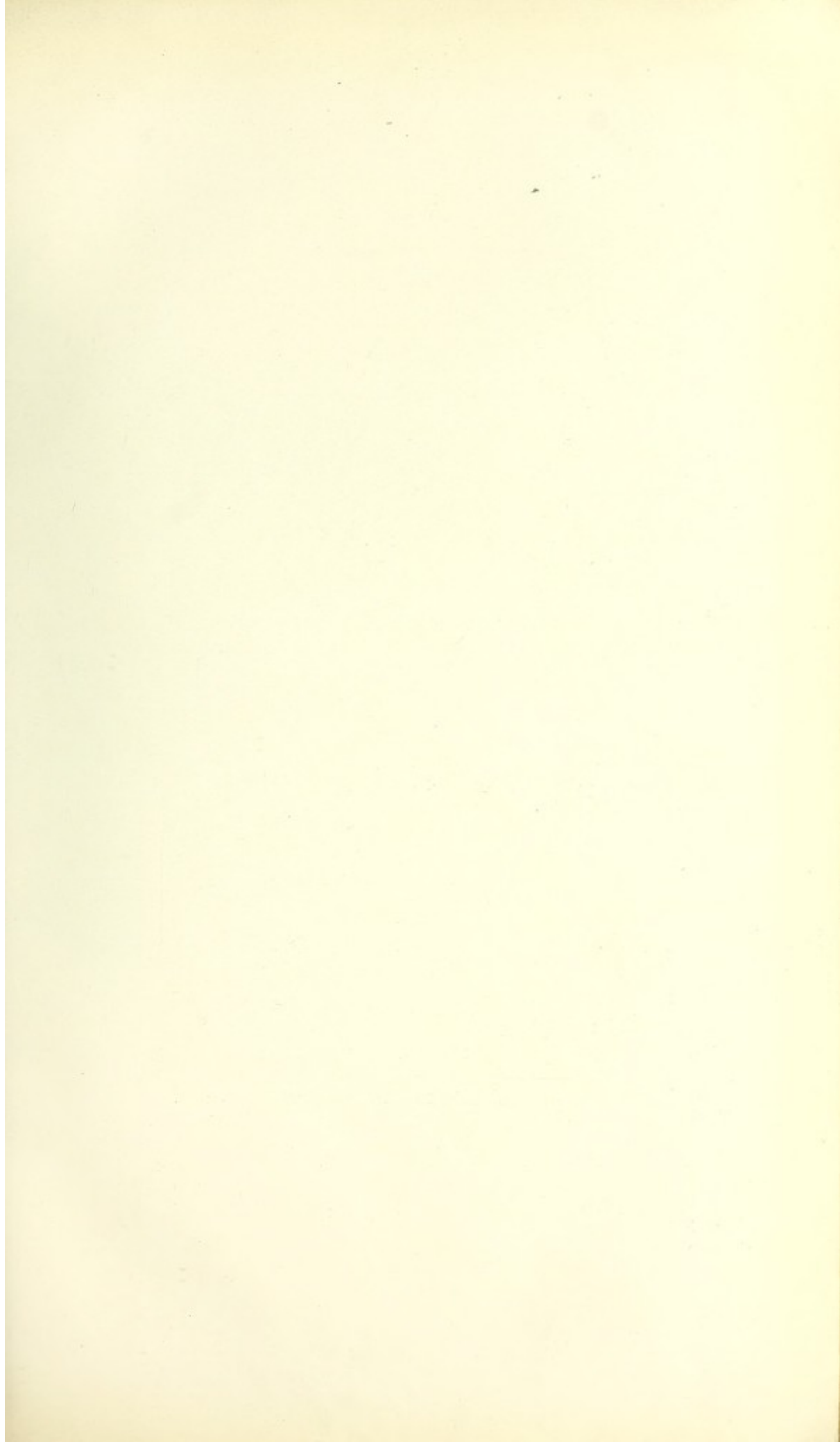


OPERATING ROOM. NO. 20 GENERAL HOSPITAL.



KITCHEN. NO. 20 GENERAL HOSPITAL.

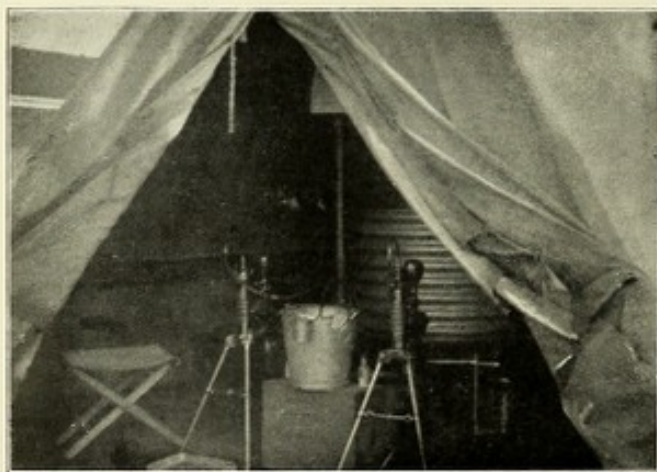




(To face p. 139)



SOYER'S STOVES FOR BOILING DRINKING WATER, AND AYMARD'S STERILISERS
NO. 20 GENERAL HOSPITAL.



FILTER TENT. NO. 20 GENERAL HOSPITAL.

"A room 5 feet by 15 feet by 8 feet, for sterilising dressings, towels, &c., forms portion of the annexe, with communicating door to the operating theatre. It is a convenience that cannot well be done without, and should contain a cupboard 6 feet by 4 feet by 1½ feet for surgical dressings, towels, &c., under care of the nursing Sister.

"*The dispensary*, size 28 feet by 21 feet by 8 feet; the pathological laboratory, size 20 feet by 21 feet by 8 feet; and the night Sister's duty room, size 16 feet by 21 feet by 8 feet, will form another hut 64 feet by 21 feet by 8 feet. The dispensary should have a 10 feet by 6 feet room partitioned off in one corner for keeping splints in; this ought to be provided with three rows of shelving 1½ feet wide all round. A poison cupboard 6 feet by 3 feet, at one corner, for safe keeping of poisons, with four shelves. A dispensing counter across room, within 4 feet of entrance door; an enamelled iron or porcelain sink at one corner, which should discharge through wall into a portable cistern outside; and four rows of shelving all round (see Plan 11).

"*The pathological and bacteriological laboratory*, situated at one end of hut, should have three windows, 6 feet by 3 feet, to afford plenty of light, and locker cupboards, 3 feet high, along the window sides. A porcelain sink and hand basin fixed in one corner, which should discharge through wall into a portable cistern outside. This room requires ample ventilation, ridge and wall.

"*The night Sisters' duty room* is very necessary for the comfort of these ladies doing night duty, especially during inclement weather. Armchairs, table, hanging lamp, and an oil stove for preparation of nourishment, also cupboards for medicines, stimulants, &c., are all the fittings necessary (see Plan 11).

"*Principal Medical Officer and Registrar's Office*.—Attached is a plan of a suitable hut, size 45 feet by 24 feet by 8 feet, for Principal Medical Officer, Registrar, and their clerks' offices, also post-office, and Orderly Medical Officer's room.

"The situation of the hut should be fairly central and convenient to all divisions for purposes of administration.

" Sizes—P.M.O.'s office	...	...	...	15' × 12' × 8'.
Registrar's office	...	...	...	15' × 12' × 8'.
Sergeant-major's and clerk's office...	...	...	...	15' × 12' × 8'.
Registrar's and pay clerk's office	...	...	...	15' × 12' × 8'.
Post office	...	...	...	15' × 12' × 8'.
O.M.O.'s room	...	...	...	15' × 12' × 8'.

"They should be all separate, with communicating doors between the first four (see Plan 12).

"*Telephonic communication* should be laid on to the sergeant-major's office from the principal hospital centres, viz.: Quartermaster's and Divisional Officer's offices.

"*Nursing Sisters' Quarters*.—Nursing Sisters, whether living in huts at base or in tents with advanced hospitals, should always have, if possible, a mess hut consisting of sitting room, dining room, kitchen, scullery, and pantry.

"The one suggested measures 64 feet by 21 feet by 8 feet, with rooms as follows: sitting room, 20 feet by 21 feet by 8 feet; dining room, 24 feet by 21 feet by 8 feet; kitchen, 20 feet by 10½ feet by 8 feet; scullery and pantry (each), 10 feet by 10½ feet by 8 feet. A large range should be fixed in the kitchen, also dressers and lockers. A sink in the scullery, which, like those in other huts, can discharge into a portable cistern outside the hut wall. The pantry would require a locker press for stores.

"A scale of equipment for Sisters' quarters on service is required.

"At the base the ladies ought to be housed in huts. One constructed on same plan as that shown for sick officers, 'single room hut,' would give very suitable rooms; size 14 feet by 9 feet by 8 feet would give accommodation for 6 on each side—12 ladies in one hut. Three such huts would be required, allowing for 34 sisters; this would give one spare room. The two end rooms in one hut should have a partition instead of a 3-foot passage between them to serve as chief matron's sitting and bedroom; the passage at further end

of other huts could be used for box rooms. A small extra hut would have to be provided for one housekeeper and three servants.

"In base hospitals, the *Medical Officers' mess hut* should be similar in design and size to the one for the nursing Sisters.

"If sleeping huts are necessary, those already described form very comfortable accommodation."

[NOTE.—Hut accommodation for the staff will only be required under very exceptional circumstances, and need hardly be considered.]

"*Disinfecting Sheds.*—The disinfecting sheds (two in number)—one for soiled clothes, the other for infected discharges—should be situated close to one another, and about 50 yards from the outer flank of infectious division, constructed of similar materials as other huts, but without matchboard lining. That for infectious clothes, size 55 feet by 15 feet by 10 feet, should consist of three divisions—

- (1) 15 feet by 15 feet by 10 feet, where all clothes are steeped in chemical disinfecting solutions and wrung out.
- (2) 15 feet by 15 feet by 10 feet, where the faecal soiled clothes and others requiring it are boiled.
- (3) 25 feet by 15 feet by 10 feet, for Thresh's steam disinfecting apparatus.

"The floor of this entire shed should be of concrete, 4 inches thick.

"The first should have three wooden tubs, about 3 feet by 3 feet in size, with a wooden tap in each, close to the bottom, for emptying them. They should be raised on 6-inch concrete platforms, and ought to be placed three on each side of lower half of shed. A small open drain, commencing at first tub each side, made in the concrete, in connection with a portable cistern, sunk at back of hut, is also necessary if main system of drainage does not exist. A low partition, 3 feet high, should separate No. 1 shed from No. 2, to allow of clothes which have been chemically disinfected and require boiling being passed into No. 2 shed for that purpose.

"No. 2 division shed requires two large sized (100 gallon) boilers with cocks. The chimneys should pass through the side walls and extend about 4 feet above the roof.

"No. 3 division shed should have a large size steam disinfecting apparatus with a door at each end, one for entrance of infected clothing, the other for exit of disinfected. (The Thresh's apparatus supplied to hospitals in South Africa was not large enough for requirements.) A partition should completely divide this shed into two, one for infected, the other for disinfected clothing. The chimney should pass through and extend 4 feet above the roof.

"A small lean-to shed at end of this division as coal cellar is also necessary.

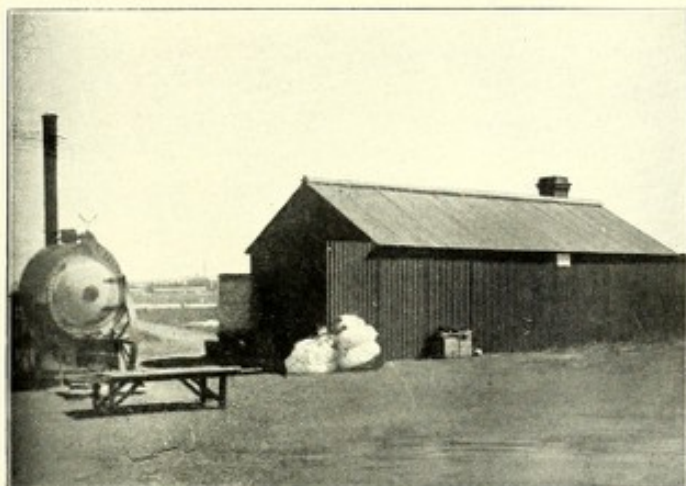
"*Excreta and Slops.*—The second shed for disinfection and sterilisation of all infected discharges and slops from infectious division, &c. (size 25 feet by 15 feet by 10 feet), should have a sink in one corner, drained into a cistern outside at back of hut, for washing bed-pans and urinals in after chemical disinfection. At one end of hut a large 100-gallon (or 150-gallon) ordinary boiler set in brick fireplace should be erected, with chimney built outside, for sterilising all infected discharges and slops. The walls all round should only extend 6 feet high, leaving a space of 1 foot below to allow for free circulation of air."

[NOTE.—See a note later on this point.]

"The clothes boiler, excreta steriliser, and outside cisterns should be emptied by hand buckets into sanitary carts as frequently as necessity demands. All these sheds should be lime-washed inside frequently, and floors washed with disinfectants daily.

"An incinerator for burning used dressings, infected and worn out clothing, and all refuse generally found in camps is a necessity. This can easily be constructed for dry materials. An ordinary covered furnace with good draught is all that is required.

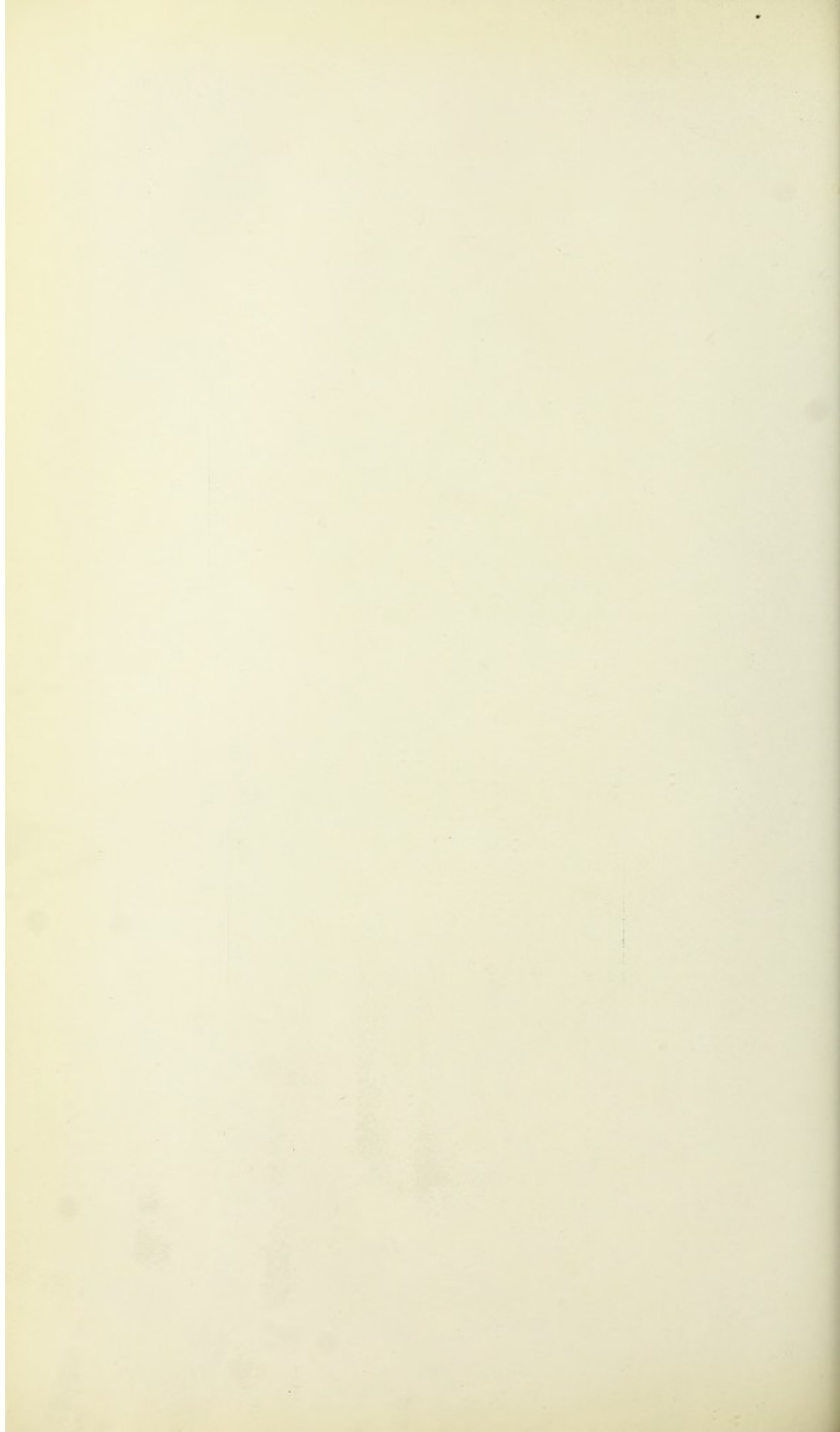
"The combination steriliser and incinerator as used in No. 4 General Hospital (which is reported on as satisfactory in every respect) is practically

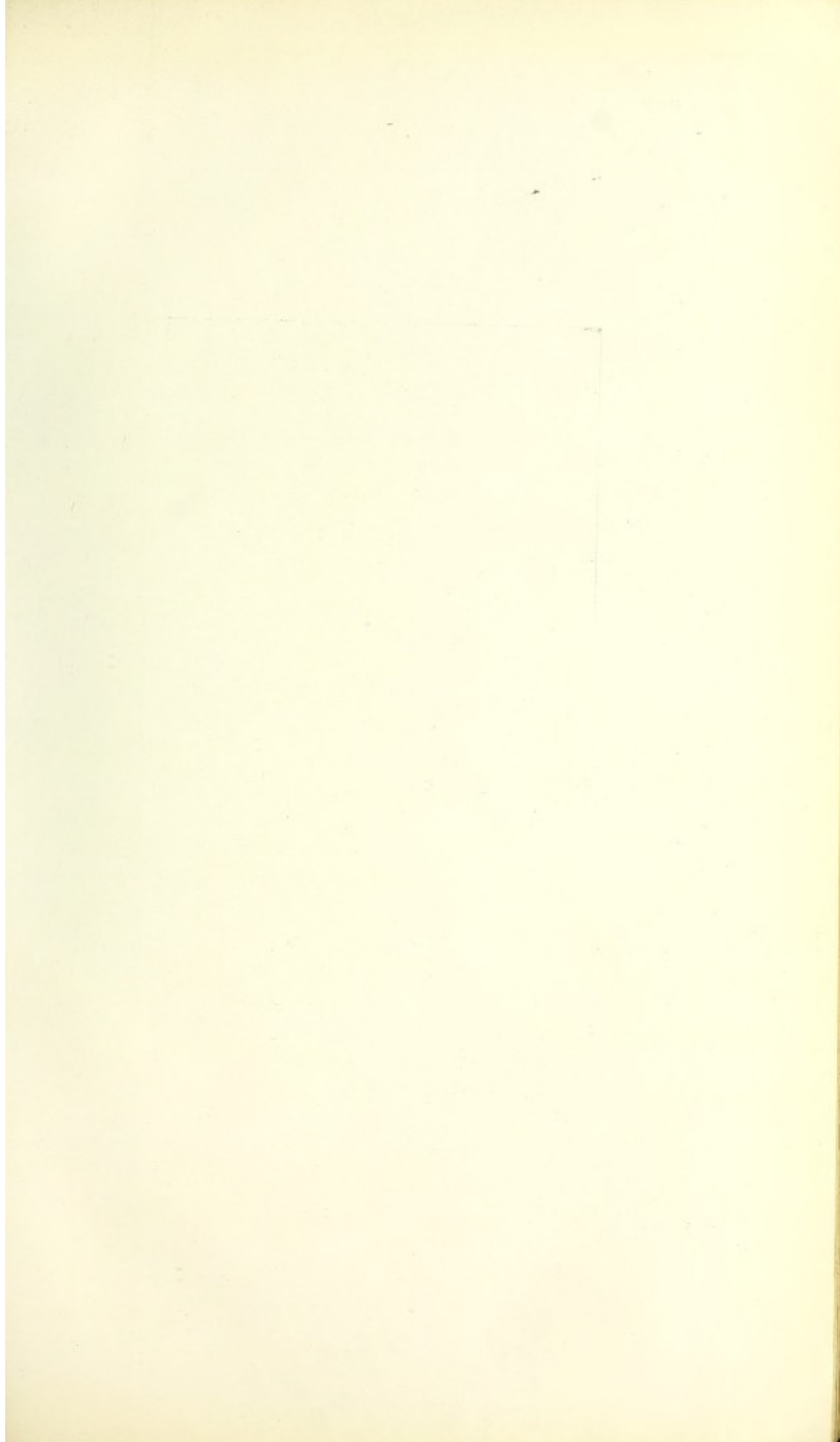


DISINFECTING SHED AND DISINFECTOR. NO. 20 GENERAL HOSPITAL.



INCINERATOR. NO. 20 GENERAL HOSPITAL.





(To face p. 141.)



PACK STORE. NO. 20 GENERAL HOSPITAL.



STEWARD'S STORE. NO. 20 GENERAL HOSPITAL.

a steriliser (as far as destruction of liquid excreta is concerned), for the heating of which dry camp refuse, infected and old clothing, &c., was used as fuel. This is an excellent plan, as both processes being performed by the one furnace fuel is saved, and the mixing of dry absorbents to render liquids semi-solid is not required. This is an appliance worthy of imitation and reproduction, plan of which is attached."

[NOTE.—The chief advantage of this method of sterilising excreta by heat is that it disposes at once of the urine and other fluids, and that it can be easily improvised on a small scale. But incinerators were used at many of the general hospitals, and when constructed of proper material worked well. The difficulties were chiefly due to subsidence and cracking, the results of faulty construction. These were, of course, most successful where it was found possible to use solid material to mix with the fluids, but in many places there was no difficulty about this. At No. 2 General Hospital and at No. 20 these incinerators worked particularly well. A plan of that at No. 20 is attached. The Committee, however, prefer boiling on account of the difficulty about fluids.]

"If a satisfactory portable appliance, combining in one both steriliser and incinerator could be designed of a sufficiently light weight, say, between 1 and 2 tons, for horse draught it would be of great advantage to field, stationary, and advanced general hospitals.

"The fire chamber should be of large size, probably lined with specially shaped fireclay blocks, and the boiler capable of holding about 100 gallons, so set in fire chamber that the flames should play all round under surface and sides.

"It would be advisable to have the whole of disinfecting, sterilising, and incinerating appliances surrounded by an 8 feet high corrugated iron fencing. Its size would necessarily depend on the size of enclosed buildings and appliances, and it should be floored with concrete.

"A small shed, 12 feet by 12 feet by 8 feet, for storage of paraffin oil and trimming all hospital lamps is required. Its position should be central, and near the quartermaster's stores, under whose care it would be.

"A hut, the same size and shape as the clean and foul linen store, divided into two, with two rows of shelving all round both rooms, and counters across near the doorways would form all that is necessary for a Red Cross and clothing stores, if still considered necessary for the Royal Army Medical Corps to perform these duties.

"A hut, to act as chapel, library, reading and writing room, would be a convenience both to patients and hospital personnel. A suitable one would be a hospital ward hut, but without partitions or small rooms, size 84 feet by 21 feet by 10 feet.

"Huts in place of tents for canteen (dry and wet), filters, also sheds for carpenter, tailor, sailmaker, shoemaker, and barber's shops, if not absolutely necessary, are very desirable.

"A fowl-house and run, size about 24 feet by 8 feet by 8 feet inclusive is a necessity when live fowls are supplied, as they were in South Africa.

"Ash-pits.—Two are necessary, each 12 feet by 12 feet by 6 feet (one side being removable), constructed of galvanised iron, and floored with concrete.

"Railway Siding.—General and stationary hospitals should be erected as close as possible to the railway line for convenience in transferring sick and wounded. If a suitable site cannot be obtained, a railway siding, with platform, should be constructed (as early as possible), to the hospital for its use. Size of platform 150 feet by 12 feet with a ramp 18 feet wide."

(ii) *General Remarks on Medical and Surgical Stores* (see Appendices XIX and XX).

A comparison of the requisitions from the general hospitals would show the difference between the medical and surgical stores actually used and those at present included in the authorised scale of equipment. The Committee state:—

"The following remarks of the late Lieut.-Col. H. J. Peard, C.M.G., we quote, as the views therein expressed are worthy of most careful consideration, and express our opinion:—

"The medical and surgical equipment of a general hospital appears to have been worked out in an entirely false principle, consisting, as it does, of the equipment of a field hospital, multiplied by five, with some drugs and instruments added. The functions of the two hospitals are quite distinct, the field hospital being intended only for the temporary reception of sick and wounded, and having only few formal operations performed in it, while a general hospital is intended for the permanent reception of the sick and wounded, and has many formal and complicated operations performed in it. In the same way the multiplication of the medical equipment of a field hospital in no way meets the needs of a general hospital."

General hospitals should be complete in themselves as regards surgical equipment, and should not require to draw on a district loan equipment. The Committee continue:—

"Most, if not all, of the surgical equipment could be packed in cases marked "General Hospital," "Surgical Instruments No. 1," or "No. 2," and a list of contents placed in each case. No panniers or fracture boxes should be held on charge; other units requiring these can obtain them from the base or advanced medical stores. A general hospital should not be a transmitting agency for these articles.

"Splints, materials for splints, dislocation apparatus, also that for extension, counter extension, &c., should be packed in one case. The cases should not be too large, but strong, and fitted with brass hinges and locks, so that they could be used as cupboards in dispensary. The surgical instrument cabinet supplied was far too small for requirements, and not entirely dust proof, which is very necessary. It would save weight, and be otherwise beneficial, if all metal splints were as far as possible made of aluminium or an aluminium alloy, which is stronger.

"There should always be a large reserve of medical and surgical supplies within easy reach of general and stationary hospitals, as these units may at any time be flooded with wounded, and a deficiency would then lead to disastrous consequences.

"We have added a few drugs (*see* Appendix XIX) we consider necessary, removed some which we consider unnecessary, and increased and decreased supplies as we judged best. The remaining drugs, &c., appearing in Appendix No. XLIV, "Regulation for Army Medical Services, 1900," and not mentioned by us, should remain in quantity as there given.

"The amount of each drug in the tablet medicine case should be doubled, the list of which we consider sufficient. The case should therefore be enlarged, or two supplied.

"It is necessary that instruments, appliances, and drugs, &c., required to equip a pathological and bacteriological laboratory be included in the schedule. They also should be packed in one or more cases marked "Pathological Equipment."

"It is also advisable that an X-ray apparatus of latest improved pattern, with all its necessary fittings, be included.

"Keetley's stretchers should form part of hospital equipment, say five, as they are very useful in the dressing of gunshot wounds of upper thigh and pelvis.

"The *surgical equipment* of a general hospital requires complete revision. The amount of surgical necessities and instruments is entirely insufficient both in variety and quantity, many of the latter being of obsolete pattern.

"Appended is a list of instruments which were all found necessary during the late war for permanent use in the general hospitals (*see* Appendix XX).

"Relative to the question of the limitation of dressings to one or two sorts, we think this scheme quite practicable for field hospitals where wounded only remain for a short time, but not for general or stationary hospitals where they remain till final recovery, and where the condition of

their wounds may from various causes change in character, necessitating an alteration in type of dressing.

"Moreover, surgeons differ in their methods of treating wounds, and it is only right that every dressing they may require should be at their disposal. If the question was one of large decrease in bulk or weight for transport, this might be an argument put forward in its favour; but when one considers that the decrease in quantity of one dressing means a similar increase in another of comparatively the same bulk and weight, we fail to see how this can affect the question much. We, therefore, are of opinion and advise that the four primary dressings, viz., double cyanide, sal-alembroth, iodoform, and boric, should still be included in the surgical material list for general and stationary hospitals. We are of opinion, however, that if these dressings were more compressed in manufacture and packing it would save much space in transport."

[NOTE.—If the decrease in the quantity of one dressing used with the increase in another was general, it would simplify the question much, but, as a matter of fact, it is not general, and both base and advanced depôts have at present to maintain full stocks of each kind to meet demands, so that the quantity of dressings, irrespective of class, actually held is greater than the total demand.]

5.—GENERAL SCHEME OF HOSPITAL CAMP.

The Committee say :—

"The laying out of a hospital camp must necessarily vary according to local conditions (size and formation of ground available) and the military considerations. For administrative purposes the principal accessory buildings, stores, offices, &c., had better occupy a central position. A scheme will be best understood by reference to attached plan, which includes three divisions, surgical, medical, and infectious (enteric), and an Officer's hospital.

"In the central road of the hospital, which is 40 yards wide, are placed the administrative offices and other buildings, consisting of (enumerating from front of hospital) :—

"Day wardmaster and duty room, dentists' consulting room; Principal Medical Officer, Registrar, and their clerks' offices; Orderly Medical Officer's room, post office; operating theatre, with X-ray room; pathological laboratory, dispensary, night Sisters' duty room (for the whole hospital), Red Cross and clothing stores, kitchen, filter hut, lamp and oil store, barber's shop, electrician's shop; tailor's, sailmaker's, and shoemaker's workshops; the fowl run and carpenter's workshop lying behind the hospital.

"In the cross avenue, which is also 40 yards wide, are placed soiled and clean linen stores, stewards' and utensil store, quartermaster's office, baths, pack store, rifle room, and chapel.

"The kitchen, including milk kitchen, with sterilisers, larder, scullery, Soyer's boiler room, and coal cellar occupies the centre of the hospital about 50 yards distant from each division. Behind the kitchen is the filter hut and lamp room, which must occupy a central position for supply of drinking water, and trimming of all hospital lamps.

"At each side of central avenue in front, are placed the surgical and medical divisions, the infectious being over 50 yards behind the medical. Each is estimated to contain 200 patients, but is capable of expansion if necessary. The Officers' hospital lies behind the surgical division, separated from it about the same distance.

"All the tents (enlarged E.P.I.P.) in the three divisions are calculated to hold 10 patients—those in the Officers' hospital (small E.P.I.P.) four patients each. The surgical division requires less bed accommodation generally on active service than either of the others, but this must be arranged, by expansion or contraction, as circumstances demand.

"Tents should be reserved for serious cases requiring special nursing, one tent for ophthalmic (surgical) patients; the last row of tents ought to be set apart for venereal patients. The Divisional Officer's office and nursing Sisters' duty rooms are placed on inner flank of division. The latrines and wash houses are on the outer flank, about 50 yards distant. The prisoners' tent can be pitched when necessary at the back of division, where sentries

can be posted without inconvenience. The operating theatre is in close proximity to the division.

"The medical division should also have tents set apart for serious cases requiring special nursing and for tuberculosis patients. The Divisional Officer's office and nursing Sisters' duty tents are placed as in the surgical division, also the latrines and wash houses on outer flank.

"The infectious division, which includes a camp for isolation cases, is also equipped for 200 patients, but is designed for expansion or contraction as circumstances demand. The first four rows of tents, with 160 beds, are for the treatment of enteric fever. The last row—40 beds—for dysentery.

"The isolation camp should be behind and well apart from the infectious division; the tents, being double circular, are pitched and struck as occasion requires.

"The Divisional Officer's office and nursing Sisters' duty tents are situated on inner flank as in other divisions.

"All the disinfecting arrangements are situated in an enclosure on outer flank 50 yards distant, in or near which is also the incinerator.

"The ashbins are also placed behind the enclosure, out of sight and near to incinerator.

"The mortuary is situated about 100 yards behind the disinfecting enclosure, out of view of the hospital.

"The Officers' hospital is practically a distinct unit in itself, having messing and sitting tents, ward tents, Divisional Officer's office, kitchen, lavatories, latrines, wardmaster's and orderly's duty tent; also a Nursing Sisters' pantry. The front row is formed of two tents, one a mess the other a sitting room. The second row has three tents, each containing four beds for medical cases. The third row has three tents, with 10 beds—eight for surgical cases and two in one as a ward for special cases. The latrines and bath room, also kitchen, are placed on one flank. In a general hospital at the base Officers should be accommodated in huts. In advance base hospitals a mess hut should be provided.

"The Medical Officers' camp is situated to the left of the hospital, and consists either of a hut containing mess, sitting room, kitchen, scullery, and pantry or two E.P.I.P. tents of large size as mess and sitting room, 22 Officers having to be accommodated. The living tents (which should be the Indian Field Officers' tent with bath attachment) are placed in rows adjacent to the mess.

"If a hut is not provided a kitchen with scullery and pantry should be erected.

"The latrine is placed to right of camp about 25 yards distant.

"*The Nursing Sister's Camp*, situated to the right front of hospital, should consist of a hut combining mess and sitting rooms, kitchens, scullery, and pantry. If hut cannot be provided two E.P.I.P. tents, large size, are necessary, also a kitchen, scullery, and pantry built as in Officers' camp. The living tents recommended for these ladies' use are the Indian Field Officers' tent, with bath attachment. These would be far more comfortable and convenient for them than the double circular. Each nurse should have a tent to herself. The latrine is situated about 50 yards to the left of camp. In general hospitals at base we recommend that nursing Sisters live in huts.

"*The Royal Army Medical Corps Camp* is placed on the left flank of the hospital. It is also a self-contained unit, having cookhouse and scullery, lavatory, wash house, and latrine.

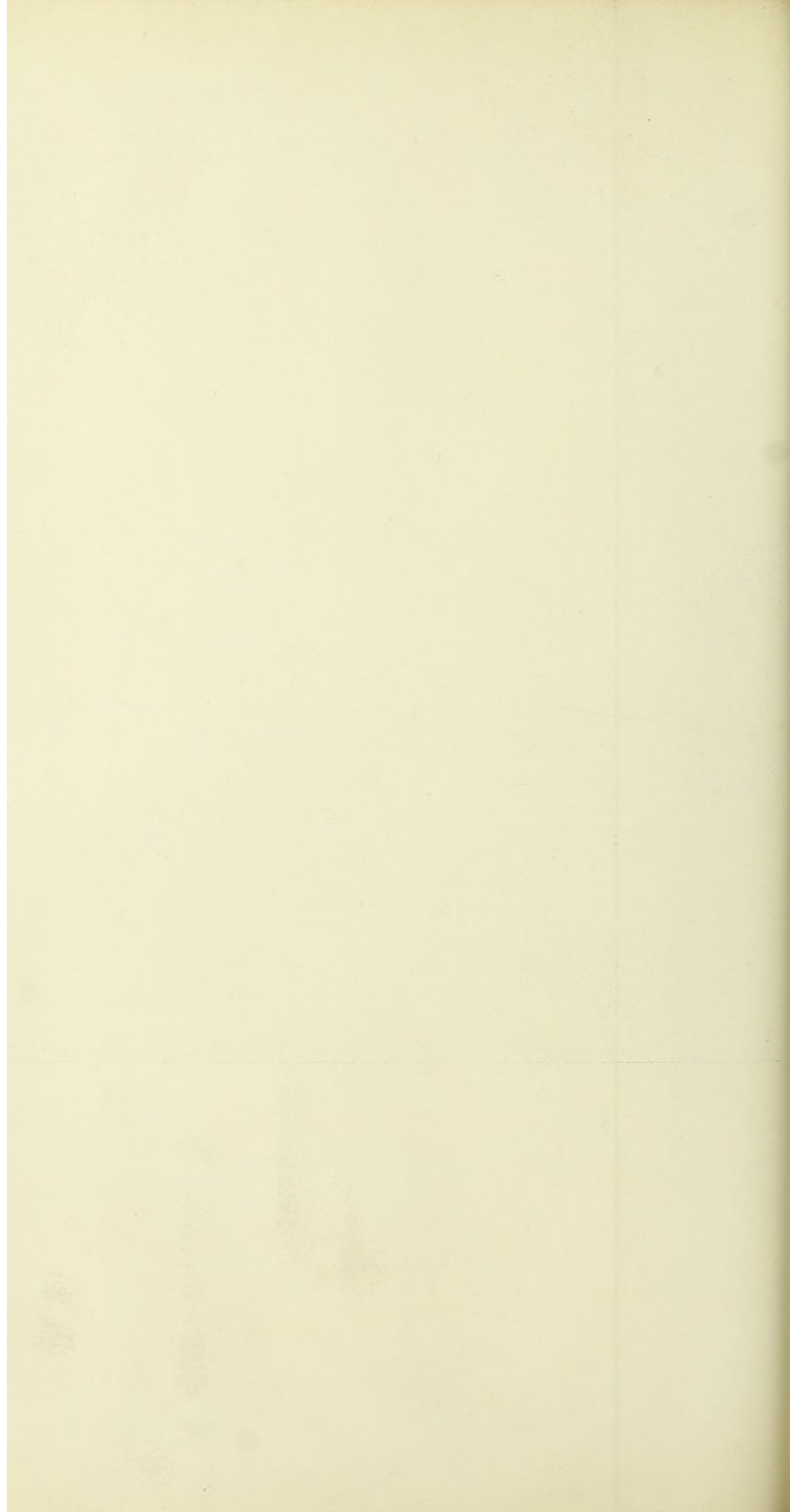
"The former is large enough for the double duty of cooking for the detachment's and sergeant's messes. This is situated behind their camp, about 50 yards distant.

"In the front row of tents are the canteen, sergeants' mess, and warrant Officers' quarters, the N.C. Officers' tents being on outer flank. The canteen had better be a small hut 12 feet by 12 feet for safe custody of supplies, latrines, and wash house lying to the inner side of camp (about 50 yards distant) with their backs to the patients' latrine and wash house.

"Another excellent hospital plan, and worthy of record, was that designed by the Principal Medical Officer of No. 20 General Hospital (Lieut.-Colonel G. E. Twiss, R.A.M.C.), which has helped us much, and from which we have copied many useful suggestions in designing the scheme



NO. 20 GENERAL HOSPITAL.



attached. We hardly see the necessity for having a division for general diseases, as all non-infectious and non-contagious diseases can be treated in the medical division, and practically the only wards that nursing Sisters may not enter are those set apart for venereal disease, which can be segregated in the back row of tents, surgical or medical division, preferably the surgical on account of the fewer number of patients generally under treatment in that division."

6.—NATURE OF A GENERAL HOSPITAL.

The Committee states :—

"We are not in favour of general hospitals being divided into sections, as we consider that complications would arise with regard to ordnance equipment (many articles of which would have to be increased), medical and surgical appliances, instruments (would require a large increase), and supplies generally, besides complications in return, both statistical and others.

"If these units were rendered more mobile efficiency would, to some extent, have to be sacrificed.

"General hospitals should be constructed and equipped to afford those facilities for professional treatment and nursing, which it would be unreasonable to demand in a more mobile unit. Their equipment should be as complete as possible.

"We therefore recommend them remaining as one indivisible unit, which should mobilize as such and continue so through the whole campaign, no matter what its length may be. The size of these units, we recommend, should be 600 beds, but in time of extreme pressure they ought to be capable of expanding to 800, the extra equipment for which should be kept at base ordnance depôts ready for any emergency that might arise.

"We are also not in favour of having two forms of general hospitals beyond what we have already recommended, viz., that those at the extreme base be supplied with ward hut accommodation (for treatment of all sick), as well as necessary buildings; and that those up country at advanced base or on lines of communications should be accommodated in tents, and, where practicable, have accessory buildings (as enumerated), the rest of hospital being under canvas.

"Beyond this difference we consider that advanced general hospitals should be equipped in every respect as those at base, and that their personnel should be of the same strength."

7.—TRANSPORT.

In the earlier months of the South African Campaign much inconvenience was felt in the general and stationary hospitals by the want of transport for the conveyance of sick and wounded, and the drawing of all supplies, &c.

In the latter months ambulances, carts, and wagons, with mules or horses, were issued by the transport authorities entirely for hospital use. This was a great improvement and saving of labour and trouble.

"We consider it absolutely necessary that every general hospital, no matter where established, should be supplied, and include in its equipment at least four ambulances, two general service wagons, and two light carts, with mules or horses and drivers. These should not, under any circumstances, be removable even as a temporary measure, and should be under complete control of the Medical Officer commanding the unit."

Stationary hospitals require transport of the same kind in proportion to their size.

8.—SUNDRY RECOMMENDATIONS.

The Committee make the following further recommendations :—

"(i) A laundry should be attached and form part of every general hospital, under the direct orders of the Principal Medical Officer; Indian dhobies would be preferable as washermen, being more amenable and managed more easily. Considerable difficulty was experienced in some general hospitals during the

South African Campaign in getting the hospital clothing properly washed, which was seldom, if ever, done in hot water, and the delay in returning it from the laundry caused frequently much inconvenience.

"A laundry belonging or being attached to the hospital would obviate all this difficulty. The present system is neither good nor satisfactory; badly washed clothing at present reflects discredit on an Officer in charge of a hospital, and not on the Army Service Corps who are responsible for it. Boilers and necessary plant for this service should be provided by the Army Ordnance Corps."

[NOTE.—This is one of the duties the Army Service Corps have to arrange, and the work is usually done by contract: it would be better to have every general hospital supplied with a laundry. This would be more economical, and the work would be better done. It is not always possible to make a contract in the same station in which the hospital is situated; as an instance, No. 12 General Hospital at Springfontein had to send its soiled clothes to Naauwpoort for washing, and, as a result, there was a delay and difficulty in getting them back, and, of course, a risk of the hospital being short of clean clothing. When No. 3 General Hospital went to Kroonstadt in May, 1900, the Army Service Corps Officer there declared that he could not arrange for the washing, so in conjunction with the civil administration of Kroonstadt, arrangements were made for the washing by employing a number of Kaffir women.]

"Recommended that pyjama suits with a 3-inch turned over collar, and made of unshrinkable flannel or flannelette be supplied instead of the hospital white cotton shirt, which is unsuitable and most inconvenient for nursing duties, especially in Sisters' wards. They would be better if made of one distinctive (hospital) colour or pattern and stamped 'Military Hospital.'

"Recommend change from brown to grey natural wool blankets for all stationary and general hospitals, being a more serviceable colour and easily traced if stolen. These should also be stamped 'Military Hospital.'

"The woven wire mattress should be attached to the side of the bedstead itself and not to hooks fixed in them as these are liable to be broken off and difficult to repair.

"An electric dynamo and necessary plant should form an item of equipment for every general hospital. We are of opinion that any expense for this would be fully compensated for by the superiority of light, less risk of fire, and general cleanliness in comparison to oil lamps. A good many of the general hospitals were lit by electricity during the South African Campaign. No accidents were reported from it, and the general opinion was unanimous as to the benefits derived from it. An electrician should be attached to the personnel to work it. He also would have charge of the erection and working of the portable telephones and electric bells recommended as follows:—A portable telephone with four transmitters, receivers, and 5,000 yards of wire should be included in ordnance equipment. This would save much inconvenience and labour and communicating between divisions and administrative offices. An electric bell battery with plant for 12 bells and about 5,000 yards of wire should be supplied for urgent calls, &c., all through hospital.

"A full equipment for Officers' hospital (20 beds) furniture requires to be added. It is impossible to draw up a scale without a knowledge of what degree of comfort and luxury the Government consider it necessary to supply. In South Africa many of the luxuries in these hospitals were supplied by the various societies and private funds which so generously aided in ensuring the comfort of the sick and wounded in the late war.

"A mineral water machine and plant capable of manufacturing 100 dozen daily should be supplied to every general hospital on active service; this, in a prolonged campaign (say, six months), would save the Government considerable expense. It would also be of great convenience as supplies could never run short. A N.C. Officer belonging to Royal Army Medical Corps could easily be taught to work it, and all varieties of aerated waters could be made to suit patients."

9.—SUPPLIES AND DIETS.

"With reference to paragraph 54, 'Allowance Regulations,' we see no reason why general hospitals on active service should not be 'dietet' in the same manner as those on home service. With a few exceptions, all the varieties of diets as detailed in the Diet Table are necessary."

[NOTE.—The hospitals at Wynberg were "dietet" from the first; the others as soon as the Army Service Corps were able to do this. The only practical difference is in the matter of accounting; the hospitals invariably got all the supplies that could be provided, and the patients in no way suffered by this difference. There is, of course, additional trouble in making out the ration indents, which require fitting in. No doubt it would be better to have them all "dietet," but it is more a matter of convenience than absolute necessity.]

"We recommend striking out of that list, firstly, milk, as the rest of the articles except milk on this diet can be ordered as extras with plain milk, and the terms 'milk' and 'plain milk' are confusing to the uninitiated; secondly, roast, including chops and steaks, as there is practically no difference between 'roast' and 'convalescent' in amounts, only in method of cooking, barley and flour being added to the latter on account of the soup in the diet. There is no necessity to have two varieties of diets of same nutritive value, and the obtaining of eatable chops and steaks is a matter of extreme difficulty, if not impossibility, on active service. 'Convalescent' we would retain, on account of the soup served with it. This diet is a favourite one with patients."

"The Diet Table for active service would then read—

- (1) No diet (extras only).
- (2) Plain milk.
- (3) Beef tea.
- (4) Chicken.
- (5) Convalescent (boiled).
- (6) Varied (for roast).

"We recommend 'chocolate, 1 pint' be added to all diets except 'plain milk,' to be served to the patients at 8 p.m. as supper. The quantities of the other articles in these diets are sufficient for requirements. The following additions to the list of extras we recommend:—

Meat juice (Valentin's).

Brand's Essence.

Benger's or Mellin's Food.

Rusk (for enteric patients not able to eat bread), as issuable on 'plain milk' diet."

[NOTE.—These were all supplied during the campaign.]

"When fresh milk is not obtainable, sterilised milk or unsweetened tinned milk in preference to sweetened, ought only to be supplied."

[NOTE.—This was done in South Africa.]

"The dietary for Officers' hospital should admit of much more variety for meals."

"The Officer in charge should have power to order, and if not obtainable from the Army Service Corps to purchase, if possible, any articles of diet, not amounting to superfluous delicacies, he may consider advisable for seriously ill or convalescent Officers."

"It is advisable that the diets for Officers' hospitals be shown on separate returns and kept from the rest of hospital diet returns. That the divisional wardmaster should make out a dietary which should be varied from day to day under instruction of Division Officer (menu) the previous evening for the following day, including breakfast, luncheon, and dinner, this dietary being for all convalescent Officers."

"We consider it advisable that a pint of *chocolate* be issued to all the personnel at 11 a.m., and to those on night duty at 2 a.m. daily."

[NOTE.—By Army Order 2 of 11.6.00, half an ounce of chocolate was authorised for issue to nursing orderlies on night duty. This was a very useful addition to their ration.]

10.—DISINFECTION.

"Every general hospital should be provided with a large sized steam disinfecting apparatus. Those supplied to hospitals in South Africa were too small for requirements. Many designs of these, both portable and fixed, are advertised.

"That most suitable for a general hospital has a door at each end of apparatus, one for entrance of infected articles, the other for removal of disinfected articles."

Kits and Hospital Clothing.—The Committee consider that disinfection by high pressure steam is the most satisfactory for such articles as are not likely to be damaged by it, and that for the others, the usual methods are satisfactory. They, however, point out that Izal in strong solution stains permanently, and that stained hospital clothing should be boiled instead of being put through the steam steriliser, as this last is also apt to cause permanent staining in these cases.

With regard to the sterilisation of excreta, the Committee, as has already been pointed out, prefer the boiling process as "most effective and reliable," but there is no doubt that many Officers with personal experience of the burning process will always use it where it is at all possible to do so.

The Committee continue:—

"A supply of Izal and carbolic solutions should be kept in all infectious, tubercular, and pneumonic wards for immediate disinfection of all bed-pans, urinals, spit-cups, slop buckets, &c. Strength of solution should be about 1 in 10 of water of former, and 1 in 40 of the latter.

"All discharges and slops from infectious division, also contents of soil buckets and urine tubs in convalescent enteric patients' latrine, also the expectoration of enteric, tubercular, and pneumonic patients should be sterilised or incinerated.

"The sanitary disinfecting arrangements should be under the charge of a specially instructed, capable N.C. Officer of sergeant's rank, with six men or eight natives, if available, working under him.

"*Infectious Division.*—Two two-wheeled light hand covered carts or vans should be provided, one painted red for carrying infected articles of clothing from division to disinfecting station, the other, grey in colour, for carrying disinfected articles to foul linen store. These carts should be under charge of N.C. Officer in charge of disinfecting arrangements. They can be backed up in front of disinfector, and the cage with its contents run into the machine and out again without any handling of its contents.

"All pails used as receptacles for enteric faeces, urine and ward slops, should be painted red colour and marked 'E' for distinctive purposes, and should not be used for any other purpose. (Provided for by regulation.)

"All urinals and spit-cups, &c., should be scoured out every morning with boiling water, and have a small quantity of carbolic lotion or Izal solution always placed in them before use.

"No discharges whatever should be permitted to remain in the wards. All bed-pans, urinals, and slop pails should be kept outside tents and wards when not in use.

"The following arrangements for dealing with disinfection of (1) excreta (urine and faeces) and (2) clothing are recommended:—

"*Urine.*—A quantity (about equal parts) of disinfectant (solution of Izal or carbolic acid which is kept in every ward) is mixed with urine before being emptied into ward slop pails, which, covered with a lid, are kept in the open air, one used solely for the reception of urine and ward slops. The urinal is then washed out with clean water and set apart for further use. The same method is used for spit-cups. The slop pails are subsequently emptied into buckets

placed in disinfecting shed (painted red).—About one pint of Izal solution is then put into slop pail before return to wards as an extra precaution.

"*Fæces*.—About three or four ounces of solution of Izal is first added to bed-pan. This is made to mix thoroughly with the contents. The pan is then taken to the disinfecting shed (with its cover on) and emptied into buckets set aside solely for the purpose (painted red). The pan is then taken to Izal bath and immersed for a few minutes and, by means of a small mop, thoroughly cleansed. It is then washed in a water bath to remove disinfectant, then dried with a towel specially provided for that purpose. Finally, the orderly washes his hands in carbolic or Izal solution, and dries with a towel, both of which are provided in shed for that purpose (*see plan of disinfecting shed under heading 'Accessory Buildings'*). The buckets containing fæces are emptied into steriliser as occasion demands, where it is subjected to intermittent boiling for some hours. Contents are then removed as already described and buried.

"Pails containing fæces should be tarred or lime-washed frequently by hospital sanitary staff.

"Floor of the disinfecting shed should be washed out daily with Izal solution.

"Walls should be whitewashed frequently.

"*Clothing*.—Clothes used by enteric fever patients are brought from the wards in carts (painted red) to the disinfecting shed, having previously been well sprinkled with Izal solution, and are placed at once in one of the wooden tubs containing mercury disinfecting solution, and let remain there for at least half an hour. They are then wrung out and hung up to dry. As an additional precaution they may be passed through the Thresh's disinfecter.

"As sheets and clothing soiled by fæces, if treated in this manner with mercury, become permanently stained, they, to prevent this, should be subjected to boiling for at least one hour.

"Boilers are placed in an adjoining shed for this purpose.

"Beds and other articles so soiled, that would be spoiled by boiling, should be placed in Thresh's disinfecter for at least one hour.

"Soiled waterproof sheets should be carefully disinfected in the mercurial bath and then hung up to dry.

"Natives are recommended to be employed as scavengers for carrying stools, slop pails, &c., from wards to disinfecting sheds and back, in place of Royal Army Medical Corps orderlies, so as to avoid the latter leaving their wards where their services are required."

[NOTE.—These methods, or their equivalents, were used in the hospitals in South Africa.]

11.—SANITATION.

"The *dry earth system* has proved satisfactory during South African Campaign, but very careful supervision is absolutely necessary. This duty should not be deputed entirely to N.C. Officers. The Orderly Medical or Sanitary Officer should be detailed to inspect all latrines, urinals, &c., at least twice daily, once between 10 and 11 a.m. and again in the evening after conservancy has taken place, and see that all duties in connection with this work have been entirely and properly carried out, and that they are in a sanitary condition, and clean.

"The depositing of dry earth in buckets after use should not be left to patients, who invariably neglect this. Scavengers ought to go round the buckets at frequent intervals to perform this duty.

"Latrine seats should be scrubbed down frequently. All buckets should be tarred inside and outside at least once a week, a surplus number being kept to permit of this being carried out.

"Covers should be provided for those buckets set apart for reception of bed-pan contents, urine, and ward slops, to prevent entrance of rain water, and care be taken that they do not overflow from this cause or overfilling.

"The floors of latrines and urinals should be brushed and washed out daily, and dry sand, with carbolic powder, or better still (if obtainable), dry pine sawdust should be sprinkled over them and amply round buckets.

"The inner walls and roof should be limewashed at frequent intervals.

"A bath of Izal solution, with small mop, should be kept in enclosure behind each latrine to disinfect bed-pans and urinals in; also a bath of cold water for washing them in after disinfection before returning to wards."

Drainage System.—The Committee recommend a somewhat elaborate system of drains, opening if possible into some existing system. It will not be often possible to arrange for this on service. Two things are, however, essential—first, a proper system to carry off storm water. Properly cut out and well kept open channels in the surface soil are sufficient for this. Secondly, some means of disposing of waste water from the bath rooms and lavatories. These again should be open channels delivering into soakage pits at some distance to leeward of the hospital camp. It is of course better to have these channels concreted, and where the hospital is likely to be established for some time, this should be done.

The great difficulty in the satisfactory establishment of a sanitary system is the time necessary for its completion. No doubt all lavatories, latrines, and the like, should have concrete floors, surrounded by a concrete drain delivering into a movable cistern so as to avoid the possibility of any leakage into the surface drains. But this all takes time and skilled labour, which may not be available when it is required.

Like the erections of accessory buildings or huts, the completion of the sanitary arrangements in the condition in which it is allowed on all sides that they should be, is a matter which depends so largely on conditions of time and place, that no general rule can be formulated regarding their necessity, nor the actual form which they should take. Much must be left to the discretion of those on the spot.

The Committee point out that latrine paper should be supplied in rolls, and not in cut sheets; this prevents it blowing about.

12.—STORAGE AND CARE OF ARMS AND AMMUNITION.

The Committee are of opinion that:—

"In general hospitals the duties in connection with storage and care of arms and ammunition should be performed by a N.C. Officer assisted by two privates of the Army Ordnance Corps attached for this duty to the personnel of the hospital. He should receive all arms and ammunition from patients immediately on their admission, enter them in his records and label them with number, name, regiment of owner, also date of receipt, and be answerable for their cleanliness and care till patient's discharge from hospital, either on return to duty, convalescent camp, or invalided home. In the two former cases the patient should sign for their receipt, in the latter the arms and ammunition should be handed into Army Ordnance Corps Depot, who should give a receipt for them.

"All ammunition should be handed into Army Ordnance Store immediately, and not allowed to accumulate in the hospital store. Oil and cleaning articles should be provided by the quartermaster of the hospital.

"The hospital rifle store should only contain the rifles of those men who will return for duty with their units, all other arms should be returned immediately into the Army Ordnance Store. It is more desirable that patients should not bring their arms with them when admitted to general and stationary hospitals, as these units are liable to capture by an enemy, but we do not see how this can otherwise be arranged without hampering the movements of their regiments in the field with a quantity of spare arms, probably at places far distant from ordnance stores or other centres where they could dispose of them."

13.—SUPPLY OF CLOTHING TO PATIENTS ON DISCHARGE.

The Committee state:—

"The supply of clothing to patients on discharge threw an enormous amount of extra work and responsibility on the hospital quartermaster, but it worked satisfactorily in South Africa, and we think it still can be performed by the hospital staff where necessary, as probably in future two quartermasters

will be appointed to every general hospital on active service. If not, a retired regimental quartermaster should be employed and attached to the unit for these duties, being responsible for clothing directly to the ordnance.

"We do not see how, otherwise, patients whose clothes are worn out on arrival at hospital can be supplied on leaving with necessary articles, unless it was done at convalescent camps or by the station commandant at a discharge depôt which should be established close to hospital.

"A ledger account of all articles demanded and received from the Army Ordnance Corps should be kept and vouchers passed. Also another for expenditure showing items every soldier or Officer receives, giving his number, name, and regiment, which should be signed by recipient. A list of articles supplied should be sent to the man's immediate Commanding Officer, or to the base if he was invalided. Only clothes and necessities should be issued from hospitals.

"Arms, accoutrements (except haversacks and water-bottles), and ammunition should be a combatant matter."

[NOTE.—It is hard to see how the patients on discharge could have been refitted except by the hospital during the late campaign. Many of them came into hospital with only what they had on them, and this frequently in such a condition that it was only fit to be burnt. The labour involved is, of course, considerable, but it appears to be unavoidable, and should be considered in estimating the future establishment of these units.]

14.—RED CROSS AND OTHER GIFTS.

During the first period of the war, before enthusiasm had subsided, many of the hospitals were flooded with gifts of various kinds, of which much was unsuitable for the sick and wounded. In most cases the generous donors wished their presents to go to a particular hospital. They desired in many cases to ignore the recognised channel (the Red Cross Society) and preferred to send them to the Medical Officers or nursing Sisters, or even to the sick direct. Of course the latter could not be permitted, as it was a practice full of risk to the sick and wounded. It has been generally acknowledged that gifts, as a rule, should pass through some central agency, such as the Red Cross, and that the latter should distribute them as required to the various hospitals, and that gifts going direct to hospitals should be discouraged as much as possible. It is not, however, safe to make a hard and fast rule, as cases will occur when it is better for perishable articles to be taken direct to the hospital. During the campaign there were a considerable number of outlying hospitals not in touch with the Red Cross, and these received very many things from local residents which were most acceptable to the sick, and which could not be supplied by the Army Service Corps.

The Committee say :—

"It is generally acknowledged that all gifts from the public to the sick and wounded should be sent to the Red Cross Society. All gifts should be sent to them fully addressed, with a statement how the donor wishes them disbursed.

"The public should be informed that only certain things can be received, so that their generosity should not be misapplied by supplying articles unsuitable for the sick and wounded, such as stimulants, which were quite unnecessary. Under no conditions should these be supplied to hospitals by the Red Cross Society. If sent as gifts, they should be handed over by that Society to the Army Service Corps, who should acknowledge and issue them as hospital supplies through regulation channels. Lists of suitable and acceptable gifts should be frequently announced in the public press by the Red Cross Society, who should not include in them any articles already supplied by a generous Government.

"The system generally carried out during the campaign was that all gifts, no matter where they came from, whether Red Cross or from private individuals, were taken over by the Quartermaster and by the nursing Sisters. The former received and stored the non-perishable, and the latter received the perishable, and all were distributed under orders from the Medical Officers.

"To receive and distribute these gifts to everyone's satisfaction was an impossible task, but much depends on the tact and common sense of the Officer in charge of the hospital. As long as wars are waged, such gifts will be pressed for acceptance, and, no matter whether they be required or not, they must be received and accounted for."

15.—PURCHASING POWERS.

"The experience of the war proves the necessity of granting responsible Medical Officers the power to purchase everything necessary for the use and well-being of the patients under their care. This should in no way interfere with the duties of the other services (Army Service Corps or Army Ordnance Corps) entrusted with supplying hospital necessities, but the power should be granted and fully exercised when these services fail, or when undue delay takes place.

"We recommend that the Army Pay Department be empowered to grant 'imprest accounts' to Officers in charge of general hospitals. This method was adopted during the late war in some hospital ships, with successful results."

[NOTE.—Even with the best intentions, the Supply Departments do not always take the same view as to the urgency of a demand as the Officer in charge of a hospital. Further, it not infrequently happens that this Officer can get what he wants more easily and quickly by his individual efforts than through the usual channels. For these reasons it seems advisable that every Officer in charge of a hospital should be empowered to purchase when necessary, being, of course, prepared to justify his action afterwards, and, except when this purchase was evidently unnecessary, his action should be upheld. It is far better that some slight additional expense, or some additional clerical labour to the Supply Departments, should be incurred, than that the patients should suffer. On the other hand, this power has to be guarded; it should not be understood as relieving the normal sources of supply of their responsibilities.]

16.—RETURNS AND CLERICAL WORK.

The clerical work in a large hospital is certainly heavy. It falls under the following heads:—

I. Relating to equipment and supplies—

Requisitions for supplies and vouchers for things received.

II. Relating to personnel—

- (a) Officers and nursing Sisters; specially pay and distribution.
- (b) Subordinate personnel, pay, clothing and equipment; discipline and distribution.

III. Relating to the patients in hospital—

- (a) Statistical: (i) Normal, for administration and record.
- (ii) Abnormal, for special purposes, often quite apart from the actual needs of the service. (iii) Returns for the Army Post Office.
- (b) Enquiries: (i) From regiments. (ii) From friends or relatives.
- (c) Documents in relation to invaliding, transfers, and the like.

IV. General correspondence.

The returns required under the first two heads are to a large extent common to all branches of the service, and not specially hospital returns, except in form. Whether they can be simplified or in any way reduced in number is not a matter which falls within the scope of this report.

As regards the statistical returns, these of course must be retained, but the tendency should be towards their simplification in the field, by reducing them as far as possible to a permanent record in some form of admission and discharge book, with some means of conveying information to Officers Commanding the various units, to the casualty department, and wherever

else necessary, by simple nominal rolls. - A weekly statement of total numbers under certain specified heads is all that is wanted for administrative purposes. There is no doubt that anything wanted in addition to this should be compiled at a base statistical office from nominal rolls supplied by the hospitals.

The "abnormal" returns, often called for on account of special necessities, should be cut down as far as possible. Much of this, however, is entirely outside any service control.

Enquiries from friends and relatives must always be dealt with by the hospital authorities, and a certain class of enquiry from Commanding Officers must be similarly dealt with, but it would simplify matters very much if, as suggested by the Committee, all routine enquiries from Officers Commanding were sent to the casualty department, who would be kept informed by weekly nominal rolls, or if a base statistical office were established. Officers Commanding would refer to it in order to find out where their men were instead of tracing them through the various hospitals by which they might have passed. Similarly the base office would make out rolls for post office requirements.

All documents connected with invaliding and transfers must, of course, originate from the hospital from which the cases are sent.

The general correspondence varies much in different conditions; it is not possible to deal with it as a general question.

The Committee say:—

"The accompanying copy of a morning state is suggested for general use in place of Army Form A 28, as giving the necessary information (see Appendix XXIV). It was used in hospitals on the lines of communication, Elandsfontein, during latter months of the war and worked satisfactorily. It should be printed on foolscap size.

"The keeping of a nominal, alphabetical index book for all patients admitted (same as kept at Woolwich and Netley Hospitals) showing transfers in red ink is suggested; also a similar book by corps in order to be able to give readily the number of sick per regiment. The columns in these books should give:—

- (a) Regimental number.
- (b) Rank.
- (c) Christian and surnames in full.
- (d) Date of admission or transfer (the latter being marked T in red ink).
- (e) From whence admitted or transferred.
- (f) Date of discharge or transfer out.
- (g) Where transferred to.
- (h) Result—(D) Died, (I) Invalided, (C) Change."

17.—OFFICERS' HOSPITALS.

The Committee recommends that "distinct units be formed at the base, or advanced base, for the treatment of sick Officers, called Officers' hospitals. These should be situated adjacent to a general hospital in order to utilise the operating theatre and surgical appliances of the latter when necessary. There should also be a convalescent home, where they could recoup their strength."

According to regulation each general hospital has accommodation for 20 Officers as patients. When more than one hospital was situated in one place, it was found to be more convenient to increase the Officers' accommodation in one of the hospitals, and treat all Officers there. Thus, at Cape Town, No. 1 General Hospital had at one time accommodation for 120 Officers, and, except while the Portland Hospital was at Rondebosch, all sick and wounded Officers were treated there. Similarly in Bloemfontein and also in Pretoria most of the sick Officers were accommodated in one hospital.

Officers' hospitals require more luxurious appointments than ordinary wards, and the dieting is on a different scale. In every case a chef was employed and the very various articles of food required were supplied on a very liberal scale. A small mess was formed in each, where those who were convalescent and did not require special dieting lived.

Each Officer's diet (and special stimulants) was marked on his diet sheet, but the diets of convalescents were "pooled" for the mess, and additional articles were accounted for on a general diet sheet. This worked very well.

Convalescent homes existed at Claremont, Johannesburg and other places.

18.—HOSPITALS FOR NURSING SISTERS.

The Committee recommend that accommodation for the treatment of nursing Sisters should be arranged, either in huts or tents, at their own hospital, and that special hospitals should only be formed under pressure of exceptional sickness. In the late war, special hospitals at Bloemfontein and Pretoria were opened, and gave valuable assistance. In Bloemfontein the hospital (at Bishop's Lodge) had accommodation for 16 patients. It was opened in May, 1900, and remained in occupation for 15 months.

In Pretoria a house was commandeered. It gave accommodation for 12 patients, and was in existence till the end of 1901. Both of these hospitals received cases from out stations.

A convalescent home was established in Johannesburg.

19.—STATIONARY HOSPITALS.

A stationary hospital as at present constituted is supposed to be a mobile unit which can approach within a practicable distance of the field medical units, so as to allow them to evacuate their sick into it. It has also to be used to afford accommodation at stations where the demand is not sufficient to necessitate the establishment of a general hospital. These duties are, however, to a great extent mutually exclusive. The present stationary hospital is, on the one hand, too heavy to be readily moved except by rail, and on the other, its equipment is not sufficient for its satisfactory employment in place of a general hospital at a fixed point. Large additions had to be made to those employed in this way in the late war.

This leads to the question whether it would not be possible to make a general hospital divisible into sections, so that one or more of these might be detached as occasion required. On this point the Committee are "not in favour of general hospitals being divided into sections." Their objections are two—first, the unavoidable complications in administration and the multiplication of articles of equipment, and second, the loss of efficiency (including mobility) in a general hospital so constituted.

The opinion of the Committee is also that of a large number of Officers with practical experience of these hospitals, viz., that the normal organisation of a general hospital should be as one individual unit, and not as the aggregate of four or five smaller units, and this certainly is borne out by our experience. The first function of a general hospital should be to provide the most complete arrangements for the care of the sick and wounded which the circumstances will allow. A unit which is designed with the intention of being broken up into sub-divisions will never reach the standard required of a modern military hospital; the probability of its division will be a constant obstacle in the way of its development, for it must always be the case that a natural development according to local resources will supplement the standard organisation and equipment of the "Mobilisation Tables."

On the other hand, our experience has shown that once a general hospital has been established as a going concern, there is no practical difficulty in detaching a portion of the personnel and equipment to meet urgent necessities arising at a later date. Under proper arrangements, additional equipment of all kinds can be obtained from the reserve supplies, and in most cases this detachment of a section will only occur, as it is only possible, when a lessened demand has reduced the accommodation necessary in its parent hospital.

The recommendations of the Committee follow the lines on which their scheme for the general hospital has been elaborated, with a proportional reduction in quantities in relation to the difference in their accommodation. They recommend a stationary hospital of 120 beds as the most convenient size; details as to the equipment and personnel are included in Appendices XXII and XXIII.

The stationary hospital, as recommended by them, would be somewhat heavier than the present pattern unit, as they recommend that they "should be supplied with bedsteads, beds, and ward necessities, also most other items of equipment used in general hospitals." This would form a most satisfactory unit for fixed points on the line of communications, but it would not be sufficiently mobile to be pushed forward off the railway into the field, for which purpose, indeed, the existing stationary hospital is hardly suited.

Reference has already been made to the necessity of providing better accommodation in the field itself for such cases as cannot be moved down the line of communications (especially fractures of the long bones), than can be provided in the field ambulance or the divisional field hospital. This accommodation has been spoken of in the section on the arrangements on the line of communication as an "advanced line of communications hospital," but a simpler term would be "field hospital on the line of communications." It is proposed that these should be pushed forward immediately behind the divisional arrangements, so as to enable the actual field units to evacuate their sick at once, and remain free for immediate movement. It is essential in the execution of this purpose to have a mobile unit, which can only be the result of a compromise between the desire to afford the greatest comfort possible and the necessity of keeping in touch with the field army. It is not proposed that these units should move forward so long as they have patients in them, but that as one fills up another should advance from the rear to take its place. The actual details as to equipment must be a matter of experiment, as there is at present nothing which could be safely taken as a guide. Hence only those points which are absolutely essential will be referred to here. These appear to be:—

- (1) A sufficiency of light bed-cots for 120 or at most 150 cases.
- (2) Light hospital clothing, best of all, pyjama suits.
- (3) A sufficient surgical equipment, both instrumental and material (especially ready-made splints and the materials for making others), to allow of operative surgery of some degree of difficulty being done.
- (4) A sufficiency of drugs and medical comforts on a liberal scale.
- (5) Good tents, double fly, probably the Hubert pattern best.
- (6) Sufficient transport for the unit. It would seem quite possible to introduce special "technical" wagons for such units as these, fitted to carry the surgical equipment and drugs in such a way that little unpacking or repacking would be needed, and a "fitted store wagon" for patients' necessities would also be a great convenience. These special wagons would have the advantage of being inalienable, as they would be useless to any other unit.

Convoy work from these units towards the base would, of course, be under the Principal Medical Officer lines of communication, and it might be more economical as well as convenient to retain the ambulance transport required for these hospitals on the lines of communication, and not to attach it to the units themselves.

In the later stages of such a campaign as the late South African War, these units would have been invaluable, as affording nuclei for the development of the stationary hospitals which had to be pushed out into the districts away from the railway. This necessity will always arise in a campaign of any magnitude and duration. Hospitals can never be supplied from home to meet all the lesser needs of the situation, and much will always have to be done on the spot in the preparation of small stationary hospitals from such material as is available. In many cases in the late war a small unit of this nature would have done all that was necessary, in the numerous instances where a small hospital had to be improvised which remained in use a short time.

TABLE A.—List of Hospitals.

GENERAL HOSPITALS.

Name of Hospital.	Station.	No. of Hospital Beds.*	Date of First Return.	Date of Last Return.	Remarks.
1. General Hospital	Wynberg ..	773	20.10.99	31.5.02	
2. " "	Wynberg ..	—	8.12.99	1.6.00	
3. " "	Pretoria ..	672	20.7.00	31.5.02	
4. " "	Rondebosch ..	—	22.12.99	1.6.00	
5. " "	Kroonstadt ..	592	1.6.00	31.5.02	
6. " "	Mooi River ..	520	12.1.00	31.5.02	
7. " "	Cape Town ..	940	30.3.00	31.5.02	Preceded by Base Hospital, Cape Town, from 13.10.99.
8. " "	Naauwpoort ..	—	2.3.00	13.7.00	
9. " "	Johannesburg ..	822	27.7.00	1.10.01	
10. " "	Estcourt ..	—	13.4.00	26.10.00	
11. " "	Pretoria ..	692	9.11.00	31.5.02	
12. " "	Bloemfontein ..	814	27.4.00	31.5.02	
13. " "	Bloemfontein ..	553	20.4.00	31.5.02	
14. " "	Bloemfontein ..	—	4.5.00	7.1.01	
15. " "	Norval's Pont ..	520	18.1.01	31.5.02	
16. " "	Kimberley ..	600	18.5.00	31.5.02	Preceded by Town Hospitals, from 20.10.99.
17. " "	Springfontein ..	500	11.5.00	31.5.02	Formerly Section No. 3 General Hospital.
18. " "	Wynberg ..	—	20.7.00	1.2.01	
19. " "	Johannesburg ..	520	3.5.01	31.5.02	
20. " "	Newcastle ..	520	10.8.00	31.5.02	Took over from No. 4 Stationary Hospital.
21. " "	Howick ..	536	20.7.00	31.5.02	Formerly No. 2 Stationary Hospital.
22. " "	Klansfontein ..	536	1.2.01	31.5.02	Formerly No. 4 Stationary Hospital.
23. " "	Standerton ..	520	1.2.01	31.5.02	Formerly No. 1 Stationary Hospital.
24. " "	Charlestown ..	520	8.2.01	31.5.02	
25. " "	Pretoria ..	201	15.6.00	31.5.02	
26. " "	Elandsfontein ..	600	1.3.01	31.5.02	
27. " "	Delffontein ..	800	5.4.01	31.5.02	Formerly Imperial Yeomanry Hospital.
28. " "	Pretoria ..	520	20.9.01	31.5.02	Formerly Imperial Yeomanry Branch Hospital.

Notes.

No. 10 General Hospital took over the town hospitals in Bloemfontein on arrival on 11th April, 1900, and rendered its first return as a General Hospital on the date shown.

Nos. 1 to 11, Nos. 13 and 14, were sent out from England, six were formed in South Africa as shown in the column of remarks, the remaining three were entirely formed in South Africa.

STATIONARY HOSPITALS.

Name of Hospital.	Station.	No. of Hospital Beds.*	Date of First Return.	Date of Last Return.	Remarks.
1. Stationary Hospital	Frere and Modder Spruit ..	—	12.1.00	13.7.00	
2. " "	Charlestown ..	—	27.7.00	1.2.01	See No. 18 General Hospital.
3. " "	East London ..	—	22.12.99	8.6.00	
4. " "	Johannesburg ..	—	20.7.00	24.9.00	
5. " "	Klansfontein ..	—	28.9.00	25.1.01	See No. 16 General Hospital.
6. " "	De Aar ..	370	1.12.99	31.5.02	
7. " "	Frere and Chieveley ..	—	5.12.99	8.6.00	
8. " "	Newcastle ..	—	15.6.00	10.8.00	
9. " "	Standerton ..	—	31.8.00	25.1.01	See No. 17 General Hospital.
10. " "	Bloemfontein ..	219	6.4.00	31.5.02	
11. " "	Greenpoint ..	6	10.11.99	31.5.02	
12. " "	East London ..	250	1.12.99	31.5.02	No. 2 Stationary Hospital, from 22.12.99 to 8.6.00.
13. " "	Port Elizabeth ..	200	1.12.99	31.5.02	
14. " "	Queenstown ..	60	23.3.00	31.5.02	
15. " "	Naauwpoort ..	377	13.7.00	31.5.02	From Section, No. 6 General Hospital.
16. " "	Winburg ..	150	1.6.00	31.5.02	
17. " "	Wakkerstroom ..	150	7.9.00	31.5.02	
18. " "	Pinetown Bridge ..	250	20.4.00	31.5.02	Formerly Princess Christian Hospital.
19. " "	Maritzburg ..	150	13.10.99	31.5.02	Formerly General Hospital, no number.
20. " "	Heidelberg ..	150	13.7.00	31.5.02	
21. " "	Mafeking ..	150	10.8.00	31.5.02	
22. " "	Middelburg Transv. ..	400	17.8.00	31.5.02	
23. " "	Krugersdorp ..	250	27.7.00	31.5.02	
24. " "	Harrismith ..	350	24.8.00	31.5.02	
25. " "	Waternal Onder ..	120	7.9.00	31.5.02	
26. " "	Machadodorp ..	125	12.9.00	31.5.02	
27. " "	Pietersburg ..	100	19.4.01	31.5.02	

* The actual accommodation varied considerably from time to time. The number of beds shown is that available on November 2nd, 1901, in the case of the hospitals that were open on that date. In the case of the hospitals that had been closed before that date, the number shows the accommodation that had previously been available in them.

STATIONARY HOSPITALS--continued.

Name of Hospital.	Station.	No. of Hospital Beds.*	Date of First Return.	Date of Last Return.	Remarks.
23. Stationary Hospital ..	Warmbaths ..	75	5.4.01	31.5.02	On closing of No. 6 General Hospital.
24. " " ..	Aliwal North ..	225	30.11.00	31.5.02	
25. " " ..	Johannesburg ..	100	4.10.01	4.4.02	
26. " " ..	Beaufort West ..	100	3.5.01	31.5.02	
27. " " ..	Burghersdorp ..	90	28.12.00	31.5.02	
28. " " ..	Worcester ..	60	31.5.01	2.5.02	
29. " " ..	Heilbron ..	120	15.6.00	31.5.02	
30. " " ..	Lindley ..	180	17.1.02	31.5.02	
31. " " ..	Ermelo ..	86	20.12.01	31.5.02	
32. " " ..	Klerksdorp ..	100	22.6.00	31.5.02	
33. " " ..	Zeerust ..	100	2.11.00	31.5.02	
34. " " ..	Ladybrand ..	40	29.6.00	31.5.02	
35. " " ..	Potchefstroom ..	100	2.11.00	31.5.02	
36. " " ..	Barberton ..	200	5.10.00	31.5.02	
37. " " ..	Lydenburg ..	125	5.10.00	31.5.02	
38. " " ..	Rustenburg ..	100	12.10.00	31.5.02	
39. " " ..	Rietfontein ..	100	19.10.00	31.5.02	
40. " " ..	Dundee ..	100	12.10.00	31.5.02	
41. " " ..	Ficksburg ..	143	8.2.01	31.5.02	

Notes.

No. 10, Naauwpoort. Left behind when No. 6 General Hospital was moved to Johannesburg.

No. 14, Maritzburg. The original Station Hospital, Maritzburg, was increased to form a General Hospital which was not numbered, and reduced again when the pressure ceased in Natal.

The first five Stationary Hospitals were sent out from England; the remainder were formed in South Africa. Many had been in existence for some time before being given a number, hence the sequence of numbers is not according to dates of opening.

TEMPORARY HOSPITALS.

Name of Hospital.	Station.	No. of Hospital Beds.*	Date of First Return.	Date of Last Return.	Remarks.
Field Hospital ..	Eshowe ..	16	13.10.99	31.5.02	} See note below, and p. 67.
Palace " ..	Simonstown ..	67	20.10.99	31.5.02	
Temporary Hospital ..	Naauwpoort ..	20	20.10.99	3.11.99	
Convent " ..	Estcourt ..	100	10.11.99	15.6.00	
Temporary " ..	Nottingham Road ..	12	1.12.99	8.12.99	
" " ..	Putters Knaal ..	30	1.12.99	8.12.99	
" " ..	Brynville Camp ..	5	15.12.99	29.12.99	
" " ..	Stellenbosch ..	9	19.1.00	31.5.02	
" " ..	Sterkstroom ..	107	16.2.00	6.4.00	
" " ..	Klip Drift ..	16	23.2.00	16.3.00	
" " ..	Modder River ..	50	23.3.00	1.6.00	
" " ..	Orange River ..	40	23.2.00	31.5.02	
" " ..	Prieska ..	22	30.3.00	31.5.02	
Sanatorium " ..	Claremont ..	50	30.3.00	7.6.01	
Temporary Hospital ..	Thabanchu ..	20	11.5.00	31.5.02	
" " ..	Boshof ..	40	18.5.00	31.5.02	
" " ..	Norvals Pont ..	75	25.5.00	15.10.00	
" " ..	Smithfield ..	25	1.6.00	3.8.00	
Race Course " ..	Pretoria ..	60	15.6.00	31.5.02	
St. Andrew's College Hospital ..	Bloemfontein ..	61	15.6.00	4.1.01	Originally opened December, 1899.
Temporary Hospital ..	Rouxville ..	5	15.6.00	14.9.00	
" " ..	Dewetsdorp ..	60	29.6.00	29.11.00	
" " ..	Wepener ..	26	29.6.00	25.1.01	
" " ..	Kroonstadt Hotel ..	14	29.6.00	13.7.00	
" " ..	Lindley ..	150	6.7.00	27.7.00	
" " ..	Viljoen's Drift ..	20	20.7.00	14.10.00	
" " ..	Senekal ..	80	20.7.00	24.8.00	
" " ..	Vereeniging ..	40	20.7.00	12.10.00	
" " ..	Pienaar's Poort ..	16	24.8.00	13.8.01	
" " ..	Edenburg ..	25	24.8.00	31.5.02	
" " ..	Vrede ..	100	19.10.00	15.3.01	
Railway Rest " ..	Pretoria ..	—	3.8.00	17.1.02	
Temporary " ..	Ottoshoop ..	4	26.10.00	28.12.00	
" " ..	Lichtenburg ..	50	7.12.00	31.5.02	
" " ..	Ventersdorp ..	50	4.1.01	31.5.02	
" " ..	Rouxville ..	5	21.12.00	4.1.01	
" " ..	Vryburg ..	27	11.1.01	31.5.02	
" " ..	Buluwayo ..	45	18.1.01	31.5.02	
" " ..	Carnarvon ..	32	4.1.01	31.5.02	
" " ..	Graaff Reinet ..	61	4.1.01	31.5.02	
" " ..	Griquatown ..	5	4.1.01	31.5.02	
" " ..	Frankfort ..	100	12.10.00	1.2.01	No further returns rendered. Hospital remained open till end of war.
" " ..	Komati Poort ..	60	22.2.01	31.5.02	
" " ..	Eerste Fabrieken ..	10	17.8.00	3.5.01	
" " ..	Daniel's Kuil ..	11	26.4.01	31.5.02	

* The actual accommodation varied considerably from time to time. The number of beds shown is that available on November 2nd, 1901, in the case of the hospitals that were open on that date. In the case of the hospitals that had been closed before that date, the number shows the accommodation that had previously been available in them.

TEMPORARY HOSPITALS—continued.

Name of Hospital.	Station.	No. of Hospital Beds.*	Date of First Return.	Date of Last Return.	Remarks.
Temporary Hospital	Aberdeen	17	21.6.01	7.3.02	
"	Kuruman	14	7.6.01	31.5.02	
"	Cradock	50	12.7.01	31.5.02	
"	Koffyfontein	18	2.8.01	31.5.02	
"	Calvinia	37	21.6.01	31.5.02	
"	Tarkastad	25	31.5.01	10.1.02	
"	Christiana	18	22.11.01	31.5.02	
"	Schmidt's Drift	5	23.8.01	31.5.02	
"	Douglas	5	13.9.01	31.5.02	
"	Ladysmith	16	4.10.01	14.3.02	
"	Matjesfontein	25	17.1.02	31.5.02	
"	Greytown	24	4.10.01	1.11.01	
"	Vryheid	50	25.10.01	31.5.02	
"	Krantskop	18	8.11.01	3.1.02	
"	Pienaar's River	81	20.9.01	24.1.02	
"	Tiger's Kloof	40	24.1.02	31.5.02	
"	Port Nolloth	50	18.4.02	31.5.02	
"	Ladysmith	30	13.10.99	31.5.02	

Notes.

This list includes only those temporary hospitals which maintained an independent existence. Those which afterwards became numbered stationary hospitals, or which were merged in other hospitals, have not been included, as for example the second hospital at Naauppoort, which was merged in No. 6 General Hospital on its arrival in Naauppoort.

On the other hand, several of these temporary hospitals were in existence before the dates shown, but they were then staffed by certain field hospitals, and the patients in them were accounted for in the returns from these field hospitals. For example, Modder River Hospital was first opened in the end of December, 1899, but only rendered separate returns from the date shown when the field hospitals which had staffed it moved into Kimberley, and it was furnished with a separate staff. The hospital at Orange River was actually opened in September, 1899, by a detachment from a Cape Field Hospital, but only entered on an independent existence with a fresh staff after the advance into the Orange Free State, when all the field units were required.

CIVIL HOSPITALS.

Name of Hospital.	Station.	No. of Hospital Beds.*	Date of First Return.	Date of Last Return.	Remarks.
Edinburgh Hospital	Norval's Pont	150	18.5.00	18.1.01	
Imperial Yeomanry Hospital	Deelfontein	1,000	23.3.00	29.3.01	
"	Pretoria	530	24.8.00	13.9.01	
"	McKenzie's Farm	—	24.8.00	29.3.01	
"	Elandsfontein	138	19.7.01	20.12.01	
Irish Hospital	Bloemfontein	100	20.4.00	29.6.00	
"	Pretoria	—	15.6.00	9.11.00	
Langman Hospital	Bloemfontein	180	13.4.00	20.7.00	
"	Pretoria	—	3.8.00	26.10.00	
Portland	Rondebosch	160	—	—	No returns. Sick included in No. 3 General Hospital.
"	Bloemfontein	—	27.4.00	21.7.00	
Princess Christian Hospital	Pinetown Bridge	200	20.4.00	—	
Scottish National	Kroonstadt	300	8.6.00	12.10.00	
Welsh Hospital	Springfontein	200	8.6.00	3.8.00	
"	Pretoria	—	17.8.00	24.9.00	

TABLE B.—List of Hospitals opened after November 1st, 1901.

Unit.	Station.	No. of Hospital Beds.	Date of First Return.	Date of Last Return.	Remarks.
GENERAL HOSPITALS.					
No. 30 Stationary Hospital					
No. 31 " "					
TEMPORARY HOSPITALS.					
Temporary Hospital	Christiana	18	22.11.01	31.5.02	
"	Krantskop	18	8.11.01	3.1.02	
"	Matjesfontein	25	17.1.02	31.5.02	
"	Tiger's Kloof	40	24.1.02	31.5.02	
"	Port Nolloth	50	18.4.02	31.5.02	

* The actual accommodation varied considerably from time to time. The number of beds shown is that available on November 2nd, 1901, in the case of the hospitals that were open on that date. In the case of the hospitals that had been closed before that date, the number shows the accommodation that had previously been available in them.

PART V.

THE CIVIL HOSPITALS.

A.—INTRODUCTORY.

A full account of these hospitals is given in the report of the Central British Red Cross Committee on voluntary organisations in aid of the sick and wounded during the South African War, pp. 42 to 55, by which Committee (or in consultation with it) they were organised and despatched. It is, however, desirable to give a short account of these units, sketching their organisation and equipment, and indicating their position with regard to the regular medical service.

These hospitals were accepted by the military authorities on certain conditions. A military Medical Officer was placed in command of each for administrative purposes, and as a channel of communication with the other branches of the service. The hospitals were to be entirely at the disposal of the military authorities in South Africa. The Imperial Government provided passage for the personnel and transport for the stores and equipment to and from the seat of war. The Government also supplied the usual rations for the patients and personnel, with the ordinary medical comforts for the patients, and undertook to maintain the stocks of medical and surgical stores, which were originally provided by the bodies furnishing the hospitals. These conditions were generally adhered to; important variations will be referred to in the detailed account of each hospital.

The tabular statement at the end of this section gives all particulars regarding these units; it is only necessary to add in reference to this table that the weights given are very approximate. The weight shipped in England as a rule does not represent the amount requiring rail transport in South Africa, as the majority of these units added very largely to their equipment by purchase in Cape Town. It is convenient here to refer to the way in which the Langman Hospital was embarked with the whole of its personnel and equipment in one vessel. In consequence it was able to proceed direct to Bloemfontein on disembarkation at Cape Town.

It will be seen that, including the Imperial Yeomanry hospitals, these civil hospitals included every type of medical unit used by the Army Medical Service. The Imperial Yeomanry Hospitals Committee furnished the large hospital at Deelfontein, and later a hospital of 400 beds in Pretoria. The Portland, Langman, Welsh, Irish, and Princess Christian Hospitals represented our stationary hospitals, while the Imperial Yeomanry field hospital and bearer company and Van Alen's Hospital were comparable with our field units.

B.—TRANSPORT.

The Irish Hospital had 15 ambulance wagons of a light pattern, and two carts with some mules, and so were enabled to send a section with some ambulances to Prieska under Lord Kitchener. Again, a section joined the 11th Division at Kroonstadt and marched to Pretoria. Their own transport proved insufficient while the section was thus acting as a bearer company, and some army transport had to be added. But though the Irish Hospital was in practice not a mobile hospital, the fact of their possessing their own ambulance transport complete with draught animals, gave them the immense advantage of being absolutely independent, and able themselves to deal in every way with their own sick.

The Portland Hospital also had both ambulance and transport wagons, quite sufficient for their use in standing camp, and were, like the Irish Hospital independent of outside aid. It is impossible to over-estimate the

value of this in the practical working of a hospital; it makes all the difference when, as will invariably be the case on service, transport is both scarce and difficult to obtain, and the possession of it more than anything else tends to smoothness in the working of the hospital. This question is referred to also in the section on general hospitals.

C.—EQUIPMENT.

It is not advisable to lay down hard and fast rules for the equipment of a civil hospital. But it would be well to distinguish between medical and surgical equipment, and general equipment and stores. The Organising Committee should be allowed to purchase whatever they thought best, in the specially technical matériel, but as regards general equipment it would be far better to follow broadly the lines on which the military hospitals are furnished. This is the result of much experience, and the detailed criticism to which they have been subjected in this campaign will result in their equipment being sufficient and entirely satisfactory without being excessive. There is no doubt that in several instances the civil hospitals erred in having equipment that was quite unsuited for field service. Certainly the equipment for the staff should conform more to the usual furniture of an Officer on service. Chests or drawers are by no means necessary, and some limit should be placed on the amount of personal baggage.

The importance of this reduction of the total weight and bulk cannot be too prominently brought forward. Transport, both by road and rail, must always be a difficulty on service, and if a civil hospital of 100 beds weighs as much as a military hospital of 500, the result to the medical service when the civil hospital goes forward is a loss of 400 beds, which is usually an important item.

D.—POSITION.

This, of course, leads to the difficult question of the position of the civil hospitals in the field. The lighter hospitals, such as the Portland, Langman, or Welsh (each of 100 beds) are suitable for any position on the line of communications, and can be pushed up in rear of the advancing army. But it does not seem advisable to place a civil hospital alone in a station; they have more difficulty in expanding to meet urgent demands than a military hospital, and, as a matter of practice, in the only instance in which a civil hospital was destined for the sole charge of a small station, it was necessary to open a small military hospital in addition, to deal with the local sick.

The field units fall naturally into their places with the troops. The larger civil hospitals are more difficult to deal with; they cannot, even if the staff were willing, be kept at the base, where, after the earlier stages, the work of the hospitals becomes less purely professional, and more and more technical, as invaliding increases, with all the more military complications, the preparation of documents, questions of pay, clothing and equipment, and the highly technical embarkation duties, which require a trained staff.

Similarly, it is only exceptionally that these hospitals can be employed alone on the line of communications, and there is little doubt that the most suitable position is in some station where a military hospital is already established. This ensures permanent accommodation for a large number of cases, while the military hospital will always expand to meet any sudden call.

E.—PERSONNEL.

Organisation.—There is no doubt that a Commanding Officer from the Army Medical Service is necessary in every case, also a few trained clerks are required to prepare the various requisitions and returns. In the case of the smaller hospitals, if these are attached to a general hospital for the purpose of administration, no doubt the Officer could then be dispensed with, but at the outset these Officers are indispensable. They should, however, be carefully selected for this duty; the qualifications are an intimate knowledge of the routine of the service, and especially of the sources and methods of obtaining equipment, transport, and supplies. No civil staff, however highly trained,

can have the requisite knowledge to enable them to get all their daily needs met, especially as the methods laid down by regulation are considerably modified on emergency. Further, the Officer selected should be tactful, so as not to press the authority, which he should undoubtedly hold, into matters which are not essential to the satisfactory working of the hospital.

It is, however, essential that the duties both of the Commanding Officer and of the staff should be well defined. There is little doubt that the staff of several of the civil hospitals failed to recognise that there are many duties in connection with a military hospital which lie entirely outside the ordinary professional work of a physician or surgeon, and that they should take their share of them. These duties are mainly of the nature of inspection and supervision of the cooking arrangements and diets, of the sanitary arrangements and the general cleanliness of the hospital camp, and others of a similar nature. Further, they should understand that in a campaign the number of cases of disease almost invariably exceeds those of injury, and that the work of any hospital will, therefore, be more medical than surgical; also that a proportion of the sick population will always be cases that are of no interest whatever from a professional point of view. Yet all these men must be looked after, and though it will always be recognised that the civil hospitals as volunteers, have a special claim to consideration in the class of cases sent to them, if this be possible, the staffs must be prepared to take their share of the less interesting cases. A further difficulty is the conflict of professional enthusiasm with the needs of the service. It may be assumed that civil hospitals will only be offered to the Government to supplement the regular service, that is, that they will take the field at a time when extra accommodation is much needed. The first and most important duty of a hospital in the field is to pass on its patients as fast as possible; if the man recovers, to send him back to his unit as soon as he is fit for duty, if he is unlikely to become fit within a reasonable time (which in the case of a hospital away from the base can be but short) he must be sent down towards the base for disposal as soon as he can safely be moved. Any delay beyond these periods for the sake of further observation of the case means a loss of accommodation where it is most needed.

This last, the general supervision of the work of the hospital, is the most delicate duty of the Commanding Officer, touching as it does on the professional treatment of the sick, which normally lies outside his province. Yet, none the less, it is a duty which he must carry out, though in nearly every case it can be done by suggestion rather than by direct interference.

F.—EXPANSION.

There is one other point of a general nature which should be considered, and that is the expansion of a civil hospital.

The expansion of any hospital beyond its normal size is of course to be deprecated, but it is not always possible to avoid this. A military hospital, as a matter of course, expands to meet such demands as are made on it, but (no doubt very naturally) there was at first a disinclination on the part of the civil hospitals to exceed their normal complement of beds. Still, when the patients are fed by Government, and the additional tentage, equipment, and personnel are also supplied from Imperial sources, it does not seem too much to ask that the civil hospitals also should be prepared to expand to a reasonable degree should the necessity arise. The condition of their acceptance, that they should be "entirely at the disposal of the military authorities," should be interpreted literally by those responsible for these hospitals.

These difficulties would almost entirely disappear were the staffs of the hospitals to understand the position clearly at the outset. It is quite possible to combine every consideration for these gentlemen, who sacrifice much for the benefit of the army, with the real requirements of the service which are, as a whole, better understood by the professional than by the volunteer.

G.—PACKING.

There are one or two points which it is desirable to note. First, as to the packing and marking of stores. All packages should be distinctly marked, and should contain a list of their contents, so that it should not be necessary to unpack the whole to find any articles required. Want of this system in at least one case delayed the work of the hospital when its services were required.

H.—“DRESSERS.”

Secondly, several of the hospitals had “Dressers” on their staff. There is no place in a service hospital for dressers; they are not equivalent either to nurses or orderlies, and are in no way necessary for the working of the hospital, which is equivalent to saying that they are superfluous. They require accommodation, rations, and transport, none of which are usually in excess. It is far better to replace them by the same number of orderlies.

J.—MESSING ARRANGEMENTS.

Lastly, in most of the civil hospitals the convalescent officers messed with the staff. Of course where the staff is maintained entirely at the expense of the donor of the hospital, who also supplies luxuries for the patients, this arrangement is convenient, and in the smaller units any change would probably cause an unnecessary complication in the arrangements. But it would appear better to avoid this in future in the larger hospitals. The combined system does not conduce to the satisfactory working of the hospital from the service point of view, however much it may appeal to certain types of convalescent Officers. It would be more satisfactory to have one system, whereby the staff would draw the usual ration from Government, and supplement it at their own expense, as is done in the regular service. This would reduce the stores to be carried for the hospital, and the staff would be no worse off than that of the service hospital.

K.—COMPARISON WITH SERVICE HOSPITALS.

As regards the comparison between the equipment of the civil hospitals and the service hospitals, only the Portland and the Langman are at all comparable when weight and bulk are considered. These two may fairly be put alongside the stationary hospitals for 100 beds. Weighing about 10 tons more, they had beds for 100 cases, instead of stretchers, and their equipment was, generally speaking, more convenient. The tortoise tents were certainly very taking at first sight, but experience of them failed to confirm this satisfactory impression. Their advantages are light weight and increased floor space as compared with the hospital marquee, but they did not stand weather so well, and their ventilation was less satisfactory, while they showed signs of wear and tear at a much earlier date than the service tents.

The civil hospitals drew their ordinary supplies from the Army Service Corps, Ordnance Department, and the medical store depôts; further, they received, like the other hospitals, supplies from the Red Cross Society and other sources. They also received much assistance from the Royal Engineers in the erection of their hospitals. But in addition to this they had money in hand, which added greatly to their facilities for satisfactory equipment.

L.—REMARKS.

This is the first occasion in which civil voluntary hospitals have assisted the Medical Service of our army in the field. It has been necessary to call attention to certain points which led to some difficulty and misunderstanding during the late campaign, but this has been done with a view to remove any possible source of friction on a future occasion. No one who served in the late war in South Africa fails to appreciate the services

rendered by these units, services which were not only of the greatest value to the army generally, but also enabled the Medical Service, of which they formed a part, to complete the heaviest task that has ever fallen to its lot. Civil Hospitals, such as those which helped us in South Africa, will always be welcomed by the Royal Army Medical Corps on any future occasion on which the patriotism of the people sends them forth.

M.—PARTICULARS OF HOSPITALS.

(1) *Imperial Yeomanry Hospitals.*

The Imperial Yeomanry Hospitals Committee was formed with the intention of providing special hospital accommodation for the yeomanry in the field. While, as far as practicable, these hospitals so provided were kept filled with yeomen, it was, of course, not possible to reserve them solely for one particular branch of the army. They were equipped and maintained on a scale which it would be impossible, as it is unnecessary for our service hospitals to imitate. The Imperial Yeomanry Hospitals Committee had ample funds at their disposal, and were therefore able to provide not only the equipment absolutely necessary, but all the minor conveniences on a most ample scale.

(a) Base Hospital, Deelfontein.

Deelfontein, 29 miles south of De Aar on the Cape Government Railway, was selected as the site for this large hospital. It is 4,460 feet above the sea, on the northern Karoo, 471 miles from Cape Town, 176 miles from Kimberley, 378 miles from Bloemfontein via De Aar and Norval's Pont, 367 miles from Port Elizabeth, and 429 miles from East London. It was therefore, as distances go in South Africa, within easy reach of Kimberley and the forces on the western line; it was a day's journey from Bloemfontein, while it was in touch with the troops operating on the other lines to the coast ports. Hence, until our entry into the Transvaal, it formed an excellent central station to which yeomen could be sent from all parts of the field.

Owing to delays in the arrival of the stores, and difficulties in the erection of the huts, it was some time before this hospital opened to its normal accommodation (500 beds), but after this it extended rapidly to accommodate over 1,000 patients, and became a most complete self-contained unit, fulfilling every necessity and providing many luxuries.

Much of its success was due to the energy and initiative of Lieut.-Colonel A. T. Sloggett, C.M.G., R.A.M.C., the Military Commanding Officer of the hospital.

This unit was taken over by the Imperial Government from April 1st, 1901, when it became No. 21 General Hospital, under Lieut.-Colonel Sloggett, a fresh staff being detailed from the regular services.

(b) Imperial Yeomanry Hospital, Pretoria.

In May, 1900, it was represented to the hospital Yeomanry authorities in South Africa, that the hospital at Deelfontein was becoming out of touch with the troops in the field, and that it would be necessary to move 250 beds with a suitable staff nearer to the front. It was also pointed out that Kroonstadt would be a suitable site.

In response to this request Mr. (now Sir Alfred) Fripp, Senior Surgeon to Imperial Yeomanry Hospital at Deelfontein, proceeded to Kroonstadt in the end of May, and he then and there decided against this scheme on the grounds that it would impair the importance of the Deelfontein Hospital. As it was found possible to equip the estimated number of beds considered necessary for the place without the aid of the Yeomanry, it was decided to let the matter drop. Later in the year, in reply to an enquiry from England, a lightly equipped hospital of 400 beds was asked for service in the Transvaal. The necessary personnel were at once sent out from England. Equipment was obtained principally from the usual service channels in South Africa. Surgeon-Major Kilkelly was detailed for administrative charge, and afterwards it was found necessary to also add a quartermaster to the staff.

The site fixed was a private house with extensive grounds, outside Pretoria. The accommodation was partly in the house, and the remainder in tents.

This hospital was taken over by us as No. 22 General Hospital in October, 1901, and an entirely new staff detailed for it.

(c) Imperial Yeomanry Hospital, Elandsfontein.

This was a small tented hospital organised and equipped in South Africa, and staffed by detachments from the larger hospitals on the breaking up of the Pretoria Hospital.

(d) Imperial Yeomanry Field Hospital and Bearer Company.

This was a well equipped unit which did much good service in the field. It would, however, have been more useful if, like the New South Wales Ambulance, it had been provided with its own transport.

(e) Imperial Yeomanry Hospital at Mackenzie's Farm.

In April, 1900, the attention of the Imperial Yeomanry hospital authorities in South Africa was drawn to the Yeomanry camp at Maitland with a view to establish a small Yeomanry hospital there by detaching a small personnel from Deelfontein. Mr. Fripp, senior surgeon to Deelfontein Hospital, inquired into the matter, and he decided not to agree to any weakening of the Deelfontein Hospital. It was then decided to establish a small detention hospital, and to continue to send all Yeomanry sick to some of the general hospitals in and around Cape Town.

Later on it was found necessary to revert to the original proposal, and to establish a suitable hospital for the numerous yeomen quartered there. Part of the equipment was supplied from Deelfontein, part purchased locally, and the personnel was detailed from the Yeomanry hospitals.

This hospital was closed in the end of March, 1901, and was bought by the Colonial authorities for use as a plague hospital.

(f) Chesham Home.

The Chesham Home was a small convalescent home for Officers opened in Johannesburg for a short time, and staffed from the larger Yeomanry hospitals.

(2) *The Portland Hospital.*

This was a very compact and practical unit of 100 beds. It had no unnecessary equipment. The tents were tortoise, and were, on the whole, fairly satisfactory; the beds had wire mattresses on light wooden frames. The ambulances and other transport belonging to the hospital were very useful.

This hospital rendered valuable service both at Rondebosch (where it was attached to No. 3 General Hospital), and at Bloemfontein (where it was attached to No. 8 General Hospital), and the staff worked most harmoniously with the regular service. It was the model of what a small civil hospital should be.

(3) *The Langman Hospital.*

This hospital opened in the cricket ground in Bloemfontein and was afterwards moved to Pretoria, where it was attached to No. 2 General Hospital. The original accommodation of 100 beds was then increased by the addition of tents and equipment.

Like the Portland Hospital it was equipped with tortoise tents and wooden framed beds. The whole of the personnel and equipment were shipped in one vessel, so that the unit was enabled to rail through from Cape Town to Bloemfontein complete as a whole, thus avoiding any delay.

The hospital did good work. The donor was always ready to comply with any suggestions, and very generously gave the whole equipment to the Imperial Government when the hospital closed as a civil hospital on November 4th, 1900.

(4) *Van Allen's Hospital.*

This was a small field unit, originally equipped for 25 patients, with three tortoise wagons. It went into the field with Lord Methuen's Division, when it did useful work, and finally was made over to the Imperial Government on July 6th, 1900.

(5) *The Irish Hospital.*

This hospital was the gift of Lord Iveagh, whose wish it was that the hospital should be as far as possible a mobile one. To this end it was furnished with 15 ambulances and two carts, with harness and 80 mules.

The ambulance wagons were of a light pattern, and did not prove satisfactory. There was no provision for general transport of the stores and equipment beyond the two carts, so that, except for the undoubted advantage of the possession of their own ambulance wagons and mules for them, this unit was little less dependent on army transport for draught animals and general service wagons than the ordinary stationary hospital. In practice, therefore, the hospital did not prove itself to be a mobile unit, but it was enabled to despatch six ambulance wagons, with a proportion of the staff under Dr. Stoker, to accompany Lord Kitchener to Prieska, while the unit itself was waiting at Naauwpoort to get into Bloemfontein; and, again, a similar but larger detail, under Sir William Thompson, accompanied Lord Roberts to Pretoria as a bearer company, while the remainder of the hospital remained in Bloemfontein.

The original equipment for 100 beds, and excluding the wagons, was comparatively light, measuring 3,400 cubic feet (say 50 tons). The wagons added 6,400 cubic feet (say 90 tons). The tents were of the tortoise pattern. The equipment was satisfactory.

This unit was employed first at Bloemfontein, and then in Pretoria, where it occupied the Palace of Justice with about 500 beds, additional military personnel having been added to the original staff to enable it to undertake this. When the hospital closed, the mules and wagons, harness, and tents were sold to Government; the rest of the equipment was presented to Government by the donor, Lord Iveagh.

(6) *The Princess Christian Hospital.*

This hospital was organised by Mr. Alfred Moseley originally for 100 beds, but afterwards very generously extended to 200 beds when it was found that the necessities of Natal required this extension. The conditions on which Mr. Moseley's kind offer were accepted differed only from the others in that the subordinate personnel (Warrant and N.C. Officers and men) were supplied, rationed, and paid by Government, while Mr. Moseley maintained the remainder of the personnel, and paid for the diets of the patients in hospital. When the hospital was enlarged, the staff was increased by two Medical Officers and nine Sisters, and the subordinate personnel was doubled. Forty natives were also employed.

The accommodation was in very good huts, and the hospital was established at Pinetown, near Durban. Mr. Moseley was himself of opinion that the huts proved unnecessarily heavy, and that a good deal of the equipment, such as sideboards, was unnecessary. The hospital was supplied with a complete apparatus for baking.

This unit was most complete and rendered valuable service. On closing as a civil hospital, the buildings and equipment were presented to Government, a new staff was detailed, and the hospital continued its work as No. 13 Stationary Hospital.

(7) *The Welsh Hospital.*

This hospital was originally organised for 100 beds, but afterwards was increased to 200, in Pretoria, by the addition of tents and equipment. It was not fully equipped in England, and the rest of the equipment was bought in South Africa.

Pending its establishment at Springfontein, where it was attached to

No. 12 General Hospital, the staff were employed in Cape Town and Bloemfontein. It was afterwards moved to Pretoria, where it was attached to No. 2 General Hospital till it closed as a civil hospital in November, 1900. The whole of the tents and equipment were kindly handed over to Government, and the hospital merged into No. 2 General Hospital.

There was a regrettable mortality among the staff. Professor Thomas Jones and Dr. Herbert Davies, and a dresser, died in South Africa; Professor Alfred Hughes died of enteric fever after his return home; Sister F. L. Sage died at Springfontein, and Sister M. A. Lloyd (who remained with No. 2 General Hospital after the Welsh Hospital closed) at Pretoria. The work of the hospital was highly appreciated, and its staff did valuable service.

(8) *The Edinburgh Hospital.*

This was organised for 100 beds, in huts. The material for the huts was brought from England, but the actual construction (as distinct from simple erection) was carried out in South Africa, at Norval's Pont, where the hospital was to be established. The result was considerable delay before the hospital was fit for occupation. The personnel arrived at Norval's Pont on April 21st, the first trucks on April 24th, but it was not till May 16th (with much help from the Royal Engineers) that the first ward was completed and equipped. When completed this hospital was very well equipped. The huts were good, but not better than those erected from ready-made sections which are easily put together. These huts were wrecked by a storm after the hospital had been taken over by us. The whole equipment was unduly heavy and bulky. The amount sent by rail to Norval's Pont was at least 400 tons (possibly more), occupying some 28 or 30 trucks, or as much as is required for the equipment of a general hospital of 520 beds.

The hospital closed on October 14th, and the huts and equipment were then presented to Government, when a fresh staff was detailed to continue the work of the hospital.

(9) *The Scottish National Red Cross Hospital.*

This hospital was organised in three sections of 100, 200, and 220 beds respectively, which arrived as shown in the attached table. The first section proceeded direct to Kroonstadt, arriving there on May 25th and 27th, and opening on June 4th, 1900, in their tortoise tents. When the second section arrived the accommodation was increased to about 300 beds, partly in tents and partly in Doecker huts. The accommodation was never increased beyond this. The Doecker huts were easily erected and comfortable, but not altogether suited for the exposed site at Kroonstadt, where one was wrecked by a gale. A large iron hut to complete the accommodation was not erected before the hospital closed.

The equipment was very complete. There is considerable difficulty in arriving at the net weight. The first section required nine bogies and one short truck, the second section 17 bogies, and the third section 11, or 37½ bogies in all. The load of 11 bogies of the second section (of which section only the way bills are available) averaged 19,595 lbs., of the remaining six the load averaged 26,112 lbs. The maximum load of the bogie is 45,000 lbs., so that these loads consisted of comparatively light but bulky articles. Much of the equipment was unsuited for camp life.

This unit did a large amount of good work before it closed as a civil hospital on October 14th, 1900, when the whole equipment was handed over to Government, and the work of the hospital continued as a section of No. 3 General Hospital.

(10) Tabular Statement.

	Medical Officers.	Other Officers.	Nursing Sisters.	Dressers.	N.C. Officers and Men.	Original Number of Beds.	Approximate Weight (tons).	Greatest Number of Beds.	Date of arrival in South Africa.	Date of Opening.	Date of Closing.	Date of re-opening.	Date of Final Closing.	Nature of Accommodation.	Number of Servants.	Number of Ambulance Wagons.	Number of Transport Wagons.	Number of Horses.	Number of Mules.	Laundry.
Imperial Yeomanry Hospitals—																				
Delffontein	20	2	40	10	110	500	No weight	1,000	4.3.00	18.3.00	—	—	31.3.01	—	10	—	—	—	—	—
Pretoria	11	3	40	—	81	400	can be given	530	—	18.8.00	—	—	30.9.01	—	8	—	—	—	—	—
Klankfontein	4	2	11	—	78	50	—	138	6.4.00	23.6.01	—	—	19.12.01	—	—	—	—	—	—	—
Field Hospital and Bearer Company	9	2	—	—	146	100	—	—	—	—	—	—	8.3.01	—	—	—	—	—	—	—
Chesham Home	1	—	—	—	—	8	—	—	—	—	—	—	10.10.01	—	—	—	—	—	—	—
Mackenzie's Farm	3	—	—	—	25	100	—	—	—	1.3.01	—	—	30.3.01	—	—	—	—	—	—	—
Portland Hospital	5	—	6	—	28	104	45	100	29.12.99	15.8.00	—	—	12.7.00	Tents	6	—	—	—	—	—
Langman Hospital	5	—	—	5	34	100	45	180	28.3.00	8.4.00	25.7.00	19.4.00	4.11.00	"	7	—	—	—	—	—
Van Allen's Hospital	2	—	—	—	17 [†]	25	—	—	6.3.00	13.3.00	—	—	6.7.00	"	—	—	—	—	—	—
Irish Hospital	5	3	4	1	30	100	—	—	26.2.00	—	See Detail	—	15.10.00	Huts	6	—	—	—	—	—
Princess Christian Hospital	5 [‡]	3	6 [‡]	2	30 [‡]	100	—	—	30.3.00	16.4.00	—	—	20.7.00	Huts	1	—	—	—	—	—
Welsh Hospital	6	1	10	—	48	100	60	200	3.5.00	7.6.00	See Detail	—	15.11.00	Tents	2	—	—	—	—	—
Edinburgh Hospital	7	—	7	7	35	100	400	150	10.4.00	10.5.00	—	—	14.10.00	Huts	2	—	—	—	—	—
Scottish National Red Cross—																				
1st Section	7	2	7	19	25	100	—	100	13.5.00	4.6.00	—	—	14.10.00	Tents (20) and huts (10)	—	—	—	—	—	—
2nd Section (equip. 5.9-11/6)	7	1	28	—	33	200	165	200	10.6.00	—	—	—	—	—	—	—	—	—	—	—
3rd Section	4	—	16	—	1	220	?	—	8.8.00	—	—	—	—	—	—	—	—	—	—	—

* Establishment authorised when in Bloemfontein.

† Measurement, 9,800 cubic feet.

‡ Tortoise wagons, includes 7 drivers.

§ Amount shipped.

† See detail.

PART VI.

COLONIAL MEDICAL CONTINGENTS.

The following Colonial Medical Contingents assisted the Medical Service during the war:—

The New South Wales Army Medical Corps.
The Australian Field Hospital and Bearer Company.
The Canadian Field Hospital.

In addition to these organised medical units, all the regiments of over-sea Colonials arrived with their own Medical Officers; there were also a few supernumerary. Nursing Sisters were also despatched from the various Colonies.

1.—NEW SOUTH WALES ARMY MEDICAL CORPS.

The New South Wales Army Medical Corps sent three contingents.

The first arrived in the beginning of December, 1899, and was sent up to Orange River. It afterwards accompanied the Mounted Infantry Division through the Orange Free State to Pretoria. During the halt at Bloemfontein it staffed the Artillery Barracks Hospital.

Colonel W. D. C. Williams arrived with this contingent as Principal Medical Officer, and was in January, 1900, appointed Principal Medical Officer of all the Australian and New Zealand Contingents in South Africa. Later, when the Mounted Infantry Division under Major-General Ian Hamilton was formed, Colonel Williams was appointed Principal Medical Officer of that division.

Immediately on their arrival in South Africa their organisation was seen to be so eminently practical that a request for a second contingent was at once submitted. This was complied with, and this second contingent, under Lieut.-Colonel R. Vandeleur Kelly, arrived in February, 1900. Its personnel were sent to Sterkstroom where they took over the stationary hospital. They were afterwards employed in the field. A third contingent arrived in April, 1901.

There was some overlapping of the services of these three contingents; some Officers and men remained with the army after their term of original engagement had expired, and so a proportion of this corps was serving in the field throughout the whole campaign.

The first contingent was composed as follows:—

Officers	7
Warrant and N.C. Officers and men .. .	85

and they were divided as follows:—

Administration—

Principal Medical Officer .. .	Colonel W. D. C. Williams.
Clerks .. .	1 N.C. Officer and 2 men.

Half Bearer Company (Captain R. E. Roth)—

(1) *Stretcher Section—*

Captain Roth, R.E.	} 18
3 N.C. Officers .. .	
14 men .. .	

(2) *Collecting Station—*

1 N.C. Officer (mounted) .. .	} 2
1 trumpeter (mounted) .. .	

(3) *Ambulance Wagons (5)*—

1 sergeant (mounted)	} 16
2 wagon corporals	...	...	...	...
3 wagon orderlies	...	...	...	...
10 drivers	...	...	...	...

(4) *Dressing Station*—

Captain Perkins, A.E.	} 14
1 Lieutenant	...	...	...	...
1 Warrant Officer	
11 N.C. Officers and men	

(5) *In Rear of Dressing Station*—

N.C. Officers and men	8
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Half Field Hospital—

Major T. H. Fiaschi	} 30
Captain T. A. Green	
Lieutenant T. M. Martin	
19 N.C. Officers and men	...	...	...	...
Transport section—8 N.C. Officers (mounted) and men	...	...	...	...

An "advanced dépôt of medical stores" consisting of 11 cases of reserve medical and surgical material.

This first contingent formed an exceedingly good mobile unit of the combined type. This unit did exceedingly good service while it remained in South Africa.

The second contingent consisted of 9 Officers and 86 N.C. Officers and men under Lieut.-Colonel R. Vandeleur Kelly, with a "mounted bearer section" consisting of 2 Officers and 23 N.C. Officers and men under command of Captain J. Marshall.

The third contingent consisted of 4 Officers and 31 N.C. Officers and men.

The second contingent arrived with complete equipment and transport. The third was of the nature of a draft.

The equipment of this unit was exceedingly good and practical. The ambulance wagons were very good, and the whole unit was very mobile. It had the inestimable advantage of possessing its own draught animals, and was thus quite independent and self-contained. Its success is an example of what may be done by a field unit which is not dependent on local conditions for its mobility.

2.—THE AUSTRALIAN FIELD HOSPITAL AND BEARER COMPANY.

Commonwealth Contingent.

This consisted of a field hospital of 100 beds under command of Major T. A. Green, and a half bearer company under command of Major R. M. Howse, V.C. Both these Officers belonged to the Australian Army Medical Corps, and had served in South Africa with the first and second contingents of the New South Wales Army Medical Corps.

The detail of organisation and personnel of these units is given in Appendix XXV.

These units arrived in Natal in March, 1902, and were retained with the Australian troops with which they arrived.

Their ordnance equipment differed in no material point from the British pattern, except that the hospital had six tortoise tents for patients. They had their own transport animals. Medical and surgical equipment was supplied to them from our stores. This unit did very good work during the short time that it was employed.

3.—THE 10TH CANADIAN FIELD HOSPITAL.

This unit arrived at Cape Town on February 21st, 1902, under the command of Lieut.-Colonel A. N. Worthington, of the Canadian Army Medical Staff, and proceeded at once to Durban, where it disembarked.

The establishment of the unit consisted of five Officers, and 56 Warrant and N.C. Officers and men, with 29 horses (*see Appendix IV*).

The equipment of the unit was of the pattern in use in the United States army. The whole was very complete and efficient, and special reference is made to it in the section of this report dealing with field medical units.

Eight nursing Sisters accompanied the hospital, several of whom had previously served during the campaign. These ladies were sent to No. 19 Stationary Hospital at Harrismith, as the hospital was sent to the Transvaal to be employed there during the operations to the west of Klerksdorp. Here the unit was split up, the hospital section established itself as a stationary hospital at Vaal Bank, while the bearer section went with a column into the field. Both sections did excellent work.

General Remarks.

These colonial medical units were more mobile than the regulation field hospital or bearer company. This was partly due to the differences in the equipment and in the wagons (both ambulance and general transport), which are mentioned in the section on field medical units. But their greatest advantage was in the possession of their own draught animals.

PART VII.

PERSONNEL

A.—DEFICIENCY OF SUBORDINATE PERSONNEL.

The deficiency of personnel has already been referred to in the general account preceding this. Lieut.-Colonel W. G. A. Bedford, C.M.G., R.A.M.C., who was Secretary to the Principal Medical Officer of the Army in South Africa for the first year of the war, gives the following *résumé* of the situation:—

“When the army corps began to arrive in Table Bay, the state of affairs was very critical. The enemy were pressing down into Natal, and were also threatening many of the northern parts of Cape Colony. There was an urgent demand for troops in all directions, and as they arrived they were in several instances despatched to the points where their services were most in demand, irrespective of the divisions to which they belonged.

“Thus the original formation of the army corps was not adhered to, and the field medical units shared the same fate, becoming detached from their own brigades and divisions, and detailed to other bodies of troops. Under the urgent circumstances that obtained in the theatre of war at that time, this was unavoidable.

“The 2nd and 5th Divisions proceeded to Natal, where the 4th Division had been formed, and these divisions had their medical units complete, while the 1st, 3rd, 6th, 7th, 8th, 9th, and 11th Divisions and 21st Brigade operated on the western side.

“Early in 1900 the 10th Division was transferred from Natal to the western side, but did not bring its medical units with it. They followed later.

“The medical units of the divisions in Natal, having been mobilised at the first, had their ranks completed with the trained colour service men and reservists of the Royal Army Medical Corps. The divisions on the western side not only were deficient in each case of their divisional field hospital (owing to these units having been taken for the brigades of the locally-formed 9th and 11th Divisions), but several of them having been mobilised later in the war, when the numbers of the corps in England had become exhausted, the ranks of their medical units were filled with untrained recruits, volunteers, and men of the St. John Ambulance Brigade. This all helped to accentuate the difficulties with which their Commanding Officers had to deal.”

All the hospitals in South Africa suffered considerably from this deficiency in N.C. Officers and men of the Royal Army Medical Corps. Nearly all of those arrived in South Africa in the early stage of the war, and were distributed almost equally between Natal and the remainder of South Africa. Even in Natal, with its comparatively small force and lesser hospital accommodation, this deficiency was acutely felt, but the greatest stress was on the Cape side, where the force was larger, and the hospitals more numerous.

In the end of December, 1899, it was necessary to withdraw 10 men from each of the bearer companies to work in the hospitals, replacing them by men of the Cape Medical Staff Corps. Later, regimental N.C. Officers and men were added to the hospital staffs, but these were to all intents useless for the technical duties of the staff, and required instruction and constant supervision.

If the deficiency had been confined to the orderlies alone, it would not have been so serious; but it was as distinct among the non-commissioned ranks, in spite of the fact that promotion had been accelerated by the relaxation of the normal rules governing it. At a later stage (October, 1901)

an attempt was made in South Africa to meet this difficulty by the grant of local rank, with pay, as sergeant and lance-corporal to selected corporals and privates of the Royal Army Medical Corps, and this helped to some extent, but, on the other hand, reduced the number of trustworthy orderlies for ward work.

The majority of the Royal Army Medical Corps who arrived after the 6th Division were untrained, or at the most partially trained recruits. Many were immature lads, ill fitted to go through the hardships of a campaign, and had not the requisite strength for the performance of their arduous duties. It must be borne in mind that the carriage of men on stretchers, and the shifting of the sick in bed, requires strength and endurance if these duties are to be carried out with the least possible discomfort to the patient. To remedy this it is necessary to raise the physical standard for the Royal Army Medical Corps recruit.

B.—AUGMENTATION FROM ENGLAND.

As regards the provision of additional personnel from England the following steps were taken :—

1. Authority was obtained in September, 1899, to open recruiting for the corps in all districts. By July, 1900, this had produced about 750 men.
2. Sections A, B, and C of the Reserves mobilised on October 9th, 1899. They amounted to 760 men, and joined the units for which they were detailed.
3. At the same time, authority was asked for to accept volunteers from Section D. This gave about 50 men, and subsequently, when the whole section was called up, about 180 more joined the colours.
4. On September 26th authority was asked to accept individual volunteers from the Militia Medical Staff Corps. This was granted, the whole corps was embodied at home on November 13th, and the total volunteers for service in South Africa amounted to about 160-180.
5. A scheme for accepting men from the St. John Ambulance Brigade was approved in October, and in November the first detachment sailed. Others followed rapidly and the total number received from this source amounted to 1,900.
6. In December authority was received to enlist men specially as compounders of medicine. This gave about 170 men of this special class.
7. In February, 1900, authority was granted to enlist men of the Volunteer Medical Staff Corps and Volunteer Brigade Bearer Companies. This gave rather more than 600 men.
8. In March, 1901, Army Order 86 was obtained which authorised the enlistment of trained men for the Royal Army Medical Corps from any source. The total number enlisted was just over 1,000, and included 400 men of the St. John Ambulance Brigade, men from Volunteer Medical Staff Corps and Volunteer Brigade Bearer Companies, also compounders of medicine. In fact it was one order taking the place of the many other means of obtaining men which are detailed above.
9. Recruiting for the Royal Army Medical Corps was, of course, going on all the time, and the total number of men of all classes despatched from England during the war slightly exceeded 8,000.

C.—AUGMENTATION IN SOUTH AFRICA.

In South Africa all that was possible was done to meet the difficulty.

On the Cape side this was done by an increase of the Cape Medical Staff Corps, a normal portion of the colonial forces. Steps for its augmentation were taken at once, and these first additions were recruited under the Colonial Forces Act. At later stages recruits were obtained under the general rules governing the South African Irregular Forces, which were then being raised in large numbers. The fact that certain advantages, which were in the last part of the war extended to the recruits of the newly raised corps, did not apply to the Cape Medical Staff Corps, affected the recruiting so materially that for some months before the end of the war it was difficult and almost impossible to get any recruits for it.

Naturally for want of hospital training, the N.C. Officers and men of this corps were better suited for work in the field than for duty in hospital, and indeed the South African experience of many of these men made their services in the field very valuable. The N.C. Officers and men of the earlier companies formed the greater part of the personnel of several of the field medical units, and did very good service with them during a great part of the campaign. Those recruited later were used to replace casualties in existing units.

One special section of about 20 men deserves special mention. This was offered for service without pay by the Jewish community of Cape Town, and these men did very good work for a long period with the army in the field.

The advantage of having some permanent organisation to work on led to practically the whole of the local assistance on the Cape side being employed in this way, as a part of the Cape Medical Staff Corps. But in the smaller towns up country it was usually possible to obtain some little help locally for general duties about the hospitals. These men were engaged at a daily rate of pay.

In Natal also N.C. Officers and men were taken from the bearer companies for duty in the hospitals and their places in the field taken by an equivalent number (25) from the general depôt. In December two local corps were raised by the Principal Medical Officer, Sir T. J. Gallwey, K.C.M.G., C.B., one the Natal Volunteer Ambulance, from the European refugees, and the other, the Indian Ambulance Corps, from Indians, obtained through the Public Works Department. Both these corps did very good work. These corps were disbanded in February and March, 1900, when also the regimental N.C. Officers and men were returned to their corps from the bearer companies, and in their place the Imperial Bearer Corps was raised from Europeans, which sent 100 men to each bearer company. At the same time the Imperial Hospital Corps was raised for duty in the hospitals on the lines of communication.

The Imperial Bearer Corps and Imperial Hospital Corps continued to be employed after the immediate necessities in Natal, for which they had been raised, had ceased. But it was found that, as the hospital duties increased while those in the field required smaller units, the men of the Imperial Bearer Corps would not work in the hospitals on the ground that they had been raised for field work only. The corps was therefore disbanded, but the Imperial Hospital Corps continued to be employed; the men were of the same type as the later recruits of the Cape Medical Staff Corps, and as in that corps recruiting fell off in the last stage of the war. Both these corps, however, were exceedingly useful in their own line.

One feature was common to all the corps or bodies of men formed to assist the Medical Service, and that was the limited term of their engagement. This was of course not limited to these corps, but was a general condition affecting all the irregular troops. It is not only in the Medical Service that the disadvantages of such a system have been felt, that just at the time a man is becoming really competent for his work, his term of engagement comes to an end, and the training of his successor has to be begun. That appears to be an important point in considering the possibilities of expansion for active service.

D.—GARRISON DUTY MEN.

The supply of men enlisted into the various medical corps did not, however, make up the personnel to the necessary strength, and additional assistance was obtained by the employment of regimental N.C. Officers and men from among those unfit for duty in the field or in garrison. Most of these suffered from defective teeth, and where, as in the hospitals, suitable food could be provided, they were quite able to do their work. Men with other minor disabilities, such as hernia and varix, were also employed. These men were not convalescents, but those who if not employed in this way would have been invalided home as useless. As the campaign went on, the employment of these men became more important, but at the same time difficulties arose with their Commanding Officers, who were anxious to get every man back to the ranks for block-house work and other duties on the lines of communication.

Further, there was a difficulty about filling the places in the regiment of N.C. Officers so employed in hospitals. This led to the issue of the following Army Order, dated December 4th, 1901, which cleared up all difficulties:—

“N.C. Officers who have been invalided by a Medical Board but are retained in South Africa for employment in army hospitals, will be considered as supernumeraries to their units, and their places may be filled by promotions on the lines indicated in Army Orders No. 3 of April 12th, 1900, and No. 1 of April 25th, 1900.

“They should be attached to the Royal Army Medical Corps for pay, &c., and when their services are no longer required by the army medical authorities the recommendation of the Medical Board should be carried out, and the N.C. Officers disposed of in accordance therewith.

“Men unfit for duty in the field and for ordinary garrison duty may be detained for duty as hospital orderlies. These men will be examined monthly by a Medical Board, and the Officer in charge of the hospital concerned will invariably notify the Officer Commanding the soldier's unit the result of the Board.”

At this time also an “establishment” for each hospital was fixed to meet its probable requirements, instead of leaving the number of regimental N.C. Officers and men to be employed to the discretion of the local authorities. This prevented an excess of personnel being maintained, and also ensured that it was not deficient in numbers.

E.—COMPARISON.

The N.C. Officers and men so obtained were of course completely untrained in all the technical duties required of them. But the difference between them and those of the medical corps (except the regular Royal Army Medical Corps) was not great in this respect, as the latter had been trained only in first aid and stretcher drill; on the other hand, the regimental N.C. Officers and men were accustomed to discipline and could be depended on to carry out many of the less technical duties without supervision. A few of the men also made very good ward orderlies after some little instruction, but their employment in this duty was exceptional. Some of the N.C. Officers made very good assistant ward masters.

As regards the relative value of the Militia and Volunteer Royal Army Medical Corps, the St. John Ambulance Brigade, and the other corps, there was, on the whole, little difference between the corps coming from England. Of those enlisted in South Africa, the earlier companies of the Cape Medical Staff Corps were, on the whole, the best. Their work in the field was very good.

The nucleus of trained N.C. Officers and men of the regular Royal Army Medical Corps which arrived in South Africa with the earlier medical units gradually diminished from the unavoidable wastage of a campaign. This loss was not compensated by the drafts which arrived from home, as these consisted almost entirely of men of the other corps already mentioned, either under the designation of the corps to which they actually belonged, or as specially enlisted men of the Royal Army Medical Corps.

There is no comparison between these auxiliary bodies and N.C. Officers and men of the regular service, including the reserve. It is not probable that the establishment of the Royal Army Medical Corps can ever be sufficient to furnish the staffs for the hospitals in a war of any importance; even although the nursing in the general and stationary hospitals be entirely carried out by Sisters and staff nurses, men will always be wanted for the field medical units and advanced posts. The only alternatives are to increase the reserve or to train the supplementary corps which will assist the regular service in time of emergency.

F.—MEDICAL OFFICERS.

It had been foreseen that the establishment of Officers of the Royal Army Medical Corps would not be sufficient for the needs of the field force, and from the first civil surgeons formed a large proportion of the staff of the general hospitals despatched from England. The number of Officers (excluding the quartermaster) allowed for each of these units was 18 instead of the authorised

establishment of 20. Of the first 10 general hospitals that were sent out, seven had 12 civil surgeons to six Officers of the Royal Army Medical Corps, three had 11, 14, and 16 respectively. In the remaining three general hospitals which came from England (Nos. 11, 13, and 14) the number of civil surgeons was less.

Later, civil surgeons were employed in every capacity, in charge of regiments, with field medical units, in ambulance trains, in the smaller hospitals, and in charge of posts on the line as well as in the general and stationary hospitals. These gentlemen were obtained from two sources, first, those sent out by the War Office, and, secondly, those engaged locally.

The total number of Medical Officers employed increased steadily till March, 1901. During the next few months there was some variation in the number, but from the end of that year the total again increased to the absolute maximum (about 1,000) in May, 1902.

Between the beginning of the war and the end of December, 1901, the number of Royal Army Medical Corps Officers employed in South Africa steadily increased, and this continued till March, 1901. After this date the numbers varied slightly from month to month until the beginning of 1902, when there was again an increase, and the largest number employed was in May of that year.

The number of War Office civil surgeons employed showed a steady increase during the campaign. After December, 1901, their numbers exceeded those of the Royal Army Medical Corps Officers, while those locally engaged diminished in number.

Up to the end of 1901 of the total number of Medical Officers employed, about 42 per cent. were Officers of the Royal Army Medical Corps, of the remainder about 4 per cent. were Militia, Volunteer, and Colonial Officers, while the remaining 54 per cent. were civil surgeons, of whom about 40 per cent. were engaged by the War Office. In 1902 the Officers Royal Army Medical Corps had receded to about 40 per cent., while the War Office civil surgeons had increased to about 46 per cent., and those locally engaged had fallen to about 10 per cent.

As regards the War Office civil surgeons, the conditions of contract were satisfactory, with the exception that the clause allowing them the use of a Government horse was a mistake. This issue should be limited by the requirements of their duties, as is the case with Officers of the Royal Army Medical Corps. The universal issue of horses to civil surgeons when it was not permitted to Field Officers of the Royal Army Medical Corps was calculated to cause annoyance, and it introduced the more practical difficulty of complications in the animal and ordnance accounts of the hospital to which these gentlemen were attached.

It is a question worth consideration whether civil surgeons engaged by the War Office should not be granted a temporary commission, say, on a "reserve medical staff." This would make their duties easier for them in many ways, and it would clear up certain disciplinary difficulties which were occasionally obvious during the late war, as their position would be at once defined.

It also appears to be important that they should be instructed on certain matters which must at first be strange to them, viz., how they obtain their pay, their relations to their Commanding Officers, and so on. A short statement on these points might be issued to them either before or after engagement.

As regards the civil surgeons locally engaged, before the actual outbreak of the war a number of medical men who had been in practice in the Transvaal were in the larger towns of the English Colonies, especially in Cape Town and Maritzburg. In Cape Town Colonel Supple, the Principal Medical Officer, South Africa, had ascertained from many of these gentlemen whether their services could be depended on in the event of hostilities, while in Natal a register had been opened by the Senior Medical Officer there, Lieut.-Colonel P. H. Johnston. When Officers of the Royal Army Medical Corps were sent from Cape Town and the vicinity to open the small hospitals at De Aar and Orange River, their places were filled by the engagement of some of these gentlemen. When the irregular corps were raised other medical men were appointed to them as Medical Officers. These, however, were regimental

appointments, and these gentlemen are, therefore, not included in the numbers engaged by the medical authorities. In Natal the same thing was going on.

As the war progressed more medical men became available, some were driven from their practices either directly or indirectly as the result of the war, others arrived in the country in the hope of obtaining employment. The majority of those who offered their services were engaged. Some, however, limited their offer of services by conditions which could not be accepted with due regard to the necessities of the service. This was especially the case after the occupation of the Transvaal, when employment in Johannesburg was very much sought for. It was, of course, impossible to accept services offered under conditions limiting the engagement to employment solely in Johannesburg. There were then serving with the army many medical men who had practised in Johannesburg before the war; these gentlemen had rendered valuable service to the army both in the field and on the line of communication from the beginning of the campaign, and it was but just that the few posts which it was possible to make permanent should be given to them. With these exceptions, and certain others who were for one reason or another not desirable, practically every medical man who could be got hold of was engaged.

Besides these gentlemen, who were engaged mainly at the coast posts, others were obtained from the ranks of the irregular corps. Several well qualified medical men were obtained from the ranks of the Imperial Yeomanry, a few from the colonial corps, both over sea and South African.

In addition to the civil surgeons engaged locally for general service, it was often necessary and always convenient to engage the services of medical men in practice in many of the smaller towns (especially in the Orange River Colony and Cape Colony) to look after the small bodies of troops stationed there, or small parties of sick and wounded compulsorily left behind in an improvised hospital by our smaller columns. Many of these gentlemen did very good service, and this arrangement set free the general service personnel for other duties where they were urgently required. Often, too, this was the only method by which the Senior Medical Officer of a column could arrange for the care and custody of the patients left behind. Most of these gentlemen had considerable local influence among the Boers, who, as a primitive people still retain their respect for a doctor, and so ensured better treatment for these isolated parties than could have been obtained by a stranger.

Three at least of the local medical men employed by us during the later stages of the war had been with the Boers during the invasion of Natal, two had been before at Ladysmith, one at Spion Kop. These three were Englishmen who had been in practice in the Transvaal, and had been compelled to go with the Boers.

Out of the 128 civil surgeons engaged in Cape Town during the war, 72 were engaged in 1900, the period of greatest pressure. No record has been kept of the numbers engaged in other centres.

Taken as a whole, the civil surgeons did exceedingly good work. Those sent out from England at the beginning of the war were, as a body, better than the majority of those who came out later, as they were mainly younger men fresh from the hospitals, where many of them held house appointments. The later arrivals, though among them were many good men, did not, as a class, reach the same standard. There were even greater divergencies from an average among the civil surgeons engaged in South Africa. Some were exceptionally good men, and their local knowledge of all the conditions was very valuable, while their practical experience of life in a comparatively new country made them more useful and readier in adapting themselves to circumstances than those sent out from England.

Many of the civil surgeons served for long periods; a few throughout the whole campaign. The longer they served the more useful they became, as they learned by experience what was required.

Besides the civil surgeons a certain small proportion of colonial Officers were employed during the war. Most of these belonged to certain definite units, *e.g.*, the Canadian Field Hospital, the New South Wales Ambulance, and the Cape Medical Staff Corps, but a few were unattached. All these

Officers did very good work, most of it in the field, where many of them distinguished themselves.

G.—NURSING SISTERS.

The authorised establishment of Sisters for a general hospital was one Lady Superintendent and eight Sisters. This was found to be insufficient with the deficiency of trained orderlies of the Royal Army Medical Corps, and the numbers were increased to an average of five Sisters for every 100 beds, which was taken as the standard to be maintained.

The first seven general hospitals that came out had only the authorised establishment, and their numbers had to be increased; those sent later had 20 Sisters each on their strength, and with the increase of the accommodation of these units the number of Sisters was also increased.

The numbers employed steadily increased to the maximum in May, 1901, after which date there was a slight diminution in their strength. These nursing Sisters were obtained from four sources—the Army Nursing Service, the Army Nursing Service Reserve, Colonial Sisters, and those locally engaged in South Africa.

The following tabular statement shows the approximate composition per cent. of the Nursing Service in South Africa in the months given :—

—	A.N.S.	A.N.S.R.	Colonial.	Locally engaged.
June, 1900.. .. .	9	57	1	32
May, 1901.. .. .	6	71	4	19
May, 1902.. .. .	8	74	4	14

In addition to these ladies employed in the hospitals in South Africa, a large number were employed on the various sick transports and hospital ships. In the earlier stages of the war these were mainly qualified nurses engaged in South Africa specially for this duty.

Sisters were available locally under exactly the same sources as the civil surgeons, that is, from those previously working in the country, fresh arrivals, and those in small towns. There were also many offers of service from ladies, some of whom were not qualified either technically or by education, but who were "willing to learn." At the outset, and especially in Natal, it was necessary to employ a number of nurses who had not the requisite period of training; many of these were excellent nurses, and all proved useful under the circumstances, but as the necessity diminished these ladies were gradually eliminated.

During the war 337 nurses were engaged at Cape Town, of whom 216 were for duty in the homeward bound transports, the remainder for duty in the hospitals on shore.

As in the case of civil surgeons, no complete record exists of the numbers engaged elsewhere.

Special mention must be made of the nursing Sisters from the over-sea Colonies. Sisters came from Queensland, Victoria, New South Wales, South Australia, Western Australia, Tasmania, and New Zealand, while Canada also sent Sisters in November, 1899, and February, 1900, of whom several returned to South Africa with the second contingent sent in 1901.

Most of these Sisters were originally sent free of expense to the Imperial Government, their services having been engaged either by their respective Governments or by private societies which sent them out. Others came with recommendations from their Colonies, and were engaged immediately on their arrival in South Africa. All these ladies were, without exception, full of zeal and energy, and were anxious to get as far as possible to the front. Many of them served throughout the whole campaign, and all did most excellent service.

It is impossible to say too much of the services which the nursing Sisters
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rendered in South Africa. Their devotion to duty, often under very trying conditions, was only exceeded by their kindness to their patients, many of whom owed their lives to the attention of these ladies. As regards the quality of their work, while the general average was very good, there were, of course, variations, and the best Sisters were undoubtedly those from the staffs of large hospitals at home. Those who had been engaged in private nursing were not so efficient as a class, and their employment is not to be recommended if Sisters can be obtained direct from the hospitals.

H.—GENERAL REMARKS.

As regards the augmentation of the permanent establishment to meet the necessities of a big war, Surgeon-General W. H. McNamara, C.B., C.M.G., makes the following observations, which in most respects coincide with the opinions formed by most Officers after our experience in South Africa :—

“ Mode of Supplementing the Regular Medical Service on the Line.

“ In small wars the Royal Army Medical Corps will be able, unaided, to carry on the Medical Services. The most advantageous manner in which outside aid may be utilised appears to be as follows :—

“ Royal Army Medical Corps (Militia).—The Officers in any capacity suitable to their rank, the N.C. Officers and men to form part of the personnel of hospitals with the Royal Army Medical Corps. St. John men are very good for a similar purpose, they are carefully chosen, and after a very short time fall into the routine of a hospital; some of them, with a little additional training during peace in such duties as pack store and linen store, would take the places of many Royal Army Medical Corps N.C. Officers who are always in demand. A fair workable unit could be formed with N.C. Officers, half Royal Army Medical Corps, the other half Militia and St. John Ambulance men; rank and file, one third Royal Army Medical Corps, the remainder St. John and Militia. In a unit of this kind the nursing Sisters would have to do nearly all the nursing properly so called, but men very soon get into the less technical part of the treatment required by most of the patients in military hospitals.

“ Civil compounder and cooks may take the place of Royal Army Medical Corps men to a great extent in large hospitals. Civil surgeons and Army Nursing Service Reserve Sisters are utilised on similar lines. Civil surgeons who have been house surgeons in provincial hospitals and manage such hospitals will be found the best men for independent charge of small hospitals.

“ Royal Army Medical Corps (Volunteers) could form units of their own, or preferably a division in a communication or general hospital, or be utilised with the Royal Army Medical Corps as above; they could also staff ambulance trains and hospital ships.

“ When a large unit is formed it would be desirable to have a Royal Army Medical Corps Officer and a few N.C. Officers of that corps, the former should be Staff Officer and very carefully chosen, and be prepared to sink his own individuality as much as is compatible with efficiency, and do nothing to interfere with the dignity and importance of the remainder of the personnel. A unit or part of a unit of this kind should be detailed in peace for the duties it is intended for in war, and the personnel to their individual duties, clerk, compounder, wardmaster, cook, &c., and taught their duties in the manner already described in dealing with the training of the Royal Army Medical Corps. At present too much attention is paid to drills, &c., whereas organisation is the great difficulty. The equipment should be provided for by the Army Corps authorities in the same manner and be of the same pattern as that intended for the unit they are meant to replace, they should have sufficient of the equipment in peace for instructional purposes, but this need not be very much.”

PART VIII.

LINES OF COMMUNICATION AND BASE.

INTRODUCTION.

From the very outset of the war the arrangements at the base and on the lines of communication were of the greatest importance.

The more purely medical arrangements at the base have already been dealt with in the general account preceding this. The remaining duties at the base fall under the following heads, some of which are dealt with in separate reports :—

- (1) Disembarkation duties (*see* Part XI, p. 239)—
 - (i) Transport of healthy troops.
 - (ii) " " sick.
 - (iii) Hospital ships and sick transports (*see* Part X, p. 220).
- (2) Invaliding (*see* p. 209)—
 - (a) Officers.
 - (b) Other ranks.
- (3) Medical stores (*see* Part XII, p. 252).
- (4) Engagement of personnel (*see* Part VII, p. 171)—
 - (a) Civil surgeons.
 - (b) Sisters.
 - (c) Subordinate medical personnel.

In Cape Colony by far the greatest part of these duties were carried out in Cape Town; at the other two ports, East London and Port Elizabeth, the duties were practically confined to the disembarkation of healthy troops, and the forwarding of comparatively small quantities of stores of various kinds, but from each of these ports small parties of sick were from time to time sent round by sea, very rarely by rail, to Cape Town.

In Natal most of the duties detailed above were carried out at Durban, but invalids were sent direct from the hospitals on the railway line for embarkation, as owing to the shorter distance from the sea this was not only possible but most convenient.

Main Lines of Communication.

The main lines of communication by rail were :—

- | | |
|---|---------------------|
| (1) Cape Town to De Aar. | } Western sections. |
| (2) De Aar to Kimberley, Vryburg, and Mafeking. | |
| (3) Port Elizabeth to Naauwpoort and Norval's Pont. | } Midland section. |
| (4) East London to Bethulie. | |
| (5) Norval's Pont to Springfontein and Elandsfontein. | } Eastern section. |
| (6) Elandsfontein to Charlestown. | |
| (7) " " to Pretoria. | } Eastern section. |
| (8) " " to Klerksdorp. | |
| (9) Pretoria to Komati Poort. | } Eastern section. |
| (10) " " to Pietersburg. | |
| (11) Durban to Charlestown. | |

There were in addition some smaller branch lines north of the Orange River, and some intercommunications south of it, of which the most important was the main line between De Aar and Naauwpoort.

Of these main lines two require special mention; first, the Pretoria-Komati Poort line, on account of the special health conditions in the Krokodile Valley; and secondly, the Natal Railway. The last was open to Colenso from the first, and was little interfered with in rear of the advancing force, while after June, 1900, peace conditions prevailed in Natal, and the line was uninterrupted to the border of that colony, a condition very unlike those prevailing on the other lines.

The special conditions on the eastern line to Komati Poort are dealt with in the report by Lieut.-Colonel J. C. Dorman, C.M.G., which is included later.

Reports from Surgeon-General W. H. McNamara, C.B., C.M.G. (Principal Medical Officer, Lines of Communication, Cape Colony); from Lieut.-Colonel J. C. Dorman (Principal Medical Officer of the Eastern Line); and from Lieut.-Colonel B. M. Skinner (for some time Principal Medical Officer, 6th Division and Lines of Communication, Bloemfontein), are embodied herein.

I.—LINES OF COMMUNICATION HOSPITALS.

(a) *Establishment.*

Some account of these has already been given in the general report which precedes this.

The great difficulty in the early stages of the war was the provision of accommodation for sick at advanced points on the lines of communication. The detail for an army corps in war establishments includes only provision for the actual field army. Lines of communication hospitals are supposed to be detailed according to the special circumstances of each campaign, having regard to the health conditions of the seat of war, and other considerations. In this case four stationary and four general hospitals had been detailed to accompany the force (giving a total of 2,480 beds). The first stationary hospital did not arrive until October 17th, and the first general hospital until October 25th, both, however, well in advance of the bulk of the force from England.

The first demand in a campaign is for accommodation for the sick who have accumulated among the force on the outward voyage. When No. 1 General Hospital was opened its accommodation was largely taken up by wounded from Natal; hence the previously existing station hospital at Woodstock was utilised for sick from the transports. Later as the number of general hospitals at the base increased, evacuation from the front was being rapidly carried on, which took up their accommodation, and necessitated an increase at Woodstock for the continued influx from the arriving transports. This hospital was conveniently situated for dealing with cases from the transports, it was in communication by rail with the docks, and the sick were conveyed direct from the ship to the hospital in ambulance trucks prepared to the order of Colonel Supple before war broke out.

In the meantime events had been moving rapidly in Natal, while on the border of Cape Colony defensive operations on a small scale were being carried out. Hospital accommodation on the lines of communication for the troops engaged in these was confined to the previously existing hospitals (between 500 and 600 beds), and the small temporary hospitals (which had been staffed and equipped from the small resources of the country during the weeks immediately preceding the outbreak of hostilities), at De Aar, Orange River, Stormberg, and elsewhere. Natal was more fortunate in having a station hospital (though small) existing in Ladysmith itself, while the station hospital at Maritzburg formed a nucleus for the later establishment of a large hospital within a short distance of the fighting line.

No. 1 General Hospital at Wynberg was ready to receive the wounded sent down from the early engagements in Natal, a course necessitated by the absence of sufficient hospital accommodation there at the time, as the station hospital, Maritzburg, had to be evacuated owing to an expected attack of the enemy and temporary local arrangements made in the town in lieu of this. No. 2 General Hospital (also at Wynberg), with No. 1, received the wounded from the engagements on the western line. These two units were working under considerable pressure at this time pending the opening of No. 3

General Hospital, which did not arrive till the last week of November, and No. 4 during the second week of December. Nos. 2, 3, and 4 Stationary Hospitals arrived between the 13th and 23rd of November; of these No. 4 went to Natal, while No. 2 was sent to act as a base hospital at East London for General Gatacre's force, leaving only No. 3 available for use as an advanced hospital on the lines of communication. This unit took over and enlarged the temporary hospital at De Aar.

There was, however, no demand for additional hospital accommodation at advanced points on the Cape line until the concentration of the force under Lord Methuen at De Aar, which began a few days before the establishment of No. 3 Stationary Hospital there. After this the demands steadily increased, and the difficulties of the position were accentuated by the distance (500 miles) from the base, at which this concentration and the early engagements took place. This point had been foreseen, and the hospital trains prepared beforehand to the order of Colonel Supple, R.A.M.C. (Principal Medical Officer, South Africa, before the war), were ready for work as soon as they were required. Many cases were transferred direct by them from the field to the base hospitals at Wynberg. One drawback to this system was that many men who were slightly wounded or suffered from comparatively minor ailments were brought to the base, when for every reason it would have been better to have retained them in closer touch with the fighting line.

It will therefore be seen that the difficulties at the beginning of the war on the lines of communication were due to the fact that advanced hospital accommodation was not available until large numbers of the troops had arrived and taken the field. It must be remembered that before the war only the equipment of one general and two stationary hospitals was in possession of the Army Ordnance Department, and it was not till October 4th that sanction for the additional three general and two stationary hospitals was given to complete the number allotted to the original force detailed (one army corps and a cavalry division). That all the stationary hospitals had embarked by November 4th, and all the general hospitals by November 15th shows that there was little delay in preparing these complex units.

But though those units arrived with the field force, the account of the arrangements at the beginning of the war shows that this is not sufficient. If the medical arrangements in a campaign are to be entirely satisfactory they must not be hampered at the outset. Hospitals for the lines of communication must be among the first units to mobilise and embark. This point cannot be too strongly pressed. It is, of course, the case that the probable sick rate in any campaign depends largely on the local conditions at the seat of war, but there is an irreducible minimum which always will occur. General and stationary, that is, advanced hospitals on the lines of communication should be included in the war establishments of an army corps for at least 7 per cent. of its strength, and should be held ready to mobilise and embark at the very earliest possible moment, so that they may be on the ground when their services are required. The remaining hospitals necessary to bring the accommodation up to 10 per cent., or whatever may be considered necessary, should follow as early as possible, but the permanent hospitals of the army corps should be always as ready for departure as any other unit of the force.

Lines of communication troops and those at the base figure less prominently before the public eye than the actual field force. But they require hospital accommodation at a rate which is not much less than that probable in the field army. Hospital accommodation for these troops must be provided (and should embark with them), in addition to that for the army corps, and every addition to the force on the lines of communication requires an increase of hospital accommodation, unless this increase should be compensated by a reduction in the field army.

Hospital accommodation should always be estimated for on a liberal scale. Whatever the proportion of beds allowed for the force as a whole, it will frequently happen that local necessities in certain areas will exceed the normal proportion, either in consequence of engagements or from the outbreak of disease. The necessity, too, for the segregation of cases of enteric fever, dysentery, and the like involves the deduction of a considerable number of beds from the total available for all purposes. Hence it is not sufficient to provide beds only for the probable minimum sick rate.

In calculating the number of hospitals to be provided, the field units must, of course, be set aside. The permanent hospitals (general and stationary) of the army corps, if sent out at the very first, should be sufficient for the smaller sick rate of the opening weeks of the campaign.

With regard to these points, Surgeon-General McNamara points out that "a base hospital should arrive in one of the first ships, as accommodation will have to be arranged for the sick accumulated on board ship; this will usually amount to from 1 per cent. to $1\frac{1}{2}$ per cent. according to the length of the voyage;" and, further, with regard to the lines of communication hospitals generally, "there is an idea that field units are available to deal with the sick until there is time to organise and prepare these hospitals. This is an entire fallacy, it is only when operations have begun, and at the extreme end of the lines of communication that these units treat sick, and then only temporarily. The hospitals should be mobilised as nearly as possible simultaneously with the rest of the army."

(b) Organisation.

With regard to the actual organisation and situation of the base or advanced general hospital, Surgeon-General McNamara points out that one base hospital at least should be close to the docks, and that all should be on the railway line. This was the case in nearly all the general hospitals in South Africa. At Wynberg the situation prevented the railway being carried into the hospital, but the other hospitals were, almost without exception, either situated at the side of the railway or had a special siding running into them. The advantages are obvious. Surgeon-General McNamara further points out that special accommodation is required as follows:—

Lunatics	...	...	...	...	...	5 beds.
Prisoners	...	...	...	...	...	10 "
Infectious disease (in 3 wards of 5 each)	...	...	...	...	...	15 "

The care of lunatics in a tented hospital is always an anxiety. In Pretoria special wards were maintained in a small house at the Race Course Hospital. At Woodstock (No. 5 General Hospital), and at Wynberg (No. 1 General Hospital), and in the old Station Hospital in Maritzburg, there was special accommodation in buildings. Lunatics were sent down country to the base under escort as soon as their condition was established.

Special accommodation for prisoners (British military) is specially necessary at the base, elsewhere arrangements can usually be easily made.

Infectious hospitals were established in several of the larger stations. Special tentage can always be told off for this purpose only, and can be destroyed if necessary.

Full details as to the organisation and equipment of general and stationary hospitals are given in a separate section (Part IV, p. 120).

(c.)—Equipment.

Facility in movement, erection and opening is the first necessity in lines of communication hospitals. Provision for the actual needs of the sick should be the earliest consideration, and elaboration of the hospitals secondary to this. On this point Surgeon-General W. H. McNamara makes the following remarks:—

"The equipment of hospitals should be as light as possible; in the base hospitals 50 per cent. of the bedsteads may be the small narrow iron with spring wire (bedsteads folding, special wire spring mattress, 6 feet 6 inches by 2 feet 3 inches, weight 50 lbs.), and mattresses to suit. With the wire springs the mattresses need not be more than half the usual thickness. The remainder of the beds could be full sized beds with fracture boards for 5 per cent. All the bedsteads in communication hospitals should be of the special pattern (narrow), all easy chairs should be of the light camp variety. Lightness is everything on service, not alone on account of the difficulty of rail and other transport, but to save unnecessary strain on the men in loading and unloading."

Probably by making the bedsteads of light tubing the width could be increased to at least 2 feet 6 inches with a considerable reduction in weight.

"The personnel should know the exact weight of the hospital, and the weight of articles such as tents (which may be left behind at the base if buildings are available at its destination), easy chairs, &c., which might be temporarily left behind in case of difficulty of transport. Such things as games, furniture for recreation rooms, should not be part of the equipment of the unit but be held by the Ordnance Department to be drawn when absolute necessities are all in working order, and fancy tablecloths, ornaments, should find no place in a service hospital, there should be no more cushions than necessary, and none without washable covers, or pillows without washable covers; the overworked staff has not time to look after them. No unnecessary permanent buildings should be erected tending to make a hospital immobile when it is one which may require to be moved. Each general hospital should have a portable X-ray apparatus, and there should be others to be utilised in communication hospitals as required. There should be a chemical and bacteriological laboratory attached to a hospital at the base."

He points out that the Army Ordnance Department should hold reserve equipment for the establishment of additional hospitals on the line as required in addition to those detailed from England, and for the equipment of hospital trains, also that they should have ready for issue Thresh's disinfectors (for the larger hospitals), Arnold's sterilisers (for the smaller), extra stretchers and empty barrack mattress cases, and pillows for use in convalescent camps.

Each hospital requires at least one Scotch cart permanently on charge for the purpose of drawing supplies. The General Hospital Committee thinks that more is necessary.* The great initial difficulty in the erection of a hospital is usually in getting sufficient transport locally to carry its stores from the dock or railway site, and arrangements for this should be made in advance whenever possible.

The personnel of the lines of communication hospitals should be detailed for certain duties in connection with the erection of the hospital before their arrival at the port of disembarkation so that no time is lost when the site for the hospital is reached.

"Buildings can also be taken over on similar lines, each party knowing the amount and kind of space (fittings, shelves, &c.) necessary for its requirements: the steward for his stores, the wardmaster for wards, the cook for kitchen and scullery, and so on. As the work progresses the Commanding Officer can re-distribute the staff between the different services according to requirements. Engineer requirements should be at once represented to the Royal Engineer, supply, to the Supply Officer, &c. At the same time the Commanding Officer should, in case of necessity, himself utilise local resources by hiring labour, and justifying his action afterwards. It is of great importance to have all hospitals connected with a regular water supply and a sewerage system if possible, and in any case hospitals should as soon as possible arrange for the removal of refuse and excreta, local labour being employed for this purpose.

"All Principal Medical Officers and Medical Officers in charge should be in constant communication with Officers of Ordnance and Supplies, and help these Officers in every way to anticipate medical requirements. When some articles are falling short, substitutes should be used. They should also utilise, with Commanding, Ordnance and Supply Officers, the resources of the country for the good of the sick and wounded. If getting necessary supplies, &c., for the sick through the usual channels is likely to cause any detriment, Medical Officers should themselves purchase, and report to the Officers concerned. When on detachment duty, such as convoy, an imprest might be obtained to enable them to buy milk, eggs, &c.

"The field canteen and sutlers should not be forgotten as a source of supply. Steps should be taken to prevent others getting milk and eggs when the supply is limited, until the wants of the sick in hospital are supplied." (See also Appendix XXXVIA, I.)

* See p. 145.

These are the main points in the earlier stages of the development of the hospital system. Later there seems to be no reason why the hospitals should not be elaborated, to render them not only capable of meeting the actual and urgent necessities of the sick, but of providing such additional comforts and conveniences as the local conditions may allow. Where the conditions are favourable, it is quite possible to raise the standard of accommodation in a general hospital to equal that in any civil hospital in the kingdom. This was done in the general hospitals during the late campaign as soon as rail transport became available.

(d) Kits, Arms, and Accoutrements of Patients.

Under paragraph 1726, "King's Regulations," the kits, arms, and accoutrements of sick and wounded are to be sent with them to the field hospitals, and passed with them in any future transfer down the line.

It is, of course, very important that the arms and accoutrements should be available, either for their original owner, or for re-issue in the event of his becoming inefficient. It is not possible for the unit to which he belongs to retain charge of them, nor could it be hampered by the necessity for carrying and guarding them. But their care, custody, and carriage is a very great tax on the resources of the present establishment and transport of the field hospital, and the difficulty is not much lessened when the patient is transferred to the hospitals on the lines of communication.

Some additional personnel is required to look after these, and in the later stages of the campaign, garrison duty men were employed in the hospitals for this purpose. It would seem advisable to attach a small staff to each general and stationary hospital to clean and look after the arms, and preferably under a N.C. Officer of the Ordnance Department. This is not a duty which should be performed by the men of the Royal Army Medical Corps, who are trained for other duties. Certainly in a general hospital, where there will probably always be some 500 rifles, their proper care is sufficiently important to justify the addition of a qualified man for this purpose.

The arms and accoutrements of a man who is permanently unfit should, of course, be handed over at once to the Army Ordnance Department.

The Geneva Convention in its present form does not appear to be explicit regarding the effect of the presence of arms in a hospital on its neutrality. The practice on the Continent suggests that the neutrality is not affected by their presence. But in more than one instance our ambulance wagons were confiscated by the Boers on the ground that the arms and ammunition of wounded were being carried in them, and therefore, in actual practice, arms and ammunition were not carried on our hospital trains, in order to avoid any complication of this nature.

There appears to be no sufficient reason why the presence of arms in a hospital should not be legalised definitely under the Geneva Convention; and as it always occurs that a man is brought in with a few odd rounds of ammunition in his pockets, the presence of small quantities of ammunition should not be regarded as constituting a breach of the Convention.

(e) Development of the Lines of Communication Hospitals.

The obvious method of development of the system of hospitals on the line of communication as it extends behind the advancing fighting line is simple—the first points to arrange for are the junctions either of two railways, or rail and road, next the other stations where larger masses of troops are to concentrate, to draw supplies, or to be stationed at, while the intervening smaller stations are filled in with smaller advanced hospitals or detachments of them. Unfortunately military and physical considerations intervene and disturb the simplicity of this scheme.

In the late war the Natal railway system presented no complications. The line of communication was short, and the resources of the country were available at no great distance from the points which had to be supplied.

In Cape Colony the points of first importance geographically were De Aar and Naauwpoort, the midland and eastern lines were secondary. De Aar was also an important concentration point. As has been already

shown, its physical features were far from satisfactory, nor did the lines of defence admit of the establishment of a general hospital there.

At Naauwpoort the military position was for long too precarious to admit of any large hospital being established; indeed after No. 6 General Hospital had been erected and opened there, it appeared as if it would have to be suddenly evacuated, with the loss of its tents and equipment, on account of the advance of the enemy. So that considerations other than medical in the one case prevented and in the other delayed the most suitable arrangements.

After the occupation of Bloemfontein and the opening of the railway from Norval's Pont through the Orange River Colony to the Transvaal, the development of the hospital system on the railway line proceeded as rapidly as the condition of traffic on the railway permitted. All the important points were occupied in the manner shown in detail in the historical section of the report, and require no further reference here.

While the main line of communication will always follow the main arteries of traffic in any country, whether by rail or road, depending on the locality of the seat of war, transverse movements between the main channels will invariably occur. In the South African War the most important of these was the advance under Lord Roberts towards Kimberley, and afterwards to Bloemfontein. But in this instance the line of communication stopped at Osfontein, afterwards the force was self dependent, until it reached its objective.

As regards the advance and investment at Paardeberg, it has been shown how the transport was reduced below that necessary for the efficient working of the field units; it would therefore have been impossible to push forward stationary hospitals. Every vehicle and every animal that could be collected were employed for the haulage of supplies, principally food, to the force engaged.

After Paardeberg it was doubtful whether, under the most favourable conditions, any great difference (beyond the possession of complete field units) could have been made in the arrangements. Under no possible conditions would it have been practicable to carry a sufficient number of stationary hospitals across the Orange Free State, to make any material difference in the hospital accommodation in Bloemfontein prior to the opening of the railway.

Two other movements on a large scale fall into the category, one the advance of Sir Redvers Buller, V.C., from the Elandsfontein-Natal railway line, and the advance of General French from the Pretoria-Elandsfontein railway line eastward, to Swaziland. These differ in that General French's advance in the early months of 1900 was made after line of communication hospitals had been established on all the railway lines bounding the area in which he was operating, while General Buller broke entirely fresh ground.

The remaining operations in the various colonies were on a smaller scale, and need no special reference.

(f) *Convalescent Camps and Homes.*

Convalescent camps were established at—

Pretoria.	Norval's Pont.
Middelburg.	Kimberley.
Barberton.	Harrismith.
Germiston.	Howick.
Standerton.	Rondebosch.
Krugersdorp.	East London.
Kroonstadt.	Green Point.
Bloemfontein.	Victoria West Road.

These camps relieved the hospitals of those who, though unfit for duty, did not require continued hospital treatment. The first of these was opened at Greenpoint Camp (near Cape Town) in the end of 1899, and from this time they formed a regular part of the medical arrangements as these developed.

In some cases these camps were under a military commandant, and the men in them were inspected daily by a Medical Officer. This was the case at Victoria West Road, where there was no large hospital; in Norval's Pont,

Johannesburg, and Elandsfontein the camps were also worked in this way. But in most other cases they were under the command of an Officer of the Royal Army Medical Corps, who was responsible for all duties in connection with the camp. There is no doubt that this method is more satisfactory, especially when, as should normally be the case, the camp is established as an adjunct to a large hospital. In these cases the camp is really an extension of the convalescent wards of the hospital, and the men are under closer supervision than in a camp under a military commandant.

Surgeon-General McNamara makes the following remarks on these points:—

“Besides the dieting now practised in hospitals, there should be a convalescent diet laid down for service, consisting of field service rations, with such extras as may be available from medical comforts or local resources, and accounted for on diet sheets in bulk. This was suggested by Major Elderton at No. 1 General Hospital, when there were large number of convalescents. It facilitates dieting and gives variety. When there is pressure on the staff and equipment of a hospital, these men need not be in hospital clothing, and could be provided with ordinary service tents, &c., and their own field equipment with any added articles of clothing and necessaries required. They could look after their own kits, be divided off into messes with N.C. Officers and men from amongst themselves as orderly sergeants, orderly men, &c.; in fact, doing everything for themselves as if they were not in hospital. In this manner, though under medical treatment, they would not absorb much of the time of the medical staff. Men of this class might be treated in a convalescent camp under Regimental Officers, rationed in a similar manner, but under strict medical supervision. Such camps should be in the vicinity of hospitals. Convalescent camps away from regular stations are very undesirable unless there are very good climatic reasons for them. Similarly, hospitals far from military stations are undesirable. When men are being moved about to such places they rarely get back to the fighting line as soon as they ought to, and there is a difficulty in having them prepared and equipped to return to the ranks.”

These suggestions represent what was actually carried out in practice in the convalescent camps: a scale of diet was authorised for camps near the coast ports (Lines of Communication Order No. 10, d.8.9.00 (*see* Appendix XXXV k), but that used in the up-country camps depended more on local conditions. The Medical Officer in charge of the camp added such articles as he considered necessary in individual cases.

The equipment of these camps varied slightly. In some bell tents were used, in others the Indian service tent was employed, and occasionally hospital marquees or E. P. tents, when these were available. The Indian service tent is very suitable for this purpose; it holds six men on mattresses and is easily ventilated.

Bedding consisted of waterproof sheets, mattresses, and blankets. The mattresses were not altogether successful; they became rapidly worn out, and it was more satisfactory (as in the camp at Bloemfontein) to dispense with them and increase the number of blankets. The remaining equipment was that of an ordinary standing camp. In some instances the kindness of the residents of the locality provided reading and recreation rooms for the use of the men in the camps.

There is no doubt that the system was entirely satisfactory, not only in diminishing the demand for hospital beds, but in ensuring that no man was returned to the ranks until he was absolutely fit for duty. Camps on these lines should always form a part of the medical arrangements on the line of communication.

Convalescent Homes.—Soon after the beginning of the war Sir James Sieveright offered the use of some houses at Somerset West as a convalescent home for the army. He supplied two nurses, and it was proposed to accommodate some 250 cases in the three houses, tents, and huts. The locality is difficult of access; it is on a branch line from Cape Town, while the staff for such an establishment could not be spared. This kind offer was therefore not accepted.

In its place an Officer's convalescent home was opened in Claremont Sanatorium, under the charge of an Officer of the Royal Army Medical Corps with two Sisters. This building (a private concern) was not suited for use as a hospital, as the rooms were small, but it afforded excellent accommodation in separate rooms for some 50 Officers, while, at a later date, additional accommodation was taken over, which gave about 30 beds more. An excellent chef was employed, and the whole arrangements were very satisfactory. Many Officers who required rest and good food were admitted direct to this sanatorium on arrival from the front, while others were transferred from the general hospitals as soon as it was considered safe for them to go. In this way the hospital accommodation was not strained by the necessity of retaining those not actually requiring treatment, while on the other hand it prevented many of the Officers from living in the hotels in Cape Town, which would have been necessary had this not existed.

Later, a similar institution was opened in Johannesburg in a house built for the late Mr. Barney Barnato. The building was an excellent one, giving accommodation for over 30 officers, but it had to be furnished and equipped. Here also an officer of the Royal Army Medical Corps was in charge (Lieut.-Colonel E. R. Cree) with Sister Gray. This establishment proved of the greatest use in the convalescence of Officers from the Transvaal and Orange River Colony, who were saved the long journey to the coast.

During the early months of 1900 arrangements were made for the reception of a small number of Officers at Lemoenfontein, near Beaufort West, and later a home was opened at Matjesfontein in a house belonging to Mr. Logan, M.L.A., and kindly offered by him. For this the staff of Lady Layard's home was brought from Madeira.

There is no doubt that something of the nature of the convalescent homes at Claremont and Johannesburg is necessary during a campaign, certainly in one of any duration. Officers get worn out with hard work and indifferent food; they, however, do not require any hospital treatment, and are, in fact, better away from the necessary limitations and restraints of a hospital proper. But at the same time it is not conducive to the recovery of their health, and, presumably to the interests of the service, that they should spend their time of rest in an ordinary hotel. This was frequently the case both at Cape Town and Durban. Every Officer sent down for rest should be under supervision, and this can best be arranged in a properly managed home.

Both in Claremont and Johannesburg the table was good, and the bill of fare devised with reference to the needs of the convalescents. Each Officer was allowed a certain quantity of wine or other drink as considered advisable by the Medical Officer. Meals were, of course, at fixed hours, and, while convalescent exercise was encouraged, care was taken that this privilege was not abused.

II.—POSTS ON THE LINES OF COMMUNICATION.

(a) Organisation.

Owing to the activity of an ubiquitous enemy, precautions had to be taken to safeguard the more vulnerable parts of the railway lines in their whole extent. All important bridges were protected, and most of the more important culverts, while each station had a guard, varying in size with its importance, not merely as a station, but as a centre for the accumulation of stores for the troops in the adjacent district.

At some of these stations a small detention hospital was formed under charge of a Medical Officer (usually a civil surgeon) with the requisite equipment. Each of these small hospitals was in touch with the nearest lines of communication hospital, to which normally all sick were sent. Colonel J. C. Dorman says: "At intermediate posts, where it may be deemed advisable to have a Medical Officer, a few beds should be provided for the temporary detention and treatment of sick until they can be removed to hospital; this is particularly necessary, when, as in South Africa, the communications were liable to be interrupted for days by the enemy, or where, as in the Komati Valley, the sick rate is occasionally excessive."

Evacuation from these small detention hospitals was carried out regularly by ordinary trains (in cases where this was possible), and, in the later stages, (3959)

special ambulance carriages were attached to the ordinary trains and used solely for this purpose. The regular hospital trains were also sent to clear all the smaller hospitals when there was any pressure on the line.

Each of the Medical Officers in charge of these small detention hospitals was also in charge of a section of the line on which he saw cases requiring attention, and arranged for their removal to the nearest hospital. Medical Officers were also stationed at some of the more important posts, although no hospital accommodation was considered necessary there owing to the proximity of a line of communication hospital. Details of the work on the Bloemfontein section are given by Lieut.-Colonel B. M. Skinner, and on the eastern line by Colonel J. C. Dorman, C.M.G., and show the method of working of this system.

(i) Medical Arrangements on the Eastern Line.
(Colonel J. C. Dorman, C.M.G., R.A.M.C.)

The distance from Pretoria to Komati Poort is about 280 miles, and from the attached table it will be seen that hospitals were established at Middelburg, Machadodorp, Lydenburg, Waterval Onder, Barberton, and Komati Poort, while at all intervening stations, beds were provided for the accommodation and treatment of sick until they could be removed to hospital. There was often considerable delay in doing this, owing to the frequent interruption of traffic by acts of the enemy. In the lower valley, from Godwan to Komati Poort, more beds had to be provided than on the high veldt, owing to the very high sick rate which occasionally prevailed.

Middelburg was the headquarters of the eastern line, and a large garrison was maintained there. This hospital received all sick from the east, and only transferred men to Pretoria for invaliding, or when there was insufficient accommodation. Machadodorp was also held by a large garrison (usually about 1,200 men), and was a point from which columns frequently operated. It also is the point to which sick from Lydenburg were brought. Lydenburg is about 48 miles from the railway.

Waterval Onder is at the head of the lower valley. Here all sick from the valley were received. Serious cases were retained for treatment, and those fit to travel (if accommodation was not available) sent on to Middelburg. At Barberton there was a large garrison, and a large hospital was needed during the unhealthy season.

Although very few sick were retained at Komati Poort (as owing to the extreme unhealthiness of the climate it was deemed advisable to send all fever patients as soon as possible out of the valley or to Delagoa Bay), a large number of beds had to be kept available both for local sick and for transfers being sent from other stations to Delagoa Bay.

During the unhealthy season a hospital ship was stationed in Delagoa Bay to which sick from Komati Poort and other stations in the lower valley were transferred. At Wonderfontein 50 beds are shown. This was not a hospital, but for the temporary accommodation of sick and wounded sent in from columns until they could be removed to Middelburg; 20 beds were provided at Brugspruit for the same reason, these being two points from which many columns drew supplies and to which they sent sick.

Besides these a section of No. 12 Field Hospital was held in readiness to proceed out and form a receiving dépôt for sick from columns in the field. It was employed thus for a considerable time at Carolina, 35 miles south of Wonderfontein, where it was most useful, and at other places.

Transport.—For the transport of sick and wounded, hospital trains, such as the "Princess Christian" (which was principally employed on this line), afford every possible convenience and comfort, and the employment of such trains is an absolute necessity. In the evacuation of sick and wounded from the neighbourhood of a battlefield, or in the evacuation of advanced hospitals, serious cases can be taken, and rapidly conveyed to the base with greater safety than they can be carried short distances in ambulance wagons. In view of keeping the advanced hospitals as clear as possible these trains are of the greatest value, but for the constant conveyance of small parties and almost daily from posts, these are too big and expensive, and I think some such method as employed on the

eastern and northern lines in the Transvaal essential.* On these lines the evacuation of sick went on quietly and regularly, except when railway communication was interrupted by acts of the enemy. The ambulance train was free to evacuate the large hospitals to others further down country, and a reserve was held ready to despatch to any point where it was likely that the influx of sick would be greater than the local arrangements could cope with.

Stationary Hospitals and Detention Posts on the Eastern Line of Communications, Transvaal.

Name of Station.	Accommodation for Sick.
Eerste Fabrieken	10 beds.
Pienaars Poort and Van-der-Merwe	16 "
Bronkhorst Spruit	6 "
Wilge River	6 "
Balmoral (a large garrison)	14 "
Brug Spruit (a point where columns frequently halted)	20 "
Oliphant's River	6 "
Middelburg (17 Stationary Hospital)...	400 "
Pan	4 "
Wonderfontein (a point to which sick were frequently sent from columns)	50 "
Belfast and Dalmanutha (a large garrison)	12 "
Machadodorp (21 Stationary Hospital)	125 "
Waterval Boven	6 "
Waterval Onder (20 Stationary Hospital)	120 "
Nooitgedacht	4 "
Godwan (sick transferred here from Kaapsche Hoop)	12 "
Elandshoek (malarious and unhealthy station)	12 "
Alkmaar " " " " " " " " " " " "	12 "
Nelspruit " " " " " " " " " " " "	14 "
Krokodil Poort " " " " " " " " " " " "	12 "
Kaapmuiden " " " " " " " " " " " "	20 "
Koomati Poort (Station Hospital)	60 "
Barberton and Avoca (36 Stationary Hospital)	200 "
Helvetia	4 "
Schwartz Koppies	4 "
Witklip	6 "
Lydenburg (37 Stationary Hospital)	125 "

Northern Line.

Pietersburg (22 Stationary Hospital)...	100 "
Warm Baths (23 Stationary Hospital)	75 "

(ii) Report by Lieut.-Colonel B. M. Skinner, R.A.M.C., P.M.O., 6th Division and Line of Communications, Bloemfontein.

Bloemfontein became an advanced base for an extensive tract of country, increasing in area as the field force advanced northwards, until Kroonstadt was in a position to maintain its own line of communication hospitals. Even then the area it served was large, consisting of the whole centre of the Orange River Colony, the main lines of evacuation in which were from Ventersburg Road to Bloemfontein, from Winburg and the vicinity, from the Ladybrand-Thabanchu line, as well as from columns operating to the west. The forces operating in the early days of the invasion of the north-east of the Free State passed their sick back to Winburg. Later those in the northern part of this position evacuated through Heilbron to the railway north of Kroonstadt. Meanwhile Lindley, Bethlehem, and Heilbron formed advanced hospital centres of a temporary character. Finally Harrismith became the advanced base for the locality, and sick and wounded only found their way to the main line when columns were working towards it. But Bloemfontein, certainly till the end of 1900, was the main goal of the sick from all the country north of

* Details are given later, p. 201.

it, for whenever the large hospitals at Kroonstadt and beyond became loaded Bloemfontein became the receptacle for the overplus.

For some months after the advance from Bloemfontein, small columns were despatched in various directions from Bloemfontein itself, marching about for varying lengths of time. To provide medical units for these columns Medical Officers had frequently to be withdrawn from general hospitals, or from units of the garrison. Tents, ambulances, "comforts," medical and surgical equipment were requisitioned from the depôts for these units; personnel was borrowed from the general hospitals, and supplemented by soldiers belonging to the column. The detail for a column of 500 men would be (besides the Medical Officer who would be found with one at least of the units, and also in addition to the medical equipment of the units)—

- 1 Medical Officer.
- 1 corporal and 2 men Royal Army Medical Corps.
- 4 regimental orderlies.
- 2 hospital bell tents.
- 2 ambulance wagons.
- 2 field panniers, medical and surgical.
- 1 field fracture box.
- 2 boxes of medical comforts.
- 2 or 3 surgical haversacks.
- 1 water cart.

If the column were not operating from a position containing a hospital, in addition to the above it would be necessary to send out a small unit, constituted similarly to that shown above, to form a rest depôt between the force and the nearest hospital.

It will be gathered that this method of equipping columns involved frequent changes in the personnel of general hospitals, especially in the matter of Medical Officers. The experience gained in equipping numerous columns in the manner above noted points to the desirability of the possession by the Principal Medical Officer, Line of Communications, of numerous small units on the lines of the one sketched above. Each of these small units should be complete in itself for taking the field at a moment's notice (the notice given is frequently only a few hours) fully equipped for the duties of a miniature field hospital and bearer company combined, if required for a column, or if required for a station or rest depôt equipped in addition with beds.

If in possession of medical units of such a class, the Principal Medical Officer, Line of Communications, would only have to draw transport when it became necessary to furnish a column with medical aid. The line of communications from Bloemfontein to Wolvehoek would then have had one of these sub-sections at each station; one at Winburg, which could have been increased when required, for use under the Superintending Medical Officer there, to assist columns in discharging their sick. Every small station like those to be named below would be provided with a sub-section, while the Principal Medical Officer would retain constantly at least two at his headquarters for use for columns and temporary posts.

This, though not provided for by regulation, was the system adopted by the Principal Medical Officer, Line of Communications, Bloemfontein. The provision of a regulation unit to meet this necessity, which must arise in every war, will save extemporisation, and will provide units thoroughly acquainted with the rôle they will have to carry out. It will save dislocation of personnel of general hospitals, correspondence and loss of time in collecting a scratch unit, and the necessity for instruction which occurred when each fresh unit was formed.

[NOTE.—This method of extemporising small medical units only obtained over a limited area for a time, as has been stated already. When the collapse of the enemy as a concrete force took place, and our divisions were replaced by comparatively small columns, the field units were re-organised to meet the new necessities. But during the period covered by Lieut.-Colonel Skinner's report, these columns of which he speaks were in addition to the organised force in the field.

After detailing the position of the larger hospitals [in the line of communication in the Orange River Colony Lieut.-Colonel Skinner continues.]

On the portion of the Cape railway between Bloemfontein and the Vaal River there was then one advanced base and numerous posts. This system included Winburg, situated at the head of a small branch line running east from Smaldeel. Winburg formed an important strategic position intermediate in size between an advanced base and a post. The garrisons of all these places varied from time to time and, in the enumeration given below, the strengths stated are those which represent about the average kept up at the posts named.

The medical personnel of these posts or stations was collected piecemeal. In some cases a few men were detached from a regular medical unit; in the majority the Medical Officer was a civil surgeon. He had to obtain untrained regimental N.C. Officers and men to carry out the nursing as well as the fatigues of the hospital. The whole of the arrangements were improvised owing to the regularly organised medical units being required elsewhere.

The distance by rail from Bloemfontein to Kroonstadt is 127 miles, and from Kroonstadt to Wolvehoek 66 miles. The stations north of Kroonstadt evacuated into the general hospital there, as also did those immediately to the south. The latter, however, sometimes passed their sick to Bloemfontein if trains travelling in that direction were able to take them.

The medical and surgical equipment for small posts was somewhat similar to that noted above for a column of 500 men, extra appliances being supplied where necessary for treatment of sick.

List of Posts and Small Stations—Main Line.

—	Strength of Garrison.	Medical Officers.	R.A.M.C. Rank and File.	Regimental Orderlies.	Nurses.	—
Glen and Karce Siding ...	300 to 100	1 Civil Surgeon	1 private, 1 N.C. Officer.	6 to 10	—	The post at Glen protected the railway deviation and the works for the new bridge over the Modder. At Glen a cottage was utilised as a hospital, with bell tents in addition as required. The same at Karce.
Brandfort ...	Very variable, 600 to 900.	1 Civil Surgeon	—	10	1	An important town, with a large railway bridge to be protected. A small house, marquees, and tents used as hospital, altogether 24 beds. The number of sick treated here was sometimes increased by passing columns transferring their cases. As hospital trains could not always be depended on for their removal, the hospital had to be expanded by 6 beds.
Eensgerouiden ...	70	—	—	1	—	This outpost was visited by the Civil Surgeon from Brandfort, cases being transferred for treatment, as occasion arose, to his hospital, if they could not be taken to Bloemfontein.
Vet River ...	800, latterly 300	1 Civil Surgeon	—	10 to 12	—	A post guarding the deviation and the railway bridge works over the Vet. A hut, at first used for hospital purposes, was subsequently handed back to the railway. Marquees, 3, and bell tents, 2 to 6, met the requirements of a hospital—30 beds. Enteric fever was frequent at this post. Water supply variable, till a bore provided sufficient clean water.
Smalkeel ...	200	1 Civil Surgeon	1 N.C. Officer, 2 privates.	5 to 6	—	The junction for the Winburg branch of the railway. A hut supplemented by marquees and bell tents—20 beds. Passing columns frequently transferred sick. Here troop trains were provided with hot water for making tea.
Doorn River ...	300	1 Civil Surgeon	1 N.C. Officer, 2 privates.	—	—	A railway bridge to be guarded. Hospital bell tents, 4.
Sand River...	1,000 to 700	1 Civil Surgeon	—	2 N.C. Officers, 6 privates.	—	An important deviation and reconstruction of railway bridge had to be guarded. Marquees and bell tents. Water supply variable, till borings by R.E. supplied clean water. One ambulance.
Riet Spruit...	200 to 250	1 Civil Surgeon	—	1 N.C. Officer, 2 privates.	—	A small bridge over the spruit to be guarded. Hospital bell tents. The Medical Officer was not constantly kept at this post. When he was absent it was visited from Sand River or Ventersburg Road.

List of Posts and Small Stations—Main Line—(continued).

—	Strength of Garrison.	Medical Officers.	R.A.M.C. Rank and File.	Regimental Orderlies.	Nurses.	—
Ventersburg Road ...	Generally 200	1 Civil Surgeon	—	3 to 6	—	Hospital bell tents. Troops frequently passed through here, transferring sick. According to convenience of training, these sick were sent either to Kroonstadt or Bloemfontein. The Medical Officer sometimes had to take charge, in addition, of the neighbouring posts.
Hoffontein ...	Variable	1 Civil Surgeon	{	2	—	These posts were not constantly held. Hoffontein was visited as required by the Medical Officer at Ventersburg Road. Geneva was in charge, when held, of the Medical Officer of the unit forming the garrison.
Geneva ...				2	—	
2 Kroonstadt ...	—	—	—	—	—	Formed part of the Kroonstadt garrison.
B Bloemfontein ...	—	—	—	—	—	
Amerika ...	200	1 Civil Surgeon	—	2	—	Hospital bell tents were used at these posts.
Houingspruit ...	70	—	—	1	—	
Serfontein ...	96	—	—	1	—	Hospital bell tents.
Roodeval ...	450	1 Civil Surgeon	—	3	—	R.E. borings for water provided a supply.
Rhenoster Camp ...	100	—	—	1	—	Leeuwspruit was unhealthy. Water supply provided by R.E. by boring.
" Bridge ...	260	—	—	1	—	
Leeuwspruit ...	76	—	—	1	—	Well sunk.
Koppies ...	—	1 Civil Surgeon	—	4	—	
Vredefort Road ...	—	1 Civil Surgeon	{	1 N.C. Officer,	—	Hospital bell tents. Good deal of trouble about obtaining water at Krommellenboog. Wolvehoek, well sunk.
Krommellenboog ...	—	1 Civil Surgeon	{	4	—	
Wolvehoek ...				1	—	

List of Posts and Small Stations.—Winburg—Senekal Line.

—	—	Strength of Garrison.	Medical Officers.	R.A.M.C. Rank and File.	Regimental Orderlies.	Nurses.	—
Winburg ...	...	Variable, from 800 upwards.	1 Major, 1 Quartermaster, 2 Civil Surgeons.	3 N.C. Officers, 6	3 N.C. Officers, 30	5	Situated at end of branch line from Smaldeal. Hospital accommodation, 134 beds (church, 56; town hall, 26; school, 40; iron church, 12). Separate buildings for soiled linen store, clean linen, medical store, and Quartermaster's store. On emergencies this accommodation was expanded by occupying empty houses when ambulance trains did not arrive in time to remove sick brought in from the field. Later (September 18th) a field hospital was sent here to assist, both locally and by forming connecting links between columns operating in neighbourhood and the Winburg hospitals. In early part of operations was served by a field hospital, utilising building; subsequently evacuated. So long as the garrison was maintained at Senekal, the road to Winburg formed a route for convoys of food passing up and of sick passing down. But when the town was evacuated the hospitals were evacuated, and the transfer of sick along this line only occurred when columns were operating in the neighbourhood.
Senekal ...	...	...	Brigade 12th Brigade Field Hospital		...	...	In September, 1900, this village was occupied as a centre for military operations by a small flying column and a garrison. A small hospital of 6 beds was provided on September 25th, and was located in the church, in addition to tent accommodation for such cases as could not be transferred to Brandfort. The largest accessions of patients there were on October 6th and November 28th, when wounded were under treatment as the result of actions in the neighbourhood. The distance from Brandfort was 30 miles; it was not possible to maintain a rest depot between Bultfontein and Brandfort, as the neighbourhood was a disturbed one. The flying column was removed on October 2nd, 1900. The water supply, at first good, became bad and scarce in October, 1900. Filters were used.
Bultfontein...	...	200	1 Civil Surgeon	1 N.C. Officer, 2 privates.	3	—	Temporary post for transfer of sick back to Bultfontein from a small field force working from Abram's Kraal. Two bell tents with stretchers, 2 ambulances, 1 water cart, field panniers, medical comforts. This post was withdrawn in December, 1900.
Drie Pan ...	...	Police post	1 Officer R.A.M.C.	1 N.C. Officer, 2 privates.	—	—	

Ladybrand-Thabanchu Line.

At first Ladybrand was on the line of trek of the 8th Division, and the dispositions for the disposal of sick were made by that division.

In August the town was besieged by the Boers, and on its relief on September 5th the sick were evacuated to Thabanchu, Ladybrand being taken into the Bloemfontein lines of communication. It contained a small hospital in the care of a civil surgeon resident in the town.

Thabanchu and the neighbourhood was occasionally the scene of fighting. At Thabanchu a small temporary hospital was maintained. This, in September, was enlarged to meet the requirements of additional forces operating in the neighbourhood, a field hospital being also sent there temporarily. The Bedford Regiment and some mounted infantry formed the ordinary garrison; sick were sent on to Bloemfontein for treatment as much as possible.

At Sannah's Post was a garrison of a battalion of infantry and some mounted infantry. A small temporary tent hospital was constantly maintained for the immediate treatment of sick. Dependent on Sannah's Post for treatment of its sick was a small outlying post of Yeomanry, occasionally maintained at Krantz Kraal (strength 90 to 100).

At Boesman's Kop, when required, a small rest post was maintained.

Along this chain of posts an ambulance train worked, transporting sick to Bloemfontein for treatment in the general hospitals there.

—	Strength of Garrison.	Medical Officers.	R.A.M.C. Rank and File.	Regimental Orderlies.	Nurses.	—
Boesman's Kop	—	1 Civil Surgeon.	1 N.C.O., 2 privates.	—	—	A temporary post occasionally established for passing down sick. Hospital accommodation: 2 bell tents with 4 stretchers for beds (besides stretchers in the ambulance), medical and surgical pannier, 2 panniers medical comforts, 2 ambulances, 4 extra stretchers, 1 water cart.
Sannah's Post..	Gloucester Regiment.	Captain R.A.M.C.	—	12	—	Bell tents for hospital. Water cart, 3 ambulances, field panniers, medical comforts, &c.
Thabanchu ..	Bedford Regiment and M.I.	S. Captain	1 N.C.O., 2 privates.	3	—	25 beds in house and bell tents, 3 ambulances. A field hospital was added in time of additional pressure caused by active operations.
Ladybrand ..	600 Black Watch.	Lieut. R.A.M.C. and 1 Civil Surgeon.	—	6	3	This post remained under the 8th Division until after September 6th, 1900. It subsequently passed into the L. of C. under consideration.

(b) *Equipment for Posts on the Line of Communication.*

The Ordnance Department should hold reserve hospital equipment of all descriptions. The following are very necessary:—

Ambulance wagons.—One per 100 beds, over all, though certain hospitals may not need them.

Stretchers.—A large reserve should be held in ordnance charge for issue on demand. These are required for convoy work, and in the absence of bedsteads are extremely useful in extemporised hospitals.

Palliasse cases and pillows (empty).—For convalescent camps, extemporised hospitals, and locally made-up trains. Surgeon-General McNamara suggests that these (with stretchers) should be drawn by the Senior Medical Officer of the station on the line nearest the scene of action, and sent forward to the fighting line to aid in the evacuation of the casualties, should it be necessary to employ ordinary instead of ambulance wagons for the conveyance of the sick.

Tents.—Reserve tentage must be held in ordnance charge, both the hospital pattern (preferably of the type of the E.P.I.P.) tents, double and single circular, or better, of the Indian service pattern.

A large number will usually be required for addition to existing hospitals,

for small detention hospitals along the line, and for convalescent camps. The Army Service Corps should hold in reserve a large stock of disinfectants, as the demand is always large (*see also* p. 391).

(c) *Rest Hospitals and Railway Stations.*

When the line of communication is by road, sick convoy duties should be carried out by a section of a bearer company or its equivalent, as was done between Ermelo and Standerton, and between Carolina and Wonderfontein. Rest hospitals will be required at convenient distances, with tentage and some equipment, beds, cooking apparatus and supplies, to supplement that of the convoy party. These would be detached line of communication hospitals.

By rail, the hospital trains proper are self-contained. Locally made-up trains were often provided with a kitchen car, but in the case of ordinary trains conveying convalescents, arrangements had to be made to feed them at stations in the line. No elaborate arrangements are necessary; the important point is that the Officer in charge of the party should give early intimation of the numbers to be arranged for, and an idea of the time of his arrival.

It is most important that arrangements should be made in the larger railway stations for the supervision of parties of troops passing through it, and for immediate attention to any sick. It is the smaller parties of men without an Officer that require particular attention. Small parties of sick, too, are constantly arriving from the smaller posts on the line, possibly without ever having been seen by any Medical Officer, and in the confusion which exists it is very probable that they may escape notice unless there be a staff on the platform, whose duty it is to look for them.

In Bloemfontein a Medical Officer and a small staff were constantly on duty in the station, while in Pretoria a small rest hospital was established close to the railway station, and its staff met every train that arrived. In this way it was ensured that no man requiring attention failed to receive it.

Much assistance was given by residents at different stations on the Cape Railway, especially at Wellington and Worcester. At these stations a committee of ladies met every train conveying sick, and supplied delicacies for their use.

Mr. and Mrs. Osborne Howe also gave very great help to the army generally by establishing small "coffee shops" at various railway stations, where small parties of men (not parties of sick) travelling on the line were given refreshment, where otherwise they would have had to go hungry.

III.—MEDICAL ARRANGEMENTS ON LINES OF COMMUNICATION GENERALLY.

(1) *Scheme.*

The hospitals on the lines of communication should include :—

- (1) Stationary and general hospitals on the *permanent establishment* of the army corps at 7 per cent. of strength.
- (2) Additional stationary and general hospitals for the army corps at 3 per cent. of strength, or more.
- (3) Stationary and general hospitals for 10 per cent. of troops at the base and lines of communication troops.

The sequence of the development of the medical arrangements should be as follows :—

A. Base—

- (i) General hospitals as required—one near and in communication by rail with docks; others on the railway line.
- (ii) Base depôt medical stores.
- (iii) Base company, Royal Army Medical Corps.
- (iv) Convalescent camp.
- (v) Special accommodation for nursing Sisters arriving, quite distinct from the hospitals.
- (vi) Statistical office.

B. Lines of Communication proper—

- (1) Hospital trains.
- (2) Advanced base.
 - (i) General hospitals—as required.
 - (ii) Advanced dépôt, medical stores.
 - (iii) Convalescent camp.
- (3) Junctions—Rail and rail, or road and rail, stationary or general hospitals, according to their importance; convalescent camps and subsidiary medical store dépôts according to distance from the advanced base, and between these junctions.
- (4) Intermediate stations—Stationary hospitals or detachment hospitals from the larger units where needed; at still smaller stations, detention hospitals in rail communication with adjacent larger hospitals.
- (5) Stationary hospitals in touch with the field force.

A. Base.

As regards (1) and (2) it need only be remarked that the base dépôt medical stores should mobilise with the army corps, and embark on one of the first ships, in such a manner as to disembark without any delay. A base company, Royal Army Medical Corps, is essential from the first to systematise and facilitate the purely regimental work of the corps. A convalescent camp diminishes the pressure on the hospitals, and is better for the men, who have greater freedom than in hospital.

A statistical office at the base should be established for the compilation of all returns and records from materials furnished from hospitals. This would relieve the hospital staff of much necessary, but laborious, work which interferes considerably with the attention that they can give to other matters.

Special arrangements must be made at the base for the reception and accommodation of the nursing Sisters who arrive for the advanced hospitals. These ladies cannot go up the line until accommodation and servants are ready for them, and it is unfair to expect the arrangements at the base hospitals to be strained by additional demands on their resources when their legitimate work takes up all their time. An assistant Matron should be put in charge of this base dépôt for Sisters.

B. Lines of Communication proper.

(a) *Hospitals, position of.*—Developments on the lines of communication naturally follow the progress of the advancing army. Surgeon-General W. H. McNamara says on this point: "As the troops advance by rail communication hospitals should be advanced, remembering that wherever there is a concentration of troops, 1 per cent. to 2 per cent. of beds will be required *at once*. When stations are formed at more important junctions, &c., one or more communication hospitals should be established which should detach small hospitals to serve any minor stations on the line in the vicinity." In addition to these established at definite points, he recommends that the remainder should be kept on the railway "as near as possible to the scene of operations, so as to relieve the field units of their sick and wounded as soon as possible. These should be kept as empty as possible, especially when an action is expected." He suggests accommodation for 5 per cent. of the men engaged (two-fifths for seriously wounded, three-fifths slightly wounded) with means of evacuation of from 3 to 5 per cent. as a sufficient provision. Colonel Dorman says on this point: "These hospitals should not be allowed to become crowded with patients likely to require prolonged treatment; as far as practicable they should be kept clear for the reception of any rush of sick or wounded. As a rule, only those unfit to move, or men likely to be able to rejoin their units in a short time, should be kept; all other patients should be passed on as soon as possible towards the base. These hospitals should, in the first instance, be comparatively lightly equipped, so that they could be pushed forward without any unnecessary delay. They should also be capable of being moved away from the railway, when necessary, to form

receiving depôts for sick from columns in the field, such as was attempted to be done at Carolina with imperfect means. Had it been possible to send a few such hospitals by ox transport after the army in its advance to Paardeberg and Bloemfontein, much suffering might have been avoided. After Paardeberg the field hospitals could have evacuated the wounded into these, where they could have been more comfortably treated than is possible in a field hospital, which is necessarily almost destitute of comforts, and from which early evacuation is imperative.

In considering these points the term "stationary hospital" has been used, as it is that sanctioned by custom. But it conveys an erroneous impression of the duties that should be performed by the advanced hospitals on the lines of communication. Similarly the term "field hospital" suggests accommodation which cannot be provided in the fighting line. There is no doubt that the solution of the problem of dealing in the most satisfactory manner with the sick and wounded of the field army, can only be solved by eliminating the field hospital as a place for the treatment of sick and wounded, and the provision of more elaborately equipped light communication hospitals to move immediately in the rear of the fighting line, into which the field units can evacuate their patients daily. It must be recognised that the field ambulances (as they should be called) of an army in the field are not intended, and should not be used, for anything beyond the immediate succour of patients admitted to them. Every case which requires admission to the field ambulance should be passed on at once to the hospitals immediately behind the fighting line, and, except after an engagement, the field ambulance should normally be clear of sick and wounded. This relegates the field ambulance to its proper place as a dressing station of a more elaborate type than is at present contemplated by regulation.

It will probably be necessary to retain some form of divisional hospital in order that each division may be complete within itself. But this unit should be more elaborately equipped than the field ambulances, and should be provided with some form of light bed, and with pyjama suits for the patients. Further, it must be recognised that when this hospital becomes full of cases which should not be moved, it must be immobilised, and its place with the division taken by a similar unit from a reserve on the lines of communication. It should not be necessary for all sick from the brigade field ambulances to pass through this divisional hospital when it is possible to send them direct from the field ambulances to the advanced lines of communication hospital.

(b) *Evacuation of Hospitals.*—This system of immediate evacuation requires two conditions satisfied to be possible; first, a sufficient ambulance service between the hospitals of the division and the advanced lines of communication hospital; and, secondly, that these advanced hospitals shall always be in touch with the field army. Once it is recognised that this system is the only possible means of dealing with the case, there appears to be no reason why both conditions should not be invariably fulfilled. But so long as the field medical unit is spoken of as a "hospital," and is said to be equipped for so many "beds," it is not probable that any material advance will be made.

The route by which a wounded man would proceed from the field to Netley would then be:—

- (a) Field ambulance or divisional hospital.
- (b) By sick convoy (probably always by road).
- (c) Advanced line of communication hospital in rear of fighting line.
- (d) By sick convoy to (by road or rail)—
- (e) Hospital on the line of communication.
- (f) By hospital train to—
- (g) Base hospital.
- (h) By hospital ship or sick transport to—
- (i) Netley.

Successful medical administration in the field ensures two points; first, the removal of all inefficients through wounds or disease from the fighting units at the earliest moment possible after their inefficiency has been established, and, secondly, the return to the ranks of every man as soon as he has become fit to bear arms. The scheme outlined above provides for both

of these conditions. As to the second point the great desideratum is that the less serious cases shall be treated as close to the fighting line as possible. The less severe the wound or disease, the shorter the distance which the patient should be carried down the line of communication, so that the base hospitals should receive only cases of men seriously incapacitated or totally disabled. This involves a large proportion of the fixed hospital accommodation being established up country, but these advanced hospitals act as so many filters, so that only a comparatively small residuum reaches the base, and the number of men returned to duty at an early period is increased. It is a commonplace that the further a man is removed from the unit to which he belongs the more difficult is it for his Commanding Officer to get him back to the ranks, and this quite apart from the time he spends in hospital.

The only possible objection to the use of advanced line of communication hospitals to work immediately in rear of the fighting line is in the additional transport required. There would, however, be a small reduction in the transport of the field ambulance which might be reduced in equipment. Apart from this, however, there is no doubt that the authorised scale of the medical establishment for an army in the field (as provided for the late war) is too meagre, that considerable additions are necessary to render the system workable at all, and that the responsibility for a maintenance of the present insufficient provision should not rest with the Army Medical Service.

(c) *Mode of Evacuation.*—There are three stages: (1) between the fighting line and the field ambulance; (2) between the field ambulance and the line of communication hospital; and (3) between this last and the base.

(1) It has been shown in the general account how great the distances may be which have to be traversed in modern warfare in the conveyance of the wounded to the field hospital, as especially instanced at Magersfontein, where the difficulties are very distinctly shown. It is a physical impossibility for ambulance transport which has been employed in this way to continue the evacuation over the next stage to the line of communication hospitals.* Lieut.-Colonel Skinner (who as secretary to the Principal Medical Officer, 6th Division, saw the work in the advance to Bloemfontein) with regard to this says:—

“The next line of assistance to the sick and wounded provided for in the British army is the general hospital, or the stationary hospital. Between this and the first line no link is provided in war establishments, unless the field army is on an open railway. No provision is arranged for conveying sick and wounded from the field to the railway or to the nearest hospital. The Principal Medical Officer of a division has enough to do to look after his own units; he cannot be expected, even if he has ample sick transport, to look after his lines of communication. War establishments allow 10 ambulances per bearer company; this number if actually present might enable the divisional Principal Medical Officer to evacuate his sick a short distance after small actions. But those who have seen a battlefield extending over some miles of country, with wounded scattered about and requiring searching for, often prolonged, will not expect the ambulances to not only take the wounded from the field to the field hospital, but also to remove them thence along a line of communication. It must be remembered that these ambulances have marched to the scene of action; have travelled for hours over the battlefield, backwards and forwards between the fallen groups of wounded and the field hospital situated one to two or more miles in the rear, and perhaps have not completed this task till daylight the next day; and also that they will have to march forward again with the force the day after the fight. That these ambulances can convey the wounded to the advanced base, and return to overtake their field army is out of the question. Ambulances engaged in linking up the field units with the advanced base should not belong to the field force, as laid down in paragraph 158 of ‘Regulations for the supply of an army in the field, &c.’”

It has already been shown how some of the field units were detained behind their brigades during Lord Methuen's advance owing to the fact that they had to dispose of their sick on the line of communication.

* A motor ambulance is the only form of vehicle which could or should be used in this way.

(2) The want of some organisation to remove the sick and wounded is illustrated by the difficulties during the investment at Paardeberg, when convoys had to be sent back in empty supply wagons. The same thing, except that the numbers were smaller, occurred during Lord Roberts's advance to Kroonstadt. In both only improvised methods were possible.

It is, however, to be hoped that the use of advanced lines of communication hospitals, pushed up close behind the fighting line, will diminish this difficulty by shortening the distance to which the wounded have to be conveyed.

Two things are necessary for the conveyance of the sick and wounded from the field ambulances and divisional hospital to the advanced hospitals on the lines of communication; these are, an ambulance wagon train, and personnel for convoy duty, both Officers and men. The field units, as at present constituted, cannot spare the personnel required for convoy work. The legitimate work of the brigade field ambulances, in picking up and attending to the sick and wounded, demands all the strength and energy that can fairly be expected from their staffs, and the additional strain of convoy work only leads to a disastrous breakdown. Additional Officers and men must be added to the numbers at present sanctioned for a division for these convoy duties.

As regards ambulance wagons, as a rule it will not be possible to make much use of those belonging to the field ambulances for convoy duties, though on occasions it may be possible to withdraw some for this work. Ambulance wagons should be available from a reserve on the lines of communication, and should be pushed forward as early as possible. But it will probably always occur that the supply of ambulance wagons cannot be made equal to the demand, and in such cases the empty supply wagons must of necessity be used. If the palliasses cases recommended to be held on the lines of communication are sent forward empty to be filled on the spot, these supply wagons can be made comfortable. (See also some remarks on this subject under the section dealing with field medical units, p. 118.)

The duties of the Principal Medical Officer of a division as regards the evacuation of his cases would certainly cease at the advanced lines of communication hospital; behind this convoys would come under the jurisdiction of the Principal Medical Officer, Lines of Communication, whose duty (or that of a Senior Medical Officer at the post nearest the fighting line as his deputy) it would be to see that not only was sufficient accommodation available in the advanced hospitals to meet any probable demands, but that the Principal Medical Officers of divisions operating from that section of the line were supplied with such additional ambulance wagons and personnel for convoy duties as the circumstances at the time might require.

(3) Evacuation between advanced line of communication hospitals and the base.—It will probably happen that the advanced hospitals are off the railway line. During the South African War there were numerous instances. From Ermelo sick convoys were brought into Standerton by a bearer company, and the hospitals in the eastern part of the Orange River Colony were similarly situated, but, as a rule, the calls on them were smaller.

Evacuation by rail was carried out by:—

- (1) Hospital trains proper.
- (2) Improvised hospital trains made up of saloon carriages with a kitchen car added.
- (3) Ambulance wagons attached to ordinary trains.
- (4) Ordinary trains.

The hospital trains proper are described under a separate section (Part IX, p. 213).

As far as possible, the more serious cases were retained till they could be sent by the hospital trains proper. The improvised hospital trains acted very satisfactorily for cases of less severity, while ordinary trains were normally used only for convalescents. Ambulance wagons attached to ordinary trains were used for short distances only, working from a large centre (such as Bloemfontein, Elandsfontein, and Pretoria) along the line to the adjacent posts. They had the advantage of affording a more regular method of evacuation than could have been arranged for by the use of the hospital trains

proper, which were primarily designed for carrying considerable numbers over long distances. These wagons were fitted with standards to carry stretchers, with cooking stoves (paraffin), washing apparatus, commodes, and bed-pans, besides the usual medical comforts and the necessary drugs and other supplies. Surgeon-General McNamara suggests that a kitchen and store wagon should also be prepared (*see* Appendices XXVIA, B, C, and D), and points out that an improvised train made up of some of these ambulance wagons (for stretcher cases), kitchen and store wagons, with additional ordinary carriages would form a very excellent means of transport. But in a country such as South Africa where the distances are great, it is not difficult to improvise a satisfactory train from the ordinary rolling stock, saloon carriages and kitchen cars, provided the military position allows these to be obtained.

Surgeon-General McNamara says: "Ordinary trains should have a stove and some hospital appliances, such as night stools, towels, basins, tea-cans (so that men could always be provided with hot tea as may be required), which should be taken back to the hospital furnishing them," and further: "If the Medical Staff have not an opportunity of disinfecting a railway carriage used to convey enteric and dysentery cases, the carriage should be labelled for disinfection by the railway authorities. Acute dysentery and enteric should not be evacuated if it can be avoided on account of the danger to the patients and of infecting the line."

Lieut.-Colonel Skinner gives the result of his experience on the Bloemfontein section:—

"The evacuation of sick is mainly carried out by ambulance trains, but supplemented by ordinary trains. These ambulance trains usually complete their load at advanced depôts or at rail head, and are not then in a condition to take in cases at the numerous small posts.

"The Principal Medical Officer should have at his disposal, for use within his section, at least two railway carriages on bogie wheels, fitted with lying-down accommodation, latrines, lavatory, for eight or ten sick, with a small compartment for one N.C. Officer and one orderly, and a small store for drugs, surgical dressings and appliances, and medical comforts, and a stove with utensils for boiling water. These carriages will be constantly on the move, attached to ordinary trains, up and down the line, bringing in cases for treatment to the nearest stationary or general hospital, and carrying medical supplies to posts. Should the loading of a carriage be likely to occasion delay to the train to which it is attached, such carriage will be slipped, and be taken on by the next train without delay to the nearest hospital, the approximate hour of arrival being notified by the Medical Officer. Objection will be raised that ordinary trains do not travel under the Red Cross flag, and therefore an ambulance carriage should not be attached to them. The reply is that if it is possible to provide sufficient ambulance trains to deal with a long line of detached posts, there will be no necessity for such carriages as those under consideration; but if there are not sufficient, it is essential that the deficiency be supplemented as above; and it is better to run the risk of being shot at (a remote risk, as this war demonstrates), than that the sick should remain in a position where they cannot be attended to properly, and where, moreover, they are likely to become foci for the spread of disease and a source of certainly not encouragement to their healthier comrades. Besides, during this war ordinary trains were used for the transfer of sick, even though they had no special hospital appliances."

Colonel J. C. Dorman, with reference to his experiences as Principal Medical Officer, Eastern and Northern Lines, writes:—

"Eastern Line.—A Dutch ambulance coach, containing 18 beds, and a first-class carriage were kept at Komati Poort, and, according to requirements, one or both left Komati Poort every Monday and Thursday for Waterval Onder, picking up sick from all intervening stations. Two similar coaches left Waterval Onder for Middelburg twice a week. These coaches returned to their stations the following days, unless urgently required elsewhere. Of course, their running had to depend on the state of the line, whether interrupted or clear. When necessary, patients were transferred by these coaches from Middelburg to Pretoria, or an ambulance train was sent out to relieve pressure,

"For the carriage of sick from the posts between Middelburg and Pretoria a wagon fitted with 12 stretchers on standards left Middelburg twice a week, and conveyed the sick to either No. 2 or No. 7 General Hospital.

"Whenever necessary, accommodation was reserved for sick in the ordinary trains, a first-class carriage being placed at my disposal as required. Occasionally, when many sick were expected at any point on the line from columns, the Waterval Onder coaches were brought to the place, so there was no delay in their transference to hospital.

"During the time a hospital ship was in Delagoa Bay, sick were transferred to Lorenzo Marques in a first-class carriage specially reserved for the purpose; 22 patients lying down could be carried, or a larger number sitting up. From the shore to the ship sick were conveyed on a lighter covered with an awning, and towed by a launch.

"The 'Princess Christian' hospital train was stationed at Pretoria; it was chiefly employed conveying sick and invalids to Natal for passage to England, and as required was sent to bring in sick and wounded from the northern or eastern line.

"Northern Line.—On the northern line from Pretoria to Pietersburg, 168 miles, the arrangements were somewhat similar, but as the garrison holding the line was comparatively small, and sickness and fighting much less than on the eastern side, the arrangements were on a much smaller scale. Hospitals of 100 beds were established at Warm Baths (80 miles from Pretoria) and at Pietersburg, and a few beds (four or six) at some of the intermediate stations.

"Two covered wagons, each fitted with 12 stretchers, ran twice a week, one from Pietersburg to Warm Baths, and one from Warm Baths to Pretoria, and in these sick were conveyed to hospitals from the intermediate stations. On a few occasions the hospital train was sent to clear the line and relieve pressure, but this seldom occurred, as I had an arrangement with the railway that, if necessary, Medical Officers could requisition the passenger carriages at any time for sick.

"In Pretoria, Nos. 2 and 7 General Hospitals were placed on the line and special platforms were built at which all passing trains carrying sick stopped. The sick and wounded were thus brought close to hospital, and were easily conveyed on wheeled stretchers to the marquees. A special siding was built for the hospital trains.

"If it is necessary to send sick to hospital by ordinary trains, very stringent orders should be issued as to the mode of transport. I always insisted on fever and dysentery cases being brought on stretchers if sent by ordinary trains. These were placed in wagons; other sick were sent in passenger carriages, an arrangement having been made with the railway authorities that half the passengers' accommodation might at any time be requisitioned."

With regard to the mode of evacuation by improvised trains Surgeon-General McNamara makes the following remarks:—

"Nominal rolls should be made out (*see* Appendix XXVII). The Medical Officer should arrange through the staff for transport to station, accommodation required on train, and have water available in the carriages. Corridor carriages are the best; sometimes comfortable lying accommodation can be arranged for in trucks by placing barrack palliasses on the floor. Arrangements should be made that any water closets opening on to the line should be locked at railway stations. A diet should be arranged for (from rations) drawn for men fit to eat rations, and supplemented by medical comforts or articles got locally or on the journey (*see* Appendix XXVIII). Special diets must be arranged for from medical comforts, local resources, and any number of rations considered necessary to supplement them. The men on ordinary diets should be divided into messes by carriages, and one or two of their number who are fit for duty detailed as orderly men; N.C. Officers fit for duty should be detailed to the charge of two or three carriages. The Royal Army Medical Corps N.C. Officer would take charge of the kits of the seriously ill, and supervise generally the cooking and messing of the serious cases. In the absence of a nurse the Royal Army Medical Corps men cook for, and nurse the serious cases. In all these duties as many N.C. Officers and

men as are fit for duty should be told off to help. Before starting the men should be clothed and have blankets according to the exigencies of the climate, and be supplied with any necessities required and hospital clothing in cases seriously ill. A N.C. Officer preceding the men to the train should arrange the train, place night stools, &c., in the carriages, and be prepared on the arrival of the invalids to point out the accommodation for the different classes. The Medical Officer in charge of the train should telegraph to stations *en route* his requirements, and also any empty accommodation he may have; the Principal Medical Officer informs him of the hospital he is to take his invalids to, and he should keep the hospital informed of any delay in the train, &c. The hospital arranges to take over at the railway station."

The arrangements for the reception of the sick from a hospital train depend upon the local conditions at the station at which it is to discharge its load. If there be more than one hospital established there, the Principal Medical Officer details a party from the hospital with wagons and stretchers, to receive the patients and distribute them among the hospitals according to the accommodation available. Lieut.-Colonel Skinner suggests that:—

"At every advanced depôt railway station should be located a Medical Officer with a sub-section of a line of communication field or stationary hospital, with two ambulances to receive and distribute the convoyed sick to general hospitals. He should be daily supplied by the local Senior Medical Officer with a slip stating the number of vacant beds at the local hospitals, and in accordance with accommodation available he must distribute the sick at his discretion. The ambulance transport at his disposal will be sufficient to deal with the sick brought by the special railway carriages, the hours of arrival of which are likely to be erratic. In the event of ambulance trains requiring to discharge their load at a depôt, the hour of their arrival will have been notified, and a collection of sufficient ambulance transport made for the occasion."

This was substantially the method adopted in the larger stations such as Bloemfontein and Pretoria.

As to the method of entraining patients from a hospital, or of receiving them, the following remarks by Lieut.-Colonel Skinner (based on his experience at No. 7 General Hospital, Pretoria) describe one satisfactory mode of procedure:—

"The loading and unloading of ambulance trains should be carried out on a pre-arranged system. The following was found to work well:—When unloading the Medical Officer receiving the sick goes round the cases in the train with the Officer in charge. He gives each case a slip of paper marked "S" or "M," according as the case is to be removed to the surgical or medical division of a general hospital. The men able to walk out of the train are then drawn up on the platform, and placed on seats in ambulance wagons. The lying-down cases are then dealt with, stretchers being taken into the carriage, the sick men placed on them and carefully removed, being conveyed to their wards either by orderlies or by means of the bicycle-wheel arrangement found so useful in South Africa. The cases are then taken to the Medical Officer of the division to which they have been consigned, and are put to bed and treated under his direction.

"In loading a train this process is reversed, the sick are collected from divisions in the charge of one Officer; they are taken to the platform and handed over with explanatory remarks to the Medical Officer of the train. The latter then gives each man a ticket for his berth to which he is removed under the guidance of the personnel of the train, the lying-down cases being first accommodated.

"The quartermaster or N.C. Officer in charge of the pack store (if there is no quartermaster) hands over the kits to the N.C. Officer of the baggage van, handing over lists and taking receipts. In unloading the process is reversed.

"The Medical Officers hand over money and valuables of the sick, giving lists and taking receipts.

"The Officer of the hospital entraining the sick is responsible that every patient he takes to the train is properly clothed and provided for, and has obtained everything to which he is entitled."

The longer the line of communication and the more posts on or near the railway, the greater is the difficulty of arranging for the removal of odd cases of sickness or injury. The regular ambulance trains must be reserved for the more important duty of the transport of large numbers of serious cases, the smaller ambulance coaches can never be provided in sufficient numbers to ensure a daily visit to each post on the line. The difficulty both as regards hospital trains and ambulance coaches is not only one of their supply—the question of their haulage is also important. Certainly throughout the late campaign, the demands on the railway were such that while the necessities were always met, it would not have been possible to increase the quantity of sick transport running on the lines. The result is that odd cases, which require immediate transport to a hospital, have often to be transferred by the ordinary train service. This was the case in South Africa, but the necessity was greatest at the times of heaviest pressure on the railway, that is immediately after the occupation of Bloemfontein, and during the advance to Pretoria. After this, local ambulance coaches were largely employed, and special accommodation was engaged on the ordinary trains.

This is a question of care and judgment. In many instances it is far better for the patient to be sent (with due precautions) by an ordinary train to the nearest hospital, than to be kept back till special ambulance accommodation is available.

IV.—ADMINISTRATION OF LINES OF COMMUNICATION.

(a) Staff.

There is little doubt that the staff on the line of communication requires to be strengthened.

The Principal Medical Officer (on the staff of the General Officer Commanding, Line of Communication) is responsible for the whole of the arrangements on his line, the establishment of hospitals, the provision of personnel to strengthen existing staffs or to replace casualties, the transport of the sick and wounded, the supply of medical and surgical stores, of Army Service Corps supplies, and of Ordnance equipment, also for the local purchase of such things as are needed if they cannot be obtained from, or through the regulation channels. This responsibility carries with it the necessity of inspection of the line to ascertain from personal observation how the duties are being carried on, and to estimate the additional requirements. Our experience in South Africa has shown that, especially with a mixed staff such as was employed there, no inspections can be too minute or too often repeated, especially as regards sanitation. But when the line has developed to any length, when large and important hospitals have been opened (often massed in the headquarter station of the line) it becomes impossible for the Principal Medical Officer to carry out both sides of his work equally well. If he devotes his energies to the hospitals, with the very important questions of the accommodation and treatment of their patients, he must neglect the inspection of the line, and *vice versa*. It must always be remembered that the tendency will be to devote special attention to the development and elaboration of the hospital system if both duties cannot be carried out, for these come more prominently before the public eye. Every man understands when he is comfortably housed in a good hospital, but our experience with regard to work on the line (more especially sanitary), has been that such improvements as it was proposed to make have been regarded by the army generally as matters of less importance.

If the suggestions made above as to the pushing out into the field of advanced line of communication hospitals, and the supply of personnel and wagons for convoy work behind the field ambulances are adopted, this fact alone adds enormously to the duties required from the line of communication staff. The arrangements as to transport admit of no delay; they can only be carried out by an Officer on the spot in touch with the field army and in constant communication with the transport and ordnance departments. These duties are too important to allow of their being thrown on to the shoulders of an Officer in charge of a line of communication hospital, who

already has as much responsibility (if he carries out all his duties) as he can undertake.

As the line develops no doubt a sub-division into sections will always take place.

In the South African Campaign, Surgeon-General W. H. McNamara, C.B., C.M.G., was Principal Medical Officer of the lines of communication, Cape Colony, his duties extending to the borders of the Orange River Colony on all sides until late in the campaign, when the Principal Medical Officer western line (Colonel E. Townsend, C.B., C.M.G.) took over the duty between Orange River and Mafeking. In the Orange River Colony the line was divided into sections; the actual division varied in detail from time to time. But the Principal Medical Officer on the staff of the General Officer Commanding Bloemfontein was responsible for the most important section of this line. For some time after the advance to Kroonstadt, the General Officer Commanding 6th Division commanded in Bloemfontein and on that section of the line of communication, and the Principal Medical Officer (at first Colonel W. L. Gubbins and later Lieut.-Colonel B. M. Skinner) was responsible for the medical arrangements between Bloemfontein and Wolvehoek (excluding Kroonstadt). South of Bloemfontein the Principal Medical Officer at Springfontein was responsible for the section as far as Norval's Pont.

In the Transvaal, the Principal Medical Officer at Elandsfontein (Colonel J. D. Edge, C.B.) was responsible for the line to the Vaal as far as Viljoen's Drift, for the western line to Klerksdorp and the Natal line to Charlestown. Till October, 1900, Colonel J. C. Dorman, C.M.G., was Principal Medical Officer of the eastern line from Pretoria to Komati Poort, while the Principal Medical Officer Pretoria (Colonel W. L. Gubbins, M.V.O.) was also responsible for the northern line to Pietersburg. When Colonel Dorman succeeded Colonel Gubbins (on the latter being invalided home) as Principal Medical Officer Pretoria, he retained the eastern line under his jurisdiction, in addition to assuming Colonel Gubbins's duties, as the arrangements had there been working well for many months, and less personal attention was required.

At these large stations, Bloemfontein, Elandsfontein, and Pretoria, not only were the duties in connection with the railway line important, but there was a large hospital establishment (amounting in the case of Pretoria to about 2,700 beds), and for the administration of these large centres Principal Medical Officers were specially detailed. But Senior Officers for these posts only became available from among the Principal Medical Officers of divisions as these were broken up. At the smaller stations the Senior Medical Officer was responsible for the station and for the immediate needs of the adjacent small posts.

It appears to be asking too much of one man to expect him to administer a number of large hospitals (as in Pretoria and Bloemfontein) and at the same time to look after his section of the lines of communication with that personal attention to detail which experience has shown to be necessary, and which is the most essential just at the time the larger hospitals are of the greatest importance, and the success of the work in South Africa was obtained at the expense of great personal strain on the Officers to whom these duties were entrusted. But there is no doubt that the Principal Medical Officer lines of communication must be on the staff of the General Officer Commanding lines of communication (or of the section) and in touch with all that is going on on his line, and there is an obvious advantage in retaining the control of the hospital accommodation and of the means of evacuation in the same hands. Accommodation is required for the cases coming in from the line, while evacuation deals with movements of patients both to and from the hospital centres. Further, by watching the admissions to the hospitals from the posts on the line, the Principal Medical Officer obtains valuable information as to the danger points at which special attention is necessary. The local conditions at a post vary so much from time to time with the changes in the garrison, with the arrival of columns, and other incidents of the campaign, that no estimate of the possibilities of a post as a centre for disease can compare with the actual knowledge of the facts. Of course, all important changes in the local conditions should be reported to the Principal Medical Officer by the Officer in charge of the post, but is safer to give opportunity for independent opinion, the more that the Principal Medical

Officer has it in his power to compare one post with another, while the individual Medical Officer has usually no opportunity of so doing.

It would appear to be necessary to detail Officers to assist the Principal Medical Officer of large centres covering important sections of the line. These Officers should be clear-headed active men, not too senior in the service, who would be required to spend the greater part of their time travelling up and down the line of communication. One of their first qualifications should be a knowledge of practical field sanitation. Their duty would be to represent the Principal Medical Officer on the line; to report to him at once all matters requiring attention which they were unable to remedy or arrange for.

But in order to facilitate their work, which must often deal with questions of an extremely urgent nature, they should be detailed as Staff Officers to the Principal Medical Officer, and authorised to sign for him. By giving this power it would be possible to hold them personally responsible for the arrangements on the section of the line for which they were detailed.

In the South African War besides the Principal Medical Officer, line of communications, and the first Principal Medical Officer Bloemfontein, the administrative staff which came to be employed on the lines of communications was collected from the divisional staffs as the divisions were broken up.

It is, of course, the case that the line of communications is a matter of growth, and that personnel for its full length may not be required until Officers can be spared from the field army. But if the medical arrangements on the lines of communication are to be pushed further into the field as recommended above, the lines of communication staff must be strengthened from the very outset, unless indeed the operations are conducted from a comparatively small base. It would certainly seem advisable to have one Officer at each point of concentration or advance whose sole duty it would be to supervise the local arrangements for the carriage and accommodation (as regards numbers) of sick and wounded, under the general instructions of the Principal Medical Officer line of communications, to whom he should act as Staff Officer. These Officers should be included in the detail of the force to embark; it should not be necessary to take them from units after the arrival of the troops in the country. The numbers necessary would vary with the strategical conditions at the seat of war, and could only be determined for each individual campaign. The maximum would be one per division in cases where these would probably act independently.

In the late war, during the earlier months preceding the final advance to Kimberley and Bloemfontein, Surgeon-General E. Townsend, C.B., C.M.G., was Principal Medical Officer of Lord Methuen's force in the first operations. Behind him, at Orange River, Colonel Donovan, C.B., was employed as Principal Medical Officer for a time pending the concentration of the cavalry division, but apart from this, the arrangements were in the hands of the Senior Medical Officers at De Aar and Orange River, under the personal supervision of the Principal Medical Officer Army who inspected frequently. This arrangement was not entirely satisfactory. Officers in charge of hospitals in time of active operations have as much to do as they can manage, and either the supervision of the hospital or the outside arrangements must suffer. Also while the Principal Medical Officer of an army in the field is finally responsible for all matters connected with it, it is out of his province to deal with detail, in the manner which was necessitated in this particular instance.

(b).--Inspection Duties.

The importance of the inspection of the line varies very much with the staff employed on it. In smaller wars, where it is possible for the regular medical service to meet all the demands, less supervision is required than in larger operations where the trained service is supplemented from other sources. The experience of South Africa has emphasised the difference between the purely professional duties of the surgeon and physician in civil life and those of his confrere in military service. On service a Medical Officer has to consider every detail which affects the patients who come under his care, food,

clothing, transport, and the like, all the time bearing in mind the larger necessities of the army generally, the necessity of accommodation at the front, and the return of every man to the ranks at the earliest possible moment. He must recognise that his work as a physician or surgeon is only part of his duties. On the other hand, the additional staff, without military experience, lay the greater stress on the treatment of the individual as a sick or wounded man, and are apt to overlook, not only the necessities of the army generally, but the needs of the patient outside the actual medical or surgical treatment required. In most cases, however, these necessities have only to be impressed on the previously untrained staff to ensure their being carried out, but the point is that supervision and instruction in these matters are required before these gentlemen become interchangeable with the permanent staff. The same thing obtains as regards sanitation. Every officer of the Royal Army Medical Corps has some training in sanitary duties, and takes them as a regular part of his work, while the civilian personnel have often no knowledge of what is required, nor do they consider it part of their work until it is pointed out to them.

The result is that for every reason, careful and repeated inspections are obligatory if the work on the line of communication is to be carried on at all satisfactorily.

Surgeon-General W. H. McNamara says with regard to this:—

"There should be a very frequent inspection of the line, and in case of a long line one or two sectional Principal Medical Officers will be required. The chief points to be noticed at these inspections are—

"The general treatment of the sick, especially as to dieting. That no operations such as radical cure of hernia, severe operations for piles, varicose veins, &c., which do not fit men for the field in a reasonable time are performed, when beds may be required for sick and wounded.

"The sanitary condition of the hospital and the disinfection of stools, clothing, &c. (for scale of disinfectants suggested, see Appendix XXXVIA, II and III). It should be ascertained that personnel of field units are not detained in communication hospitals instead of returning to the front, that no so-called convalescents who should be at duty with their units are retained for the purpose of doing odd jobs in hospitals.

"Constant watch should be kept that no men who should be at the front or invalided to England remain in hospital, and on the evacuation of invalids, the manner in which it is carried out and the suitability of the cases. From time to time, according to the exigencies of the campaign, a definite order should be given, stating that if a man will not be fit for duty in such and such a time he should be invalided. Whenever there is a suspicion that there is friction amongst the staff of a hospital, as when Officers, nurses, men, &c., ask to be removed to another station, the hospital should be visited at once. Some hospitals will require very little inspection, while others, faultily managed, will require repeated inspections.

"The time of a hospital staff should not be taken up in attending to non-essentials, such as beautifying the hospital, &c., until necessary sanitary measures are thoroughly carried out.

"All competition between hospitals which does not have an immediate bearing on the treatment and comfort of the sick, and does not tend to return men to the fighting line should be discouraged. The man who organises a hospital complete in sanitary arrangements and all essentials for treatment in the shortest time is incomparably more useful than the one who elaborates and wastes time. All Medical Officers should know that the Inspection Officer never loses sight of this point.

"Camps should be frequently inspected and their sanitation enquired into, especially if there be any excessive sickness.

"The most arduous, anxious, and difficult medical work is done by Medical Officers on the line of communication in war, and they should be able to look forward to having their services recognised. Medical service at the front, though at intervals hard, is not continuous, and in wise administration the majority of the best Medical Officers are kept on the line.

"There should be also a systematic way for supplying tobacco, writing paper, books, recent magazines and newspapers, &c., in due proportion

according to the size of the hospital laid down in peace and regularly carried out in war. It is ridiculous to block the line of communication with old newspapers and other articles because it strikes kindly people that they would be useful. This kind of thing frequently prevents what is really wanted getting to the front.

"The Principal Medical Officer, line of communication, should get a weekly telegram giving him information, &c., which will enable him to move hospitals, increase or decrease personnel, instruct Medical Officers as to evacuation, &c. From this the Principal Medical Officer of the line can keep a chart which shows him week by week the position of each station as regards sick, hospital accommodation, personnel, &c., and can act accordingly" (see Appendix XXXVIII.)

Colonel J. C. Dorman, from his experience (especially on the eastern line), makes the following valuable observations:—

"The frequent inspection of all posts and hospitals is most important. The Principal Medical Officer should make himself familiar with the local requirements, resources, peculiarities, sanitary condition, water supply, &c., of each post or station. This is particularly necessary where civil surgeons without any previous military or sanitary experience are employed. In such stations I often found it difficult to ensure that sanitary recommendations were made or carried out in a satisfactory manner, and it was only by personal investigation on the spot that many matters, which might otherwise have been obscure, were cleared up. The boiling of drinking water may be cited as an instance of this; unless closely watched and thoroughly inquired into such a procedure might be a source of danger rather than safety. A common arrangement to find was a large tank which was rarely emptied, but a few kettlesful of boiling water thrown in daily to replace what was expended, or I have seen water carefully boiled, and then filtered or aerated by dropping through doubtful cloths. Methods of storage were often bad, and the so-called cleaning of tanks left them in a worse condition than before. In such ways a report that all water was boiled was of little value unless personally investigated.

"The management of trench latrines or urine pits was often little understood, and had to be explained, and other points in the sanitation of camps had to be carefully enquired into, particularly the disposal of refuse and rubbish, which, through alleged want of transport or labour, was often allowed to accumulate in the vicinity.

"Inspection, too, was required to ensure that the advanced hospitals were properly evacuated. To enable these frequent inspections being carried out, a senior Officer should be appointed Staff Officer to the Principal Medical Officer, capable of carrying on all ordinary duties during his absence from headquarters.

"I have already noted some points in the sanitation, but the greatest difficulty often occurred when a column visited a station for a day or two, as the ground was frequently left in such a condition that local means were inadequate to cleanse it.

"The disposal of dead animals, too, was often a difficulty, which can only be dealt with by a special sanitary staff with sufficient labour to bury the carcasses: burning was not successful in South Africa.

Latrines gave much trouble. When ground is to be occupied for a short time only trench latrines must be used, but when camps are to be occupied for a long period, if possible bucket latrines should be provided, but the management of these requires the closest supervision, otherwise the surface becomes much fouled during the removal of the soil. The use of dry earth should be insisted on. Soldiers are careless, and contractors object to this addition.

"The filth trenches for the deposit of soil require looking after, or they too will cause a nuisance. Flies are difficult to contend with. Sprinkling chloride of lime round places where they congregate seemed to be more effectual than anything else. Kitchens and all places in which food is kept should be protected with wire gauze. In malarious regions mosquito nets should be provided for garrisons; by their intelligent use with careful sanitation the sick rate at Komati Poort was reduced during the first six months of 1902 to less than half what it was in the corresponding period of 1901."

V.—INVALIDING.

The mode of transport has been described in the section dealing with hospital ships (Part X, p. 220). The details as to causes of invaliding are reserved for the statistical section.

(a) Rate of Invaliding.

Speaking generally, invaliding was carried out throughout the army in South Africa much more freely than is usually considered necessary in ordinary service abroad. There were several reasons for this.

When it was expected that the war would be over quickly, men were sent home when it was not probable that they would be again fit for duty within this estimated time. Later, there was equal reason to believe that a man might be sent home and return in time to take part in the campaign for a second time, and, as a matter of history, many of the men sent home as invalids returned to the country and rejoined their units long before the cessation of hostilities. Further, an increased rate of invaliding diminished the pressure on the hospitals in South Africa, where for a time, at the beginning of the war, the accommodation was somewhat strained in certain areas. One very important factor in the continuance of the high rate of invaliding was the existence of a satisfactory system of hospital ships and sick transports. These provided early accommodation for cases who were fit to travel, and it was not necessary, as is the case under ordinary peace conditions, to wait some considerable time for the ordinary sick transport. That is, during the late war, a sick man was often sent home for complete recovery, where, under peace conditions, he would have recovered, and probably returned to duty before an opportunity of sending him home occurred. It was easier and more economical to provide for these cases on a returning transport than to maintain accommodation for them in South Africa. There is therefore no common factor by which the rate of invaliding during the South African War can be compared with that obtaining during peace; nor is it probable, owing to the greater facilities in this case, that any true comparison can be made of our records with those of other campaigns.

There were other factors depending on the composition of the force, and the circumstances under which it was sent out, which increased the rate of invaliding. In addition to the Regular Army (including the Reserves) there were Militia, Volunteers, and Imperial Yeomanry from England, with the various corps of over-sea colonials, and of the South African irregular forces.

The physique of the first Regular troops that came out (including a large proportion of the Reserves) was excellent.

Afterwards the quality deteriorated, to reach its lowest in the later drafts that arrived which contained many young and immature lads of poor physique. As regards the Militia, they were, generally speaking, inferior to the Regulars, a large proportion were 18 or 19 years of age, the minimum age being 18, while in the Regulars, Volunteers, and Imperial Yeomanry the standard was 20 years of age. The Volunteers were, speaking generally, of good physique, as were the first contingent of Imperial Yeomanry. The second contingent were less satisfactory, while the third contained many men and some Officers who should never have been enlisted.

Among the units of the Regular Army the rate of invaliding must always be less than among an equal number of men recently enlisted. In the former a natural process of elimination has been going on, the weaker men have dropped out during the early period of their service, and the stronger remain. In the South African War this (which one may call a normal elimination) was in process during the whole campaign, and at an accelerated rate owing to the exigencies of active service. That is, the invaliding rate of an army composed as ours was in South Africa is not comparable with that obtaining in an army composed solely of Regular troops.

Apart from this, other causes contributed to increase the number of inefficient. As the campaign progressed the quality of the recruits deteriorated, partly due no doubt to the increased call for men, but there is no doubt that much of this inferiority of the later arrivals was due to want of care in the medical examination of men of the Regular Army for active

service and in the enlistment of recruits. At the beginning of the war not only were the bulk of the troops of better physique, but their examination was in the hands of the Officers of the Royal Army Medical Corps, who have a practical knowledge of what is required of the soldiers on service. Later, when the home stations were denuded of Officers of the Royal Army Medical Corps, these examinations fell into the hands of gentlemen who did not possess this special knowledge. In addition to this there is no doubt that in many instances these examinations were not conducted with the necessary care. Possibly personation accounted for some cases, as it is impossible to believe that some of the Officers and men who were sent out during the later stages, especially for the Imperial Yeomanry, could have been passed as fit for any kind of service by anyone possessing a minimum of knowledge, but in other cases there is every reason to believe that the examination was most perfunctory. In accordance with instructions received from army headquarters these cases were reported to the Adjutant-General with a view to the circumstances of their enlistment being inquired into. The Militia, speaking generally, showed a larger proportion of men who should not have been sent out than either the Regular troops or the Volunteers, but the third contingent of Imperial Yeomanry was the worst in this respect.

As regards the Colonial troops, the over-sea Colonials were of good physique, the earlier regiments of South African Colonials were good, especially the Imperial Light Horse and the South African Light Horse. The other corps raised at the same time were, like them, urgently needed, and the examination of the recruits was less stringent than is normally the case. But in spite of this these corps contributed few invalids from causes existing prior to enlistment.

As the campaign progressed the proportion of men enlisted in the South African irregular forces who were unfit for service increased till it became a very serious question. Not only did they block the hospitals, but they were a source of needless expense. Recruiting for these corps was very little under control. Each corps had its own surgeons (locally engaged by the Officer Commanding the corps), who examined the recruits obtained at the headquarters of the corps, while other recruits were sent up from their base depôts. No other arrangement was possible, Officers of the Royal Army Medical Corps could not be spared from the more important duties they were engaged in, and the recruiting had to be left to the regimental authorities. One would imagine that a Commanding Officer would prefer to exclude men physically inefficient from the ranks of his command, but it does not appear that they sufficiently impressed their Medical Officers with this view.

It is, of course, the case that the recruit for an irregular corps, which serves only for a short time and is then disbanded, need not be of the same high standard that is required in the case of a recruit for the Regular Army. It is also the case that medical men practising in the Colonies have experience of men going about, living a rough and hard life without apparent difficulty, although they are suffering from pronounced physical disabilities. But these are men who are compelled to earn their bread in spite of their disabilities, while as enlisted men it takes them a very short time to discover that they earn their pay more easily in hospital than in the saddle.

It would seem sufficient that a recruit for an irregular corps should have a healthy heart and lungs, good vision and hearing, sufficiently good teeth, and be free from obvious physical defects such as hernia, varicose veins, or piles, and not above 45. Minor defects which would disqualify him for the Regular Army might be overlooked. But these qualifications should be regarded as a minimum, and, whenever possible, the examination should be made by an Officer of the Royal Army Medical Corps.

The whole circumstances connected with the invaliding of Officers and men of all branches of the service for causes other than injury, point to the necessity of placing the physical examination of recruits and of men for active service as far as possible in the hands of the Officers of the Royal Army Medical Corps, and giving them sufficient time to carry out their examination properly.

It is, of course, the case that the recruit for an irregular corps, which serves only for a short time and is then disbanded, need not be of the same high standard that is required in the case of a recruit for the Regular Army. It is also the case that medical men practising in the Colonies have experience of men going about, living a rough and hard life without apparent difficulty, although they are suffering from pronounced physical disabilities. But these are men who are compelled to earn their bread in spite of their disabilities, while as enlisted men it takes them a very short time to discover that they earn their pay more easily in hospital than in the saddle.

(b) Method of Invaliding.

As a rule the invalids from a district passed through the general hospitals at the principal station of the district, though occasionally they proceeded direct from the larger hospitals on the line outside this. The Officers and men were brought forward in the usual way by the Officer in charge of the hospital for the approval of the Principal Medical Officer of the district.

In the case of Officers the usual Medical Board was held, for which a statement of case was prepared, and the proceedings of the Board recorded as usual on Army Form A 45, which was disposed of as usual.

In the case of men from England, irrespective of the branch of the service to which they belonged, nominal rolls (Army Form A 36) were prepared for each convoy giving all the necessary particulars. It was found to be quite impracticable to prepare the usual detailed medical history sheet (Army Form B 179), while much of the information usually conveyed in the transfer medical certificate was embodied in the nominal rolls used. It is physically impossible to perform the clerical labour necessary to prepare the detailed medical history for each invalid, when the numbers dealt with are so large, except by a complete neglect of the more important work of looking after the sick in hospital. Nor does it seem necessary that this document should be prepared. Invaliding during a campaign such as that in South Africa, is conditioned so greatly by the local circumstances that the transfer of the man from hospital at the seat of war to hospital in England should be looked on not as a break in his hospital treatment but as one continuous event. In this aspect much of the detailed information in the usual form is not required. All that is required in the case of a man invalided for disease is a statement of its nature with a warning against any possible source of danger. Information on both these points can be very succinctly conveyed. Cases of gunshot wound require no more. It is only in the cases of injury which might or might not have been caused on duty, that a statement to this effect is required for the purpose of assessing his pension, provided he is discharged on account of the injury. All this information could very easily be conveyed in a concise convoy report, which could be easily prepared and duplicated for record. In any case if the detailed medical history sheet is required from the seat of war for the Chelsea Commissioners, this duty should be performed at the base hospitals, where a special staff would be required for the purpose. Hospitals at the front cannot undertake this.

Information as to special diet or accommodation must be given in every case, and in whatever form the other details are sent, it is practically a necessity that information on these points should be put in such a form that the Officer receiving the convoy can see at once how the men should be distributed without having to consult a separate document for each case.

In the case of insanes alone were the usual documents prepared. In these all details are absolutely necessary.

In the case of soldiers of colonial corps, whether over sea or South African, the detailed medical history was prepared, as the invaliding of the soldier in these cases closed his service with the Imperial forces.

Prior to the opening of railway communication between the Transvaal and Natal (early in July, 1900), all invalids from the Transvaal, Orange River Colony, and Cape Colony were sent to Cape Town for disposal. Afterwards invalids from stations north of the Vaal were, with few exceptions, sent to the general hospitals in Natal for disposal. In the case of some irregular corps (colonials) their invalids had to be sent to Cape Town so that they might be settled up with. It was also frequently more convenient to send lunatics under escort to Cape Town, as there was special accommodation for their custody at No. 5 General Hospital in the buildings of the old station hospital.

Besides men transferred to Natal as invalids many cases were sent there for change. Indeed, it was found that a large proportion of those men sent to Natal as proposed invalids, picked up so rapidly with the change of scene and rest in hospital, that it was no longer necessary to send them home and, on the other hand, many men sent for change improved less rapidly than had been anticipated, and were sent home. This reconsideration of the cases

under new conditions was found to be very useful. The same process was carried out on the Cape side, especially at Wynberg.

As regards the invaliding of Officers in the Transvaal, Officers were invalided by Boards in Pretoria and Elandsfontein, under the Principal Medical Officer of the district. The same thing was done in Natal, while in Cape Town, in many ways the most difficult place to deal with, a standing Medical Board was early established for this purpose.

Surgeon-General W. H. McNamara makes the following weighty observations on this point :—

“There should be a special Medical Board at the base, before which all Officers proposed for invaliding to England should be examined and dealt with. This Board should be put in possession confidentially, by Commanding Officers as well as Medical Officers, of all facts likely to be useful, as though an Officer may appear physically well when before this Board, he may, from overwork or anxiety, be so suffering from mental irritation and sleeplessness, as to be incapable of performing his duty, and cause him to worry his subordinates into inefficiency. Superior Officers should give every information likely to be helpful to the Medical Board in cases of this kind.”

The President of this Board should be a man of independent character, and one not likely to be influenced by considerations other than those bearing on the fitness for service, or otherwise, of the cases brought before him. The Officers composing the Board should all be of a high standard in professional knowledge.

Apart from the actual invaliding of Officers the grant of leave in the country on medical certificate requires to be carefully controlled. When an Officer proceeds on sick leave from one district to another, it is not advisable that he should be granted additional leave from the district to which he has proceeded, without reference to the authority who granted his leave originally. There is little doubt that the establishment of convalescent homes for Officers, where they can be kept under some supervision, prevents many abuses and accelerates their return to duty.

Comparing the different classes of the Imperial forces in South Africa from the point of view of the Medical Officer, whatever may be their relative value in the field, there is no doubt that the Regular Officer or man takes illness or injury much more as a matter of course, and is more anxious to return to duty than the individual of any other class. Next to him come the Colonials, especially those from over sea.

PART IX.

HOSPITAL TRAINS

A.—PREPARATIONS IN SOUTH AFRICA.

Previous to the outbreak of hostilities, and when war appeared imminent, Colonel Supple, C.B., Principal Medical Officer, South Africa, initiated the conversion of ordinary trains into hospital trains.

In Natal, No. 1 was prepared, and was ready at the outbreak of the war. A little later No. 1A was also got ready. These trains were not elaborately prepared, and very little expense was incurred in their preparation. Ordinary passenger carriages were selected; these were not gutted nor supplied with new fittings, only very slight alterations were made. The doorways were left unaltered, and there was no through communication from end to end of the trains. Special narrow stretchers had to be used for conveyance of the patients into and out of the carriages.

At Cape Town, Nos. 2 and 3 were got ready under the immediate superintendence of Colonel Supple. These were well designed, and left little room for improvement; they were used as models for those constructed at later dates.

The following report has been almost entirely prepared by Major M. T. Yarr, who was in charge of No. 5 Hospital Train for a portion of the campaign.

B.—CLASSIFICATION OF TRAINS.

The hospital train service, as used during the campaign, may be classified as follows:—

1. *Hospital Trains.*

Specially fitted, equipped, and staffed as such, for conveyance of lying-down cases; corresponding to the Austrian "sanitätszüge." Of these there were two kinds—

- (a) Converted ordinary trains. The following (all, in fact, save the "Princess Christian") belong to this category—

No. 1	Hospital Train.
No. 1A	" "
No. 2	" "
No. 3	" "
No. 4	" "
No. 5	" "
No. 6	an abandoned Boer train.

- (b) One specially built ("Princess Christian").

2. *Improvised Hospital Trains.*

As a rule, first-class corridor car trains, unaltered, often with a kitchen car, for conveyance of less severe cases and convalescents, corresponding to "krankenzüge." A Medical Officer, provided with medical comforts and a small stock of medical and surgical materials, accompanied each convoy of sick, but there was no permanent staff.

3. *Ambulance Coaches.*

In addition, there were a number of specially-fitted carriages placed at convenient intervals on the railways (see also Appendices XXVIA to XXVIF).

These were used to pick up small parties of sick from the various posts along the lines, and were attached to passing trains for conveyance to the nearest hospital. Many of these had a regular service, usually twice a week up and down their own stretch of line. Some of these carriages were provided with the usual iron frames for support of the service stretchers. Others were similar in construction to the converted hospital train carriages.

Staff.—As a rule, one N.C. Officer and one orderly were attached for duty to these carriages, and the Medical Officers along lines of communication attended to the wants of the sick as the carriages passed the various posts (see Line of Communications Report on this point also, p. 201).

C.—HOSPITAL TRAINS PROPER.

Construction.—Hospital Trains Nos. 2, 3, and 5 were constructed on the same general lines. Nos. 3 and 5 carried 92 lying-down cases in addition to staff; No. 2, 96.

The following description of No. 5 will serve for all three, as the only differences between the trains consisted in the fact that the ward-cars in No. 5 were all converted passenger cars; in the others, partly passenger, partly post office cars. As passenger and post office cars were much the same size and shape, and both had to be completely gutted of all internal fittings before conversion, the distinction is of slender importance.

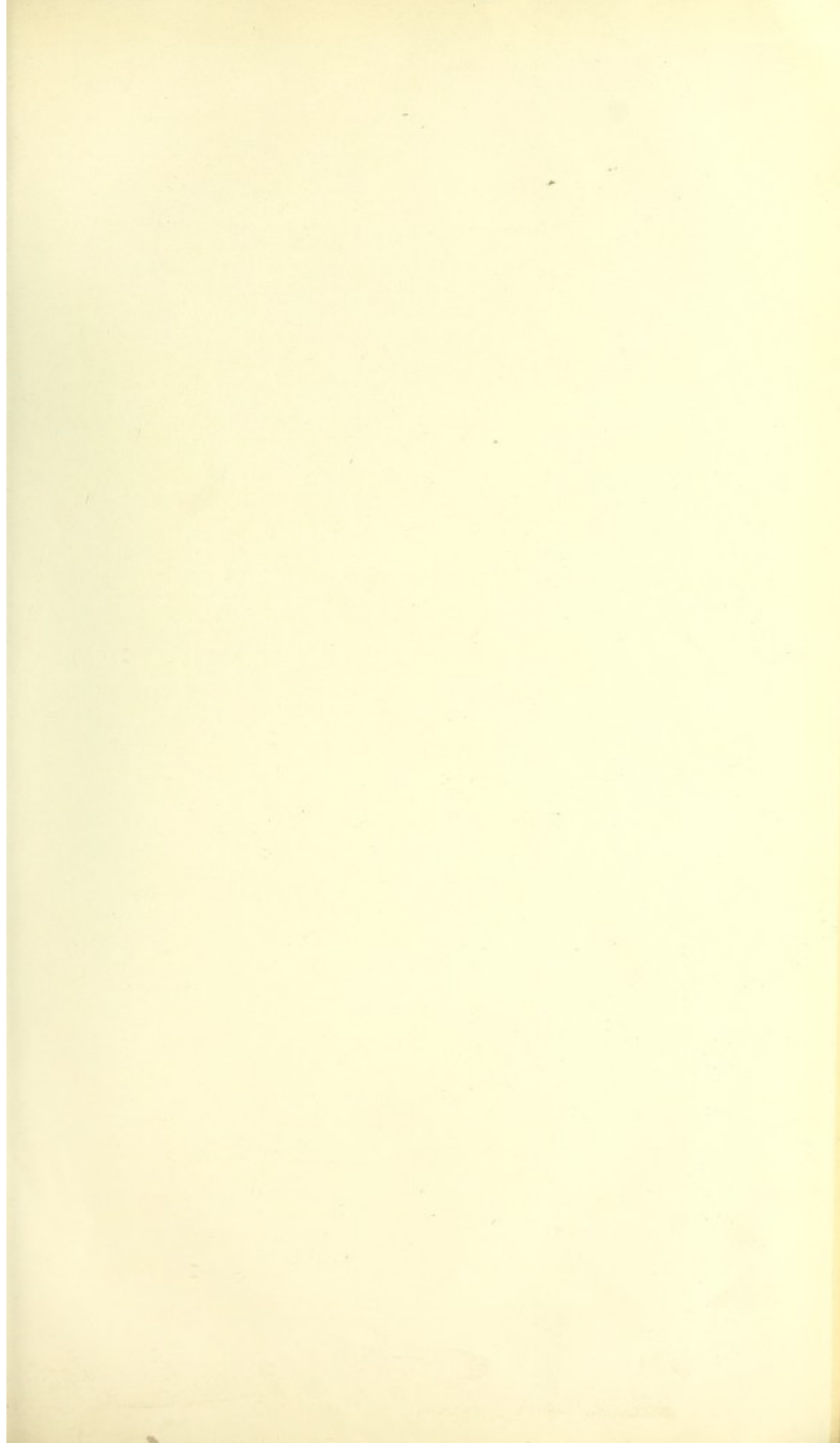
Like all the ambulance trains employed during the war, with the exception of the "Princess Christian," No. 5 Ambulance Train was improvised from ordinary railway rolling stock. The train was made up of seven coaches with through communication from end to end, arranged in the following order:—

- (1) First-class saloon car, for medical and nursing staff.
- (2) Kitchen car, with pharmacy and orderlies' room.
- (3) Ward of 24 beds.
- (4) " "
- (5) " "
- (6) Ward of 20 beds, four of which were screened off for Officers.
- (7) Pack and stewards' store car, with space for guard.

The train carried 92 lying-down patients, and a staff averaging 22. All these, with the exception of the kitchen car, were converted Cape Government Railway "bogey" coaches; No. 1 being a first-class corridor saloon car but little altered; Nos. 3, 4, 5, and 6, third-class corridor cars, which had been completely gutted and fitted up with two double-tiered rows of wooden bunks arranged longitudinally, with central passages; No. 7, an ordinary luggage and guard's van, one end of which was fitted with a steward's store-room and meat safe, the other with shelves and lockers for kits. With the exception of No. 7 (20 tons), the tonnage of each car was 24, making a total of 164 tons, a weight requiring a "first-class" engine for most parts of the South African lines, and two engines for certain long, steep gradients, such as the Hex River and Lootsberg passes. The tonnage of a train, in connection with the hauling power of the engine and the gradients of the line, is one of the most important factors to be taken into consideration in the construction of ambulance trains; every increase in weight through elaborate iron or other weighty fittings must mean a corresponding reduction in carrying power.

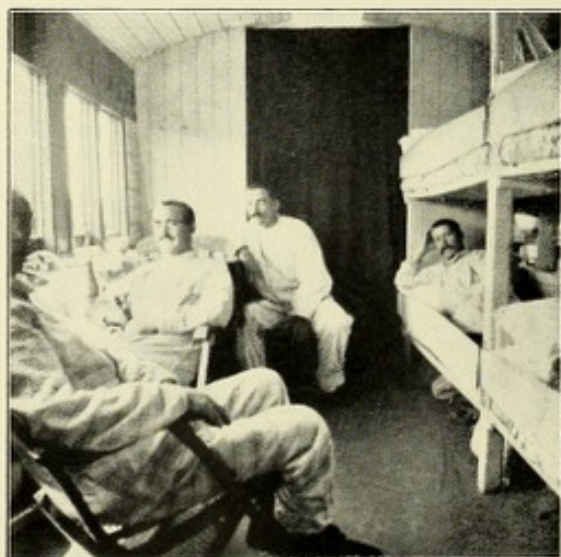
Only two cars—the staff and kitchen car—were fitted with tanks. These tanks, six in all, cylindrical, carrying some 1,800 gallons, were placed under the cars, and were easily filled from tanks or taps at the various stations; the water was passed through Berkefeld field filters before use. All water required in the cars used as wards had to be carried from the kitchen car, involving almost continuous labour on the part of the already heavily-worked orderlies. The provision of tanks to each car would be undoubtedly the ideal arrangement (as carried out in the "Princess Christian" train), but here again the ideal must be sacrificed to the practicable; filling tanks on every car is a lengthy process. It took about two hours in the case of the "Princess Christian" train, and is more often than not impossible in a crowded station in war time.

Each car, with the exception of the kitchen and pack-store cars had a





NO. 3 AMBULANCE TRAIN. MEN'S WARD.



NO. 5 AMBULANCE TRAIN. OFFICERS' WARD.

small lavatory, fitted with a hand basin and w.c. of the usual railway type at either end. During short stoppages in railway stations these were always locked. When the train, as frequently happened, had to remain some hours in station or hospital sidings, buckets with dry earth were placed underneath the w.c. pipes, the station and hospital authorities being responsible for their disposition and removal. A supply of 5 per cent. Izal solution was kept in each lavatory to disinfect the excreta as far as practicable. Bed-pans and urinals were provided for 15 per cent. of the patients, and this provision was always found ample for No. 5 ambulance train, which did not run during the early part of the war, and never carried such numbers of helpless sick and wounded as some of the other trains.

A visitor inspecting the train would enter the saloon car first, and from it walk through the kitchen and four ward cars to the pack store, and this is the most convenient order to adopt for a more detailed description of the construction.

Saloon Car.—This was a first-class saloon car of the Cape Government Railway, entered by steps at either end, and communicating with the kitchen car. It contained five compartments, the usual first-class compartments with sliding doors opening on to the corridors, with a lavatory at each end; two of these at one end, separated by a right-angled passage (fitted up with cupboards as a tiny pantry) from the other three, were occupied by the nursing Sisters. Of the remaining three, two were the rooms of the Medical Officers, the third, next the pantry, formed a little dining room in which four—or, at a pinch, five—persons could have their meals with a fair degree of comfort. The only modifications adopted in this car were the removal of superfluous seats in the Sisters' and Medical Officers' compartments, the provision of racks and hooks for clothes, &c., and the conversion of the right-angled passage between the dining room and Sisters' quarters into a little pantry by means of added shelves. The lavatories, fitted with w.c.'s and basins, were of fair size, and with a little manœuvring and the addition of camp canvas baths could be used as bath rooms.

Kitchen Car.—This car included three separate compartments, extending the whole breadth of the coach without corridors, communicating by doors. The centre compartment, much the largest of the three, constituted the very excellent kitchen, fitted with a large German range and boiler, dressers, cupboards, &c.; the range, a very fine one, occupied nearly the whole of one side of the kitchen, and by its weight tilted the car to that side a few inches, giving the car a somewhat lop-sided appearance. On the next side the saloon car was a small compartment used as a pharmacy, with shelves and lockers for the medical and surgical equipment, and four fixed wooden bunks for N.C. Officers and batmen. On the other side of the kitchen was a larger room used as a mess room by the orderlies, which was fitted up with six bunks and a table, thus providing altogether sleeping accommodation for 10 N.C. Officers and men.

Ward Cars.—Nos. 3, 4, and 5 cars were all of similar construction, so that one description will suffice for all. The original third-class corridor cars had had all the interior fittings removed and replaced by two rows of fixed wooden bunks, each row in two tiers; a central passage extended from end to end of the car between the rows. The continuity of the bunks was broken in the centre of the car by two large doors facing each other, large enough to permit of stretchers being carried in, and, with the help of hinged posts in the corner bunks, carried down the centre passage to any particular bunk or bunks. The transference of a patient from stretcher to bunk was easily carried out by gently lifting or rolling in from the stretcher placed beside the bunk. The bed-cots in the "Princess Christian" train were so arranged that they could be lifted out of the train, a better plan, of course, as patients could then be transferred from the stretchers on the platform, but on the whole the plan adopted on No. 5 train worked well, and involved no complicated fittings. The lavatory at each end of the car contained a fixed basin as well as w.c. Undoubtedly the ablution arrangements were quite insufficient in view of the fact that patients were sometimes as long as six days on the train; they had to be eked out by serving out hand-basins to each car. As a rule six basins were thus served out, making, with the fixed ones, eight for the 24 occupants of the ward.

Each bunk was composed of headboard, tailboard, and sideboard (the other side being formed by the side of the train), and measured 6 feet 3 inches long by 2 feet 9 inches wide; the bottom was formed of tightly stretched canvas; horse-hair mattresses, blankets, pillows, sheets, and pillow-slips were provided. The mattresses were provided by the Cape Government Railway; the other articles were drawn, replaced, &c., in the usual way. The sideboard could be removed to facilitate transference of patients from stretchers and *vice versa*.

No. 6 ward car was originally the same as the others, except that eight bunks at one end were screened off for Officers by means of draw-curtains. This arrangement was unsatisfactory, except on the rare occasions when all the Officers were lying-down cases, so the four bunks on one side were removed and replaced by windows, a table, and some easy chairs, thus making a very comfortable bed-sitting room for four Officers, and reducing the number carried in the whole car from 24 to 20. In No. 2 train this ward car was the same as the others, and carried 24.

No. 7 car.—The major part of this car was fitted with shelves and lockers, the former for men's kits, the latter for linen, spare blankets, Red Cross stores, &c. The far end of the car was converted into a steward's store where all wines, spirits, and extras were kept under lock and key. A small intermediate passage between these two rooms was used by the guard and contained three bunks for the conductor and two orderlies, making with the berths in the kitchen car sleeping accommodation for 13 N.C. Officers and men.

Each car had a large red cross painted on the outside on a white disc.

Equipment.—The medical and surgical equipment was that of a field hospital,* supplemented as occasion required by other drugs and articles which were always obtained without difficulty from advanced or base depôts of medical stores. All other articles of hospital equipment were drawn and held from the Ordnance—knives, forks, spoons, tin plates and mugs, blankets, &c.

Diets and Extras.—The ordinary fresh field rations were drawn by requisition on the Supply Officers at the larger stations along the line, such as De Aar, Naauwpoort, Springfontein, Bloemfontein, Kroonstadt, and many others. A telegram sent a few hours before ensured the punctual delivery of the rations, together with such fresh milk (and even, in the later stages of the war, ice) as might be required. Striking a general average of all the patients carried by this particular train, half could eat ordinary rations, a quarter required milk, another quarter "convalescent" diet; it was the custom, therefore, to requisition for "full rations" for three-fourths of the patients (part of these being stewed down to "convalescent" diets), and milk for the remaining fourth. Eggs could usually be obtained for particular cases. Extras such as beer, wine, soda-water, spirits, meat-juice, &c., were usually stored on the train at Cape Town, but even these could be obtained, if necessary, at certain stations, such as Pretoria, Bloemfontein, De Aar.

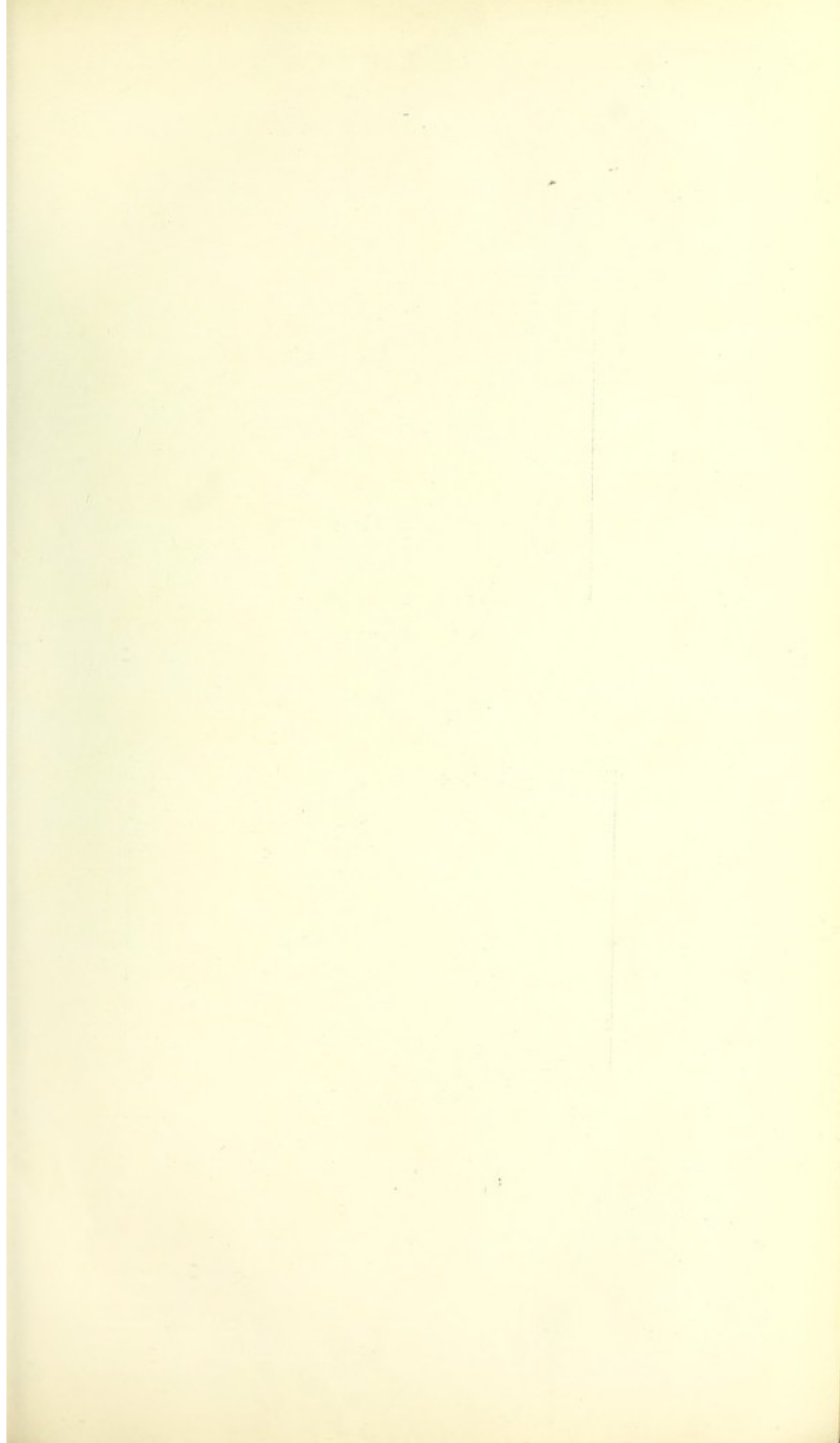
The diet arrangements of each ward were exceedingly simple, yet quite efficient. No separate diet sheets were used; a paper hung in the ward, where it could be seen by the patients, showed the diet and extras issued to each patient according to the number of his bunk (each bunk had a number painted on it, beginning with No. 1 in No. 3 ward and ending with No. 92 in No. 6 ward) thus:—

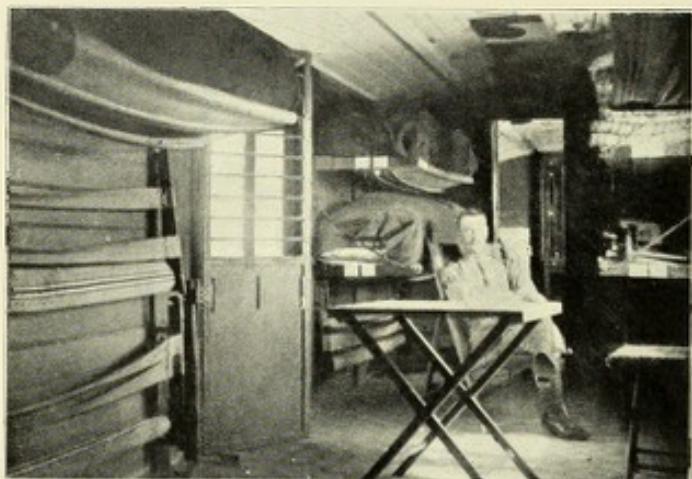
- | | |
|--|-----|
| No. 2.—Full diet.—Eggs, 2; port wine, 6 ozs. | |
| No. 31.—Milk, 4 pints; brandy, 2 ozs. | |
| No. 40.—Convalescent diet.—Stout, 1 bottle. | |
| &c. | &c. |

Patients on entering the train were at once seen by the Medical Officers and put upon diets and extras, so that the cooks and steward might know with as little delay as possible the requirements of each ward.

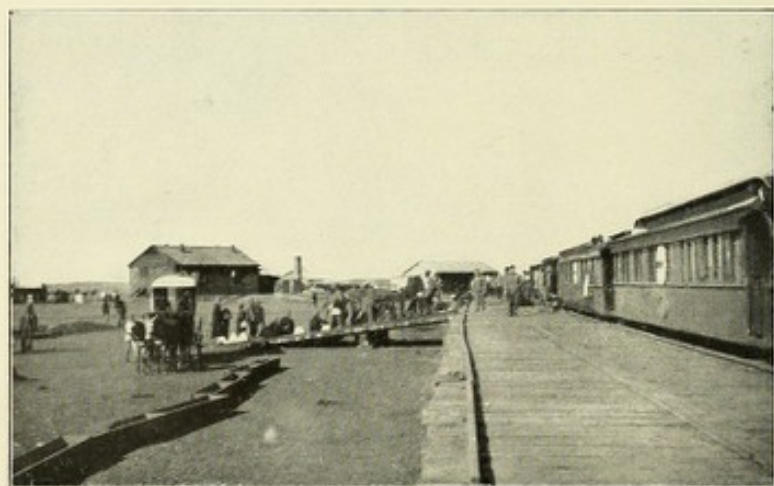
Captain Fleming reports:—"The scale of diets supplied (on No. 2) was much the same as that laid down in paragraph 285, Standing Orders for the Royal Army Medical Corps, as applicable to field service, and included

* Namely, 2 field medical companions, 2 surgical haversacks, 4 field medical panniers, 1 special surgical pannier, 1 field fracture box, and 1 antiseptic case.





NO. 4 AMBULANCE TRAIN.
(Showing method of folding up cots.)



HOSPITAL SIDING AND PLATFORM AT SPRINGFONTEIN.
(Unloading No. 5 Ambulance Train.)

'convalescent,' 'beef tea,' 'milk,' and 'plain milk.' Porridge was supplied at breakfast, except contra-indicated. A fresh field ration was drawn for each patient. Diets and extras were drawn by the ward orderlies on the usual 'Diet and Extra Sheet Summary,' and the diet for each patient indicated by a slip of paper fixed to his bedhead by a drawing pin."

The management and equipment of No. 4 train were on much the same lines as the above, but its construction differed widely from that of the others, and requires a separate description. No. 4 was fitted out as a hospital train at East London by the Red Cross Society, under the personal supervision of Sir John Furley. The work was put in hand on April 20th, 1900, and the train started on its first journey on June 10th, 1900.

"The train at first consisted of five coaches and a brake van, and later on two additional carriages were provided, making up a total of 114 beds, including six in a separate compartment for Officers. Two small vans were also added for soldiers' kits, pack stores, and guard. A continuous passage runs through the train and each coach has a lavatory. The water for the train is carried underneath the coaches. Folding doors, one each side of every carriage, allow the sick and wounded to be taken in and out on stretchers. The beds consist of iron movable brackets with sheet canvas and hair mattresses and sheets, blankets, and coloured counterpanes. As the beds fold up, every facility for airing and cleansing is afforded."

These beds were arranged in three tiers (a tier too many). Their movability and capacity for folding up were doubtful advantages, involving frequent repairs and a certain feeling of the insecurity for the patients. On the whole the system of fixed wooden bunks is preferable. Tanks under each coach save the train staff much labour, but in war time it is often difficult, sometimes impossible, to fill them all; the process is a very lengthy one, involving delicate shunting work, and a considerable length of free line-space, both conditions often unattainable in a crowded station.

No. 4 train was painted white outside (an undoubted advantage) with red crosses on each coach, like the "Princess Christian."

The car for the staff and the kitchen car were, speaking generally, of the same type as the corresponding coaches of the other converted trains.

Personnel.—No. 6 carried only 1 Medical Officer, 1 cook, 1 compounder, and 5 orderlies. Each of the other trains had the following personnel:—

Medical Staff	...	1 Major, R.A.M.C., in command.
		1 civil surgeon.
Nursing Staff	...	1 nursing Sister, Army Nursing Service.
	1	„ Army Nursing Reserve.

The numbers of the medical and nursing staff remained unchanged throughout the war.

In the early days of running there were 22 N.C. Officers and men, viz.:—

- 1 sergeant as chief wardmaster.
- 1 corporal as steward and pack-store keeper.
- 1 corporal as compounder.
- 1 lance-corporal as assistant wardmaster.
- 16 privates as ward orderlies.
- 1 lance-corporal as cook.
- 1 private as assistant cook; and
- 1 civilian as conductor and lamplighter.

This personnel, however, had soon to be reduced, owing to the exigencies of the service, to—

- 1 sergeant as chief wardmaster.
- 1 corporal as compounder.
- 1 lance-corporal as steward, &c.
- 12 orderlies for ward work.
- 1 lance-corporal as cook.
- 1 civilian as conductor.

* "Report of the Central British Red Cross Committee on Voluntary Organisations in Aid of the Sick and Wounded during the South African War."—London: Harrison and Sons, 1902. (3959) 2 E

On the journeys up country, when the train carried medical details, medical and Red Cross stores only, the N.C. Officers and orderlies got every night in bed. When, however, the train started down country with its load of sick and wounded, one N.C. Officer (or senior orderly acting) and four orderlies were constantly on duty till the patients were detrained: hence the sleeping accommodation for N.C. Officers and men on the train was quite sufficient. The larger proportion of the Royal Army Medical Corps details were Militia and Volunteers, and speaking generally, the work of these men was beyond all praise. The work of the rank and file Royal Army Medical Corps on an ambulance train is exceedingly laborious, involving not only the care of the sick on the base-ward journeys, but also loading and unloading stores and subsequent cleaning up on the upward trips.

D.—THE "PRINCESS CHRISTIAN" TRAIN.

On the initiative of H.R.H. Princess Christian the train bearing her name was built in England, at the expense of the Red Cross Society, by the Birmingham Railway Carriage and Wagon Company. For the general design and internal arrangements Sir John Furley and Mr. Fieldhouse (of the Military Equipment Company, Limited) were responsible. The train reached Cape Town early in February, 1900; was sent on from there to Durban, and made its first trip—to Ladysmith—on March 18th of the same year, in charge of the late Surgeon Lieut.-Colonel J. Forrester, of the Horse Guards, and Mr. Percy Lowe, F.R.C.S. From this date the "Princess Christian" ran continuously, with intervals for repairs, till the end of the war, mostly short trips on the Natal side and on the Pretoria-Komati Poort line. It was formally handed over to the Secretary of State for War by the Red Cross Society in June, 1901.

"The train consists of seven bogie corridor carriages, each about 36 feet in length and 8 feet in width, the passage through the centre being continuous.

"No. 1 is divided into three compartments for linen and other stores, for two nurses and for two invalid Officers respectively. The second carriage is also divided into three compartments, namely, for two Medical Officers, a dining room, and a dispensary. Nos. 3, 4, 5, and 6 are each constructed to carry 18 invalids and four hospital orderlies. The beds have been placed in three tiers . . . and by an arrangement of pulleys in the roof each bed could be raised to the proper level by one man . . .

"No. 7 contains the kitchen and pantry, including berths for two cooks and a compartment between for the guard . . .

"The whole train is light and airy, and the enamelled white ironwork and fittings and the bright draperies produce a very cheerful effect . . . It was painted white externally from end to end in the month of September, 1900. In the centre panel on each side of every carriage is a conspicuous red cross, encircled with the words 'Princess Christian Train' in royal blue and gold."*

The medical, surgical, and other equipments were on a most extensive but unnecessarily elaborate scale.

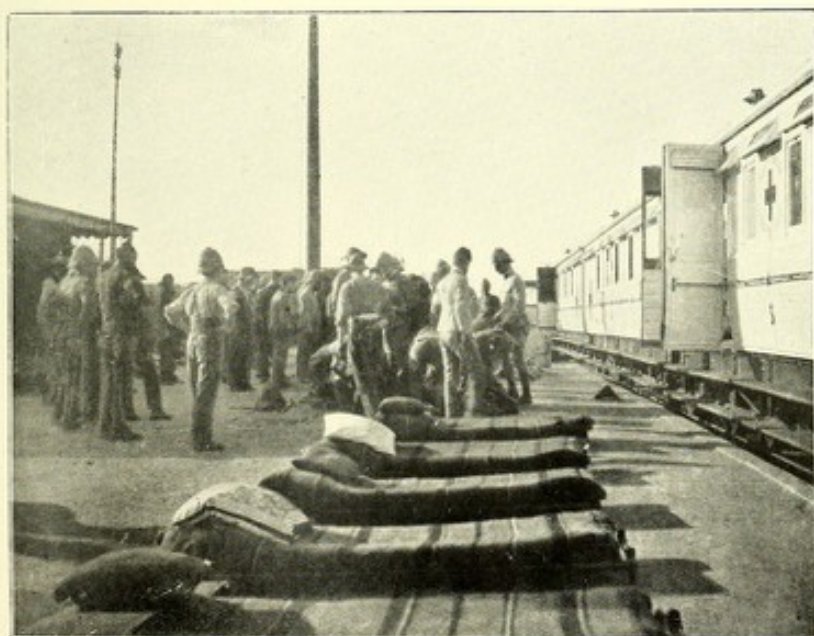
Experience showed several defects in the construction and arrangement of this expensive and beautiful train. The position of the linen store (*vide supra*) was most inconvenient: that most necessary item in any military hospital unit, the pack store for men's kits, was forgotten (a Cape railway van, not communicating directly with the rest of the train, had to be added for this purpose); three tiers of beds are one tier too many; the numbers carried—two Officers and 72 men—were limited compared with the converted trains. Lastly, the otherwise excellent system of tanks to each carriage necessitated great inconvenience and delay in stations and sidings.

On the whole, the arrangement of the bunks and general construction adopted in the converted trains was preferable; with the addition of some fixed basins, surmounted by a small tank capable of being filled by hand, to

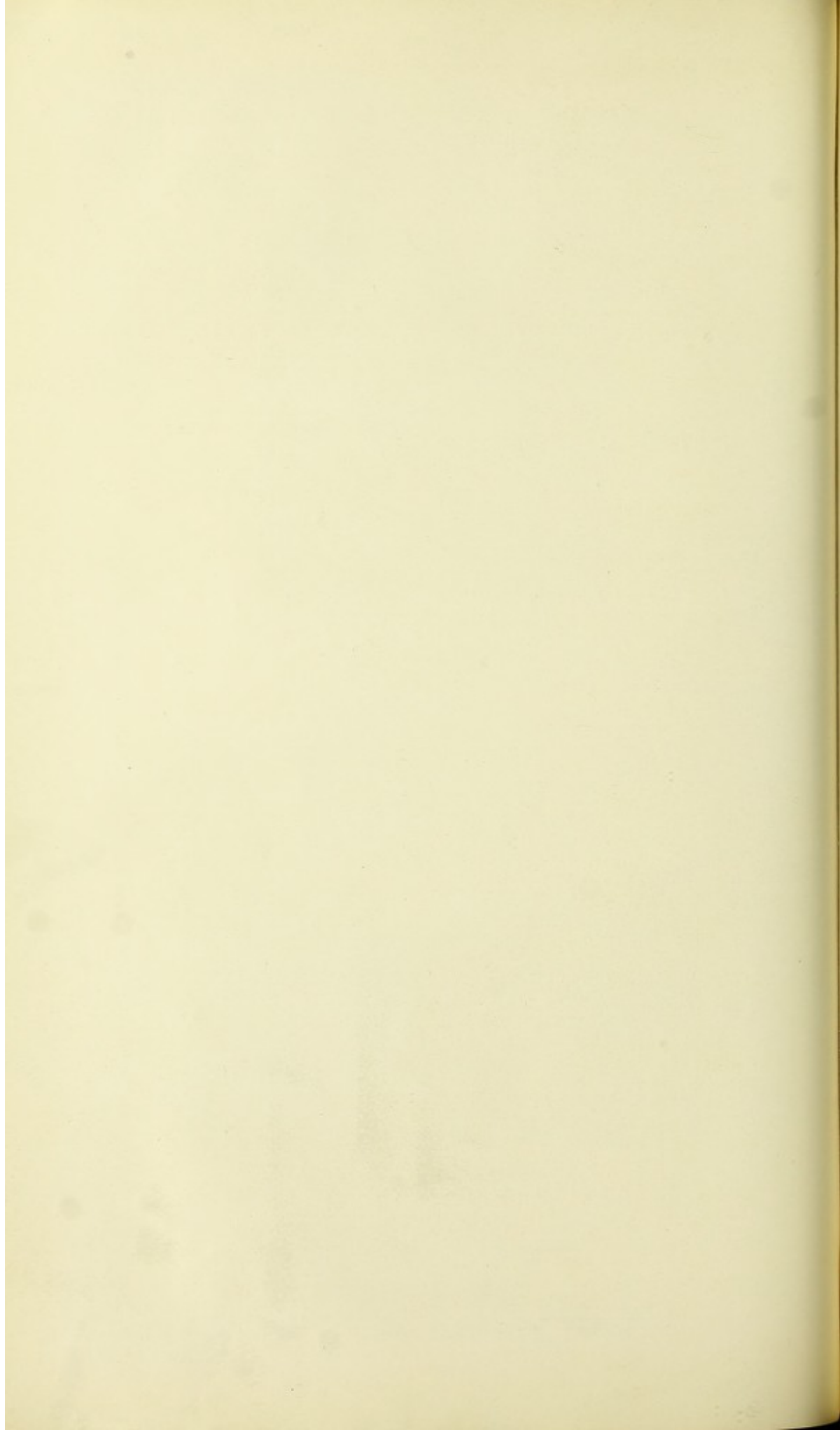
* Report of British Red Cross Committee.



PRINCESS CHRISTIAN HOSPITAL TRAIN.
(Men's Ward—Cots *in situ*.)



PRINCESS CHRISTIAN HOSPITAL TRAIN.
(Cots on platform ready for loading.)



each ward car, the type of converted train represented by No. 5 would prove the most generally useful in future campaigns.

The personnel of this train normally consisted of two Medical Officers, two nursing Sisters, cook, compounder, and 12 orderlies.

E.—IMPROVISED HOSPITAL TRAINS.

Except that the staff was put on for the journey, the work of these trains was much on the same lines as in the hospital trains proper.

F.—ORDINARY TRAINS.

A very large number of convalescents were sent to the base by this means, notably during the enteric fever epidemic at Bloemfontein. At the time of the Bloemfontein epidemic, the line from there to Cape Town was clear so that trains could run through without stopping at night; hence the want of cooking arrangements on the train was not felt, hot meals could be served to patients at certain fixed stations, and the system, on the whole, worked well. When, however, a line is infested by the enemy, so that train stoppages become irregular and for indefinite times, hospital train units must of necessity be self-supporting.

The attached tabular statement (Appendix XXVI), by Captain C. C. Fleming, D.S.O., who was in charge of No. 2 train throughout the campaign, shows the work of this one train. The others, notably No. 3, did similar work, but, owing to the fact that they did not remain under the command of one Officer throughout, no continuous record of their work over the whole period has been preserved.

PART X.

HOSPITAL SHIPS.

During the period of the war 3,116 Officers and 72,314 warrant and N.C. Officers and men were sent home as invalids from South Africa.

Their transport by sea was carried out by hospital ships and sick transports, while smaller parties were also despatched by the mail and "intermediate" steamships from Cape Town and Durban.

A.—CLASSIFICATION.

The hospital ships were of two classes :—

- (1) Those fitted and equipped in England, and
- (2) Those prepared in South Africa.

(1) Of those fitted and equipped in England, the "Spartan," with accommodation for 132 sick, and the "Trojan" for 144 sick, were fitted out by the Admiralty for the War Office. The former left England on October 9th, the latter on October 19th.

In addition to these, the Red Cross Society fitted out and equipped the "Princess of Wales" (accommodating 184 sick), while the "Maine," with accommodation for 163 sick, was generously provided by some American ladies.

(2) The hospital ships prepared in South Africa were all selected and converted at Durban by the Naval Transport Department on requisition from the Principal Medical Officer, Sir T. J. Gallwey, K.C.M.G., C.B. This conversion was rapidly carried out.

The ships were :— "Nubia" (284 sick), "Lismore Castle" (214 sick), "Orcana" (209 sick), "Simla" (278 sick), "Avoca" (302 sick), and the "Dunera" (284 sick). A description of the "Nubia" is given as a type.

The ships prepared in South Africa were in every way more suitable for the work than any of those sent from England, and were, it is believed, far more economical. Their advantages were entirely due to their greater size, with a relatively smaller draught than the "Spartan" and "Trojan." They were all more modern vessels than those used in England, which ceased to be employed long before the end of the campaign. A regular service was maintained by these vessels between Durban (and Cape Town) and England and carried on to the end of the campaign.

Sick Transports.

But even this fleet was insufficient to cope with the number of sick and wounded sent home. Full use, therefore, was made of the large passenger ships which arrived with troops and were returning empty to England. These required no structural alteration, the accommodation for invalids was ample and very good. A suitable medical staff was placed on each vessel, with the necessary stores and equipment. Full details are given in the attached report by Major Tatham, R.A.M.C., the embarking Medical Officer at Cape Town during the war. (Part XI, p. 239.)

B.—GENERAL CONSIDERATIONS.

Remarks.

Surgeon-General W. H. McNamara, C.B., C.M.G., late Principal Medical Officer at Cape Town, points out that our experiences show that "when war breaks out is not the time the first steps for the selection of ships suitable for hospital purposes, and for deciding on the alterations necessary should be taken. In time of peace suitable types of ships should be determined on, and

the plans for the conversion of each type of ship decided on, drawn out and all preparatory arrangements with companies and firms made for their alteration in case of war."

There appears to be no reason why some provision of this nature should not be made; it would obviate delay and should ensure the selection of suitable vessels.

Sick transports, as distinguished from hospital ships, were employed almost entirely at Cape Town. Surgeon-General McNamara is of opinion that these are of more importance than a regular establishment of hospital ships proper. He says:—"A hospital ship can only be useful when a country is very unhealthy and there is some very strong military reason why a hospital should not be established ashore." "As a rule there is no *raison d'être* for hospital ships. They are wasteful and of little value, and on account of their existence attention is diverted from the importance of the arrangements for invalids on return troopships, in which practically all the invalids return to England."

These opinions are the result of a long experience at Cape Town. Still the medium is as usual probably the correct course. In addition to the most perfect arrangements for the transport of invalids by sea, a hospital ship has the advantage of providing accommodation at once on arrival at the base for a certain number of sick. It is not dependent on land transport after arrival, it requires no time for erection and opening out; further, where there are more ports of disembarkation than one at the seat of war, it can readily be moved to the point where its services are most required. In this way, as distinct from the transport of invalids, hospital ships are undoubtedly useful either to provide hospital accommodation pending the establishment of the shore hospitals, or to supplement existing accommodation. The various hospital ships employed as stationary hospitals at Durban, East London, Port Elizabeth, and Capetown, were most useful as affording a temporary increase to the hospital accommodation. There is no doubt that in a healthy climate the shore hospital affords better accommodation than a hospital afloat, but there are great advantages in having at command good hospital accommodation which can be readily moved to the point of pressure.

There is, of course, no question as to the very great advantage possessed by a hospital ship where the climate is unhealthy. During the hot seasons of 1900-01 and 1901-02 a hospital ship was stationed in Delagoa Bay for the reception of cases from the Krokodil Valley and Barberton. No other possible arrangement was at all comparable with this. Not only did it afford a much-needed change, with comfortable hospital accommodation, to malarial cases for these districts, but it enabled those unfit for further service to be rapidly and easily removed by sea to Durban, in place of subjecting them to the long and trying journey by rail across the high veldt through Pretoria and Elandsfontein to Natal. On the other hand, it is certainly unnecessary to maintain sufficient accommodation on permanently detailed hospital ships to transport all the invalids of an army in the field.

Invaliding from South Africa was carried out very freely. Very many men sent home as invalids returned again to join the field force; but the number of invalids in proportion to the strength of the force will always vary with local conditions, and the proportion in one campaign (especially in such an exceptional case as that in South Africa) may not apply to the next.

It seems to be advisable that preparations should be made to mobilise a certain number of vessels as hospital ships with the rest of the force detailed; this number should probably not be less than one for each port of disembarkation. Secondly, as suggested by Surgeon-General McNamara, a proportion of the outward-bound transports should be specially selected with a view to their use on the return voyage as sick transports. These should be modern passenger ships belonging to companies of good standing; vessels of this class afford every convenience for the transport of sick and wounded. In this way a regular evacuation can be maintained. Except in an unhealthy climate, it is not probable that a hospital ship would be required for use as a stationary hospital at a time when invaliding had become important.

C.—THE HOSPITAL SHIP "TROJAN."

In the early part of October, 1899, war in South Africa appearing imminent, it was decided by the Government to send out two hospital ships. The "Spartan" and "Trojan" were selected as suitable for the purpose; they were sister ships belonging to the Union Company, each about 3,500 tons, and formerly mail boats on the Cape line.

I was appointed to the charge of the "Trojan," and was ordered to proceed to Southampton to superintend the fitting out of the ship. Orders were given to equip her in a thorough and efficient manner, and no expense was spared in providing anything that would conduce to her efficiency as a hospital ship. A large number of men were engaged working day and night, and in eight days she was ready for sea.

Operating Room and Surgery.—A fine operating room was provided on the upper deck, and was well fitted with all necessary appliances by Messrs. Savory and Moore.

The surgery, also on the upper deck, was admirably equipped by Messrs. Burroughs and Wellcome.

Accommodation.—The accommodation was altered slightly from the original estimate, as I found that the second-class cabins for Warrant Officers were not wanted, and in consequence turned them into small wards. The following is the accommodation after the alteration had been made :—

Cots for Officers.—A very nice ward was built amidships on the starboard side from part of the old saloon, and was fitted with five swinging cots, and had bath room and lavatories adjoining. The cubic space was 837 cubic feet for each cot, and superficial area of 92 square feet.

Cots for Men.—There were altogether 71 cots for men, but in times of pressure a few extra naval cots were swung in the wards, and found to be comfortable and convenient. The cots were placed as follows :—

One large ward in the fore part of the ship, taking up the entire width of the ship, and holding 37 swinging cots, and allowing a superficial area of 77 square feet and 564 cubic feet per bed.

One other large ward was in the after part of the ship, and was also the entire width of the ship. It accommodated 26 men, with a cubic space of 528 cubic feet and superficial area of 70 square feet per man.

There was also a small ward with two beds on the upper deck, with a cubic space of 514 cubic feet per bed. This ward was found most useful in treating a few cases of infectious diseases which were brought on board, and sufficient isolation was secured to prevent any spreading of disease.

The remaining six beds (making up the total of 71) were put in the Warrant Officers' quarters, which were appropriated for the purpose.

Convalescents.—Accommodation was provided for 18 convalescent Officers in various cabins, and for 50 N.C. Officers and men in the extreme fore part of the ship, where the men of the Royal Army Medical Corps were also quartered. This number was in excess of what was found practicable, especially when lying in harbour, where ventilation was somewhat obstructed. When the 50 convalescents and 18 men of the Royal Army Medical Corps were present, it only gave a little over 16 square feet superficial area per man, and cubic space of 116 cubic feet. In consequence, efforts were made to keep down the number of convalescents to 25.

Latrines, Lavatories, Bath Rooms.—The latrines, lavatories, and bath rooms were all excellent, and just sufficient for the purpose, and it was found possible at all times to keep them free from smell. There were also two hoppers provided for washing bed-pans, soiled linen, &c., and were found very useful.

Laundry.—A laundry and dirty linen store were provided on the upper deck, but the former was not found capable of doing the work intended, and large articles such as sheets, blankets, &c., had to be washed on shore. Even if the large articles could have been washed, it is not possible on a ship of this size to provide sufficient room for drying purposes.

X-rays.—An X-ray room was fitted up in Durban with the necessary apparatus.

Ventilation, &c.—The ventilation in the wards was very good, and was supplemented by electric fans. The cubic space has been given separately for each ward. It was ample and much in excess of any of the other hospital ships which were afterwards fitted up, and it is a question, having regard to economy of room on board a ship, if it was not in excess of what was absolutely required.

Lifts.—Two lifts were fitted, one for each ward, and were found very convenient for moving helpless patients to their wards.

Food.—The food for the patients was good and abundant, but at times on the coast it was found to be impossible to obtain fresh milk and eggs, the supply of these articles (which is always limited in South Africa) having been secured by other hospitals, &c., before our arrival at the ports. Ice was made on board the ship and was always procurable.

Water.—For the greater part of the time all the drinking water used was condensed on board, and was perfectly pure and palatable.

Clothing.—The clothing was the same as was supplied to all station hospitals. On being invalided home, all patients were given a full warm kit, provided chiefly from the funds of the "Absent Minded Beggar Society."

Personnel.—The medical staff consisted of one major, Royal Army Medical Corps, in charge, two civil surgeons, three nursing Sisters, and 20 N.C. Officers and men of the Royal Army Medical Corps.

Voyage.—The "Trojan" sailed from Southampton on October 19th, 1899, left Cape Town on November 17th and arrived at East London on November 20th, with orders to act as a base hospital to the 3rd Division. Here we stayed moored alongside the wharf till the middle of February, 1900.

On the 12th December we received our first convoy of wounded, consisting of three Officers and 31 men, the result of the Stormberg disaster. The bluejackets on H.M.S. "Barossa," who were very anxious to be of some use, kindly assisted in unloading the train, and within 20 minutes of arriving the patients were all comfortably settled in bed.

The Buffalo River where we were lying, is a river with very little rise and fall of tide, and lying up alongside a wharf many of the benefits of a hospital ship were lost, the ventilation was partly obstructed, and the tide was not sufficient to carry away quickly the refuse from the ship. Unfortunately there was not sufficient depth of water for the ship to lie in the middle of the stream. In consequence of this many of the Officers and men on board got slight attacks of low fever lasting a few days, and I therefore recommended that we should be allowed to proceed to Cape Town with a convoy of sick, with a view of changing the surroundings and getting the ship well aired. This was sanctioned, and we proceeded to Cape Town on February 18th with seven sick Officers and 66 N.C. Officers and men. On our arrival we were kept in the bay till March 2nd, when we went into dock and disembarked all the invalids.

We left for Durban the same day, taking some civil surgeons and nurses who were wanted in Natal.

We arrived at Durban on March 6th and left again on the 16th of the same month with a sick convoy of one sick Sister, 16 Officers, and 98 men, invalided to the Cape. After disembarking the sick at Cape Town we coaled and cleaned and painted the ship, and then sailed for Durban where we arrived on April 2nd. Here the ship stayed acting as a base hospital till August 28th, 1900, when it was decided that she was no longer required in Natal. Details of various regiments were put on board, but no sick, and we sailed for Cape Town. On arrival at the latter port on September 3rd I was informed that the "Trojan" was to be done away with as a hospital ship and was ordered to give into store all medical equipment not actually wanted on homeward voyage, all hospital clothing and surplus stores, the personnel to proceed for duty on shore. This was done and I handed over charge of the ship to Medical Officer of Scottish Hospital on September 23rd, 1900. Some invalids were put on board and she sailed for England the following day.

(Signed) A. P. HART,
Major, R.A.M.C.

24th Field Hospital,
Johannesburg,
November 12th, 1900.

D.—THE HOSPITAL SHIP "SPARTAN."

1. *Description of Vessel.*—The "Spartan" was a single screw steamer of 3,500 tons register, the property of the Union Steamship Company. Previous to being fitted out as a hospital ship, she had been used for carrying cargo, and was in a very dirty condition.

The engines were in fair condition, and she could steam on the average 12 knots an hour; occasionally, with fair wind and current, $14\frac{1}{2}$ knots.

The Admiralty decided to ballast her with shingle, 300 tons being placed forward and 200 tons aft. This dead weight caused her to roll badly, and she was unprovided with rolling-checks (bilge-keels).

She was a narrow-beamed vessel, with unusually deep draught for her size—22 feet (the large "G" class steamers of the Union Company, twice her tonnage, have only a draught of 18 feet)—and, in addition, steered badly. These latter defects quite unfitted her for the purpose she was intended for—to get over the bars of the South African ports.

2. *Fitting out of Vessel.*—The fitting out of the steamer was commenced on October 1st, 1899, at Southampton Docks, under my superintendence, assisted by Captain Heriz, R.N. Transport Officer. She was practically transformed and ready for sea by night of October 8th.

On October 9th the personnel were embarked, and the ship sailed next day for Cape Town.

3. *Personnel.*—The personnel consisted of:—

(a) Medical Officers—

Major T. P. Woodhouse, R.A.M.C.
2 civil surgeons.

(b) Sisters—

3 Sisters, A.N.S.

(c) Royal Army Medical Corps—

2 staff-sergeants.
1 lance-sergeant.
3 corporals.
14 privates.
1 pensioner, who acted as steward.

The N.C. Officers and men were accommodated in hammocks, in separate quarters adjoining the convalescent hammock ward.

4. *Accommodation for the Sick.*—The following was the accommodation for the sick:—

(a) Officers—

7 cots for severe cases, situated in ward adjoining saloon, main deck.
10 bunks in five cabins on main deck, for convalescent cases.

(b) Warrant Officers—

6 bunks in three cabins on upper deck.

(c) Rank and file—

24 cotted ward in after part of main deck.
21 cotted ward in forward part of main deck.
19 cotted ward adjoining above.
42 hammocks for convalescents, in bow of ship, main deck.
2 cotted ward in upper deck for fracture cases.

Summary of accommodation—

Cots	...	...	...	...	...	73
Cabins	...	...	...	...	...	16
Hammocks	...	...	...	...	...	42

There was, in addition, a padded ward for the accommodation of one lunatic.

The cots were of iron, swung on stanchions fixed to the deck, and so constructed so as to allow for "pitch" and "roll" movements of the ship. They were most satisfactory. A "gilguy" or trapeze was fixed over each cot.

5. *Ventilation and Lighting of Wards.*—This was accomplished by means of skylights and numerous port-holes. Electric fans were placed in each ward. The ventilation was most excellent, and was well maintained even when, owing to bad weather, port-holes and skylights had to be closed.

The ship was fitted throughout with an ample supply of electric lights; "wandering leads" also being provided for each ward.

6. *Superficial Area and Cubic Space in Wards.*—These were unusually large for a ship, owing to the great space, uncommon in so small a vessel, between decks.

7. *Latrine, Urinal, and Ablution Accommodation.*—Each ward was amply supplied with latrines, urinals, bath room, and washing basins. In addition there was a "hopper" sink for cleansing bed-pans, &c. The system for flushing latrines, &c., was most satisfactory.

8. *Dispensary, Medical, and Surgery Stores.*—The dispensary was situated on the forward upper deck; it was large and fully equipped in every way.

The medical and surgical store-rooms were situated in the after "orlop" deck, and were well suited for the purpose.

9. *Operation Room.*—This was situated on the forward upper deck; it was equipped with every modern requirement.

10. *Pack, Linen, and Clothing Stores.*—These were situated on the forward "orlop" deck, and were ample for all purposes.

11. *Means for Disembarking and Embarking of Severe Cases.*—Two lifts, one forward and one aft, worked by means of the donkey engine and derricks, were used for the embarkation and disembarkation of severe cases. They were of great service.

12. *Deck Space for Convalescents.*—A large boat deck was reserved for the exercise of convalescent patients; it was well provided with all sorts of easy chairs.

13. *Dieting and Cooking.*—The dieting and cooking were everything that could be desired.

14. *Work Accomplished by "Spartan."*—The "Spartan" arrived in Durban roadstead on November 7th, 1899, but was not able to get over the bar until November 11th. Thirty-eight sick and wounded from Pietermaritzburg was embarked the same day.

The "Spartan" was, off and on, used as a base hospital at Durban for varying periods, and, in addition, made the following voyages, carrying the number of sick noted:—

Date.	From	To	Number of Patients carried.
1899.			
November 28th ..	Durban ..	Cape Town ..	121 (included all wounded from action at Willow Grange).
December 21st ..	Durban ..	Cape Town ..	13 Officers and 112 N.C. Officers and men (including 7 Officers and 62 N.C. Officers and men from action at Colenso).
1900.			
February 1st ..	Durban ..	Cape Town ..	116 Officers and men.
March 7th ..	Durban ..	Cape Town ..	13 Officers, and 113 N.C. Officers and men.
March 19th ..	East London ..	Cape Town ..	3 Officers, and 73 N.C. Officers and men.

After the last-named voyage the "Spartan" was used as a base hospital in Table Bay, receiving large numbers of sick from the 10th (Hunter's) Division on arrival from Natal, 8th (Rundle's) Division, on arrival from England, and various transports. This work was carried on until May 21st, on which date the "Spartan" sailed for East London, with orders to lay in the Buffalo River

and act as a base hospital, relieving No. 2 Stationary Hospital. She arrived at East London on May 24th, but not being able to cross the bar, on June 2nd orders were received to land personnel and take over No. 2 Stationary Hospital, and this was done the same night.

After this date the "Spartan" was not again used as a military hospital. After waiting outside East London a long time, and still not being able to cross the bar, she was ordered to Simon's Bay and used as a hospital for Boer women.

Remarks.—The "Spartan" was not at all suited for the work for which she was intended, on account of her deep draught and erratic steering. Moreover, she was a well-known "roller," and the dead ballast, placed in her by the Admiralty, improved her capacity in this direction. She was for this reason alone quite unsuited for the conveyance of sick and wounded.

In my opinion also she was not nearly large enough, and her accommodation for sick and wounded was too limited.

The wards were well lighted and ventilated; there was ample superficial and cubic space per patient; the various stores, dispensary, &c., were all that could be required; and she was splendidly equipped.

Dover,
May 4th, 1903.

T. P. WOODHOUSE,
Lieut.-Colonel, R.A.M.C.

E.—THE HOSPITAL SHIP "PRINCESS OF WALES."

The Central British Red Cross Committee decided on September 19th, 1899, to fit out a hospital ship in the event of a war in South Africa. On September 30th it was resolved to get ready the fittings, and at the same time to find a suitable ship.

This resulted in the selection of the "Midnight Sun," renamed the "Princess of Wales." The necessary alterations were made, and the ship left for South Africa on December 8th, 1899, and arrived at Cape Town on January 8th, 1900, when some necessary repairs had to be carried out. On January 31st, 1900, she left Cape Town with 174 invalids, and arrived in Southampton on February 26th, 1900.

The second voyage out commenced on April 12th, 1900, and on May 29th, 178 sick and wounded were embarked at East London. Some of these were disembarked at Cape Town, while others were embarked, and the ship left this port on June 13th, arriving in England on July 9th, 1900, having 173 invalids on board.

The third voyage out commenced on August 23rd, 1900, and after some detention at Cape Town the ship arrived at Durban on September 2nd, here she was employed as a stationary hospital, and four Officers and 255 of other ranks were admitted and treated in the wards. On November 5th, 1900, she left for England, and on December 10th, 1900, disembarked 174 invalids at Southampton. From this date she ceased to be used as a hospital ship.

The staff consisted of five Medical Officers, four nursing Sisters, and 41 N.C. Officers and men.

The Red Cross funds paid for everything except the hospital staff and coal supplies.

Description.

The "Princess of Wales" (a vessel of about 3,200 tons gross register) had for some years previously been used as a pleasure yacht, and many changes were consequently necessary before she was fit for use as a hospital ship. The three upper decks were set apart for hospital accommodation, and for the use of the 184 patients which the vessel was to carry.

The upper deck, which could be covered by awnings when necessary, afforded ample space for helpless patients to lie out and for the convalescent patients to promenade. At the fore part of this deck was the Officers' saloon, and at the after part a deck-house, which had formerly contained cabins, but which had now been converted into a large cabin and office for the Principal Medical Officer and a ward for Officers.

The Officers' ward (Princess Victoria Ward) was arranged to accommodate four sick Officers, and was fitted with swing cots, screened off from each other

by curtains. The ventilation was perfect, there being windows on either side, and also doors which opened on to the upper deck promenade space. Adjoining the ward was a bath room having a small annexe, as a latrine, leading from it.

The accommodation for the N.C. Officers and men.—There were four wards fitted up to accommodate 178 patients. Two of these wards were in the fore part of the ship, and two at the after end situated on the main and lower decks. All the cots were made of galvanised iron and fixed, with the exception of eight cots in the "Princess Alexandra Ward" on the after part of the main deck. These latter cots were so constructed that they could be fixed or allowed to swing as desired. On the main deck there were square ports which were useful as additional means of ventilation in hot weather. They could not, however, be utilised if the weather was at all rough, and I cannot recommend them as they are not easily closed in case of emergency. There was also a small ward with two beds for infectious cases on the main deck forward. In my opinion an isolation ward should be situated at the after part of the ship, as the current of air generally passes from the fore to the after part of a vessel, especially when it is in motion. The four larger wards had each a small room (for use as a pantry) for the nursing Sister attached to them.

Disinfecting Rooms.—There was one at each end of the vessel adjoining the wards on the main deck. A room of this description is essential in a hospital ship.

The Water Supply.—In addition to the water stored in tanks there was a distiller which maintained an ample supply of fresh water. The water for drinking passed through Berkefeld filters which were fitted in the wards and on the troop deck. These filters worked well, and ensured a wholesome supply of drinking water.

The Cooking Galleys.—There were two galleys, one for the saloon, troops, and invalids, and another small one in the fore-castle for the ship's company. I do not consider this arrangement entirely satisfactory as it would be better to have separate galleys for the hospital and for the saloon and troops. The hospital diets were satisfactorily cooked.

Ventilation.—On the main deck and in the lower ward ("Princess Louise Ward") aft the ventilation was good, but in the convalescent ward situated on the lower deck forward, it was not so good as the fans did not work well at times and the ports could not be kept open if the weather was at all rough.

Latrine accommodation was good, but might have been greater for the convalescent ward and troop deck.

Lighting.—Electric light was used throughout the vessel, but when this means of lighting is used an ample supply of candle or lamp light should also be supplied for use in case of accident to the electric light plant.

Laundry.—This was situated on the main deck on the starboard side forward of the isolation ward. It worked well but was a little too small for the amount of work which had to be done at times.

Lyons' Steam Disinfector.—This was situated between the isolation ward and the laundry. It worked well.

Drying rooms were situated amidships.

Library.—There was a good supply of books and magazines on board which were much used by the patients. There were other means of amusement provided in numerous and varied kinds of games. These, together with a large supply of tobacco, cigarettes, pipes, and other luxuries, were presented by H.R.H. the Princess of Wales.

Clothing.—In addition to the hospital clothing, &c., supplied by the British Red Cross Society, there was a large number of pillows, warm rugs, sticks, &c., presented by H.R.H. the Princess of Wales. These, the patients took with them on leaving the ship, as also any other warm clothes of which they were in need (many having little or no warm clothing when taken on board).

The operating room was well supplied, and, among other appliances, was fitted with an excellent Rontgen-ray apparatus supplied by Messrs. H. Cox and Co., and the gift of His Grace the Duke of Newcastle. Some very good results were obtained from it.

The dispensary, which was situated amidships on the starboard side, was well formed and ample for all requirements.

The ice-making machine worked well, and there was always an ample supply of ice.

The refrigerating machinery and chambers (Hall's) also worked well.

The quarters for the Medical Officers were situated on the starboard side of the main deck amidships. The bath and latrine accommodation was conveniently situated.

The quarters for the nursing Sisters were situated in a corresponding position on the port side. These quarters could be completely isolated from the rest of the ship by closing the doors placed at either end of the alley way.

The total number treated in hospital during the three voyages was 741. Of these 151 were cases of gunshot wounds, 155 enteric fever, and 73 cases of dysentery, the remainder being made up of various other disease, the most important being cases of rheumatic fever and heart diseases. Of the 741 cases treated on board, in hospital, 522 were conveyed home as invalids, 173 were transferred to other hospitals or returned to duty in South Africa, and one case of enteric fever, occurring in a patient suffering from tubercular disease of lung, terminated in death. In addition to the above there were 45 admissions during the three voyages from among the hospital staff and the ship's company.

(Signed) A. PEARSE,
Captain, R.A.M.C.

Aldershot,
March 21st, 1901.

F.—THE HOSPITAL SHIP "MAINE."

Early in the war this ship with its navigating staff was generously placed at the disposal of the Government by the Atlantic Transport Company, and its conversion into a hospital ship was undertaken by a number of American ladies. As the vessel had been previously used as a cargo and cattle ship, the conversion into a hospital ship entailed heavy expenses.

The ward fittings and system of ventilation followed the lines of those of the "Princess of Wales."

The "Maine" sailed on December 23rd, 1899, and arrived at Cape Town on January 21st. On February 5th the first party of sick and wounded was received on board. For a time she was used as a stationary hospital at Durban, but left for England on March 17th, 1900, with 162 invalids, and arrived at Southampton on April 23rd, 1900. The second voyage to the Cape commenced on May 3rd, 1900.

On June 8th, 1900, she sailed from Cape Town for England with 160 patients who were disembarked on July 3rd. This terminated the work of the ship in connection with the South African Campaign.

Description.

Accommodation.—There were two wards in the fore part and two in the after part of the ship. In each case the wards were placed one above the other below. Of the two in the fore part of the ship, the upper one provided accommodation for 12 Officers, with an Officers' sitting room, bath rooms, lavatories, &c., attached. The lower ward was for N.C. Officers and men, and had 54 cots arranged in two tiers one above the other.

The system of having two tiers of cots is not satisfactory for acute cases but answers well for the lighter cases.

In the after part of the ship the upper ward had accommodation for 37 cases and the lower for 70 cases, in both these wards the cots were arranged in single tiers.

The cots were Ruskin's patent, and were supported by iron stanchions running from the floor of the ward to the deck above. The framework of the cots was of iron with a wire mattress. The side rail of the cots could be dropped down when necessary. The framework of the cot could be lifted out so as to remove cot and patient to the upper deck when considered advisable for change of air. At first some of the cots were made so as to swing in a rolling sea, but this system was soon given up as the patients do not like it.

All the iron fittings of the cots were white enamelled so that they could easily be washed.

There were two lifts, worked by a system of ropes and pulleys by which patients could be lowered from the upper deck to the wards and *vice versa*. These lifts worked well and were a great convenience.

In addition to the wire mattress each cot had its hair mattress and an ample supply of blankets, bed linen, &c.

Bed rests were supplied to support patients allowed to sit up.

The approaches to the wards were by broad companion ladders fore and aft.

Presses, cupboards, &c., were fitted to each ward for general use.

Each ward had a system of Berkefeld filters with iced water laid on.

Operating Room.—There was an excellent operating room adjoining the upper ward in the after part of the ship. It was supplied with every modern appliance for the performance of surgical operations. The operating table was made of two thick glass plates on metal supports.

There was an excellent X-ray apparatus and dark room for photography.

Surgery.—A surgery was fitted up in the fore part of the ship and well supplied with drugs and surgical appliances.

Linen Store.—Pack store and clothing store. These were fitted up in the hold.

Laundry.—There was an excellent centrifugal laundry worked by electricity and a drying room attached. The laundry was capable of washing 2,000 pieces a week. It worked very satisfactorily.

A mortuary and post-mortem room was fitted up near the fore-castle.

A bacteriological room was fitted up in the fore part of the ship.

The heating of the wards was carried out by steam radiators and was very satisfactory.

Lighting by skylights and side ports in upper wards and by side ports in lower wards. The ship was lighted throughout by electricity.

Ventilation.—By ventilators with cowls, wind sails, and also by side port holes. In the lower wards there were large ventilating shafts with air-propellers driven by electricity. These propellers were both in-draught and exhaust. The ventilation was satisfactory.

Disinfection.—There was a small steam disinfector, but for disinfecting bed linen, clothing, &c., steeping in perchloride solution and subsequent boiling was invariably carried out.

Disposal of Excreta.—Enteric and dysenteric stools were treated with Izal or carbolic acid, and afterwards poured into sinks which communicated direct with a pipe emptying into the sea. There was a constant head of water running in all the sinks, so that there was no accumulation. These sinks were placed in the lavatories attached to the various wards. The bed-pans and urinals were carefully disinfected after use.

Latrines.—The latrines were on the trough system. Seats for the patients were placed over the trough. At the most dependent point the trough ended in a pipe leading to the sea. The outlet of the pipe was some distance above the surface of the sea-water. There was a constant head of water running in the trough, so that all excrement was at once washed away and the closets were always clean and sweet. The essential point is that the water supply is ample and constant. The supply was regulated by the taps at either end, but it must be kept constantly running in considerable volume when the wards are in use. [A difficulty was experienced in the Northern Chinese waters when the ship was full of serious cases. The chief engineer reported to me that the pump supplying the water to the latrines was going at breakdown speed, and there was danger of a breakdown and consequent arrest of water supply. I called on him for a statement of the necessary fittings to ensure a constant supply of water. As soon as the sick and wounded were transferred to the Naval Hospital at Yokohama, I had the ship dry-docked and a second pump, with a larger piston, fitted to the ship. From that time there was never any difficulty.]

Drinking Water.—The condensers on the ship were not in working order, and consequently water was taken on board at various ports and stored in tanks. The water was subsequently filtered and generally boiled, but the system of taking water at various ports is unsatisfactory. A ship to be used as a hospital should be capable of condensing sufficient water for all purposes.

The ship was provided with refrigerators, where fresh meat was stored. There was an ample supply of ice for every purpose.

Diets.—The dieting was on a most liberal scale, and was supplemented by extras of every kind.

Special Provision for Infectious Disease.—The only place where infectious cases could have been isolated was in the room used for bacteriological purposes. As this was in the fore part of the ship, and the accommodation was very limited, it cannot be said to have been very satisfactory. There were no infectious cases requiring isolation during my term of office.

A special feature of the ship was the use of baths in the wards for the treatment of enteric fever cases. These baths were full-sized, and fitted on four small wheels with indiarubber tyres, so that they could be wheeled alongside any cot and fixed there.

The cold bath treatment was invariably carried out in enteric fever cases, and the results were highly satisfactory. As soon as a patient's temperature reached 103° he was given a bath, and some patients got as many as six baths in 24 hours.

Staff of the Hospital.

- 1 major, Royal Army Medical Corps, in charge.
- 4 American civil surgeons doing duty.
- 1 compounder (American).
- 7 American male nurses.
- 5 N.C. Officers and men (including one Warrant Officer as chief wardmaster and clerk, four N.C. Officers in charge stores).
- 2 American ward orderlies.
- 14 St. John Ambulance orderlies.

Another special feature was the superior training of the American male nurses. These men were educated in New York, and their practical acquaintance with nursing, bathing of patients, and with every detail of aseptic surgery made them invaluable. There were no lady nurses in my time.

As a hospital for acute cases of disease and serious cases of wounds, &c., the ship was well equipped in every detail. For convalescents it was not so suitable, as the deck space was limited. As I said before, in equipping another ship, it would be better and cheaper to start with a good passenger ship with more space between decks and more accommodation.

I ought to say that the American and British members of the staff worked very harmoniously together, and all worked well.

The professional work done by the American civil surgeons was of a very high order.

J. MEEK,
Major, R.A.M.C.

G.—THE HOSPITAL SHIP "NUBIA." (Captain F. J. Fox.)

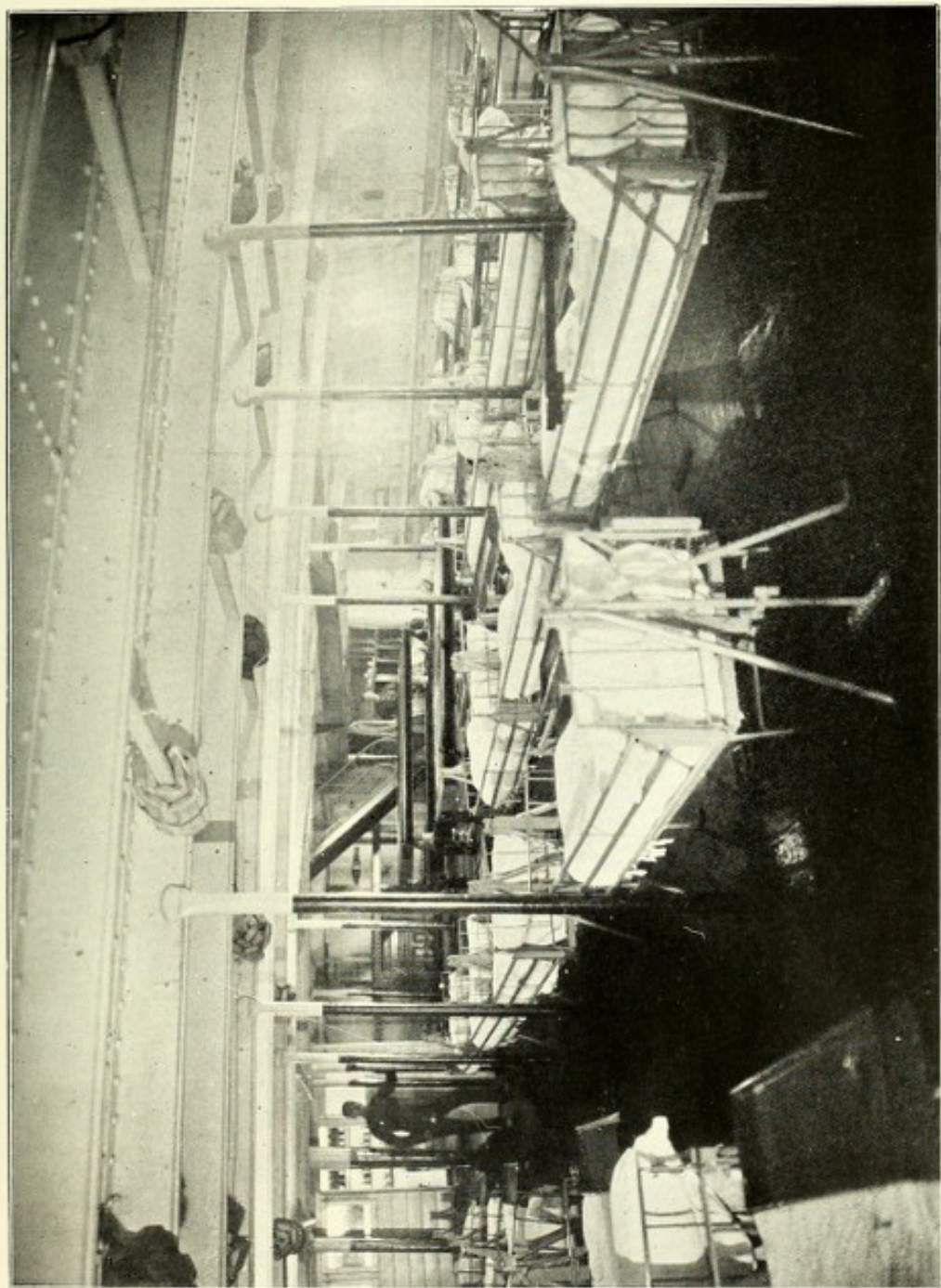
Detail.—Gross tonnage, 5,814·29; Cargo tonnage, 6,305; nett tonnage, 3,844·81.

Length, 430 feet; breadth, 49 feet; depth, 34 feet.

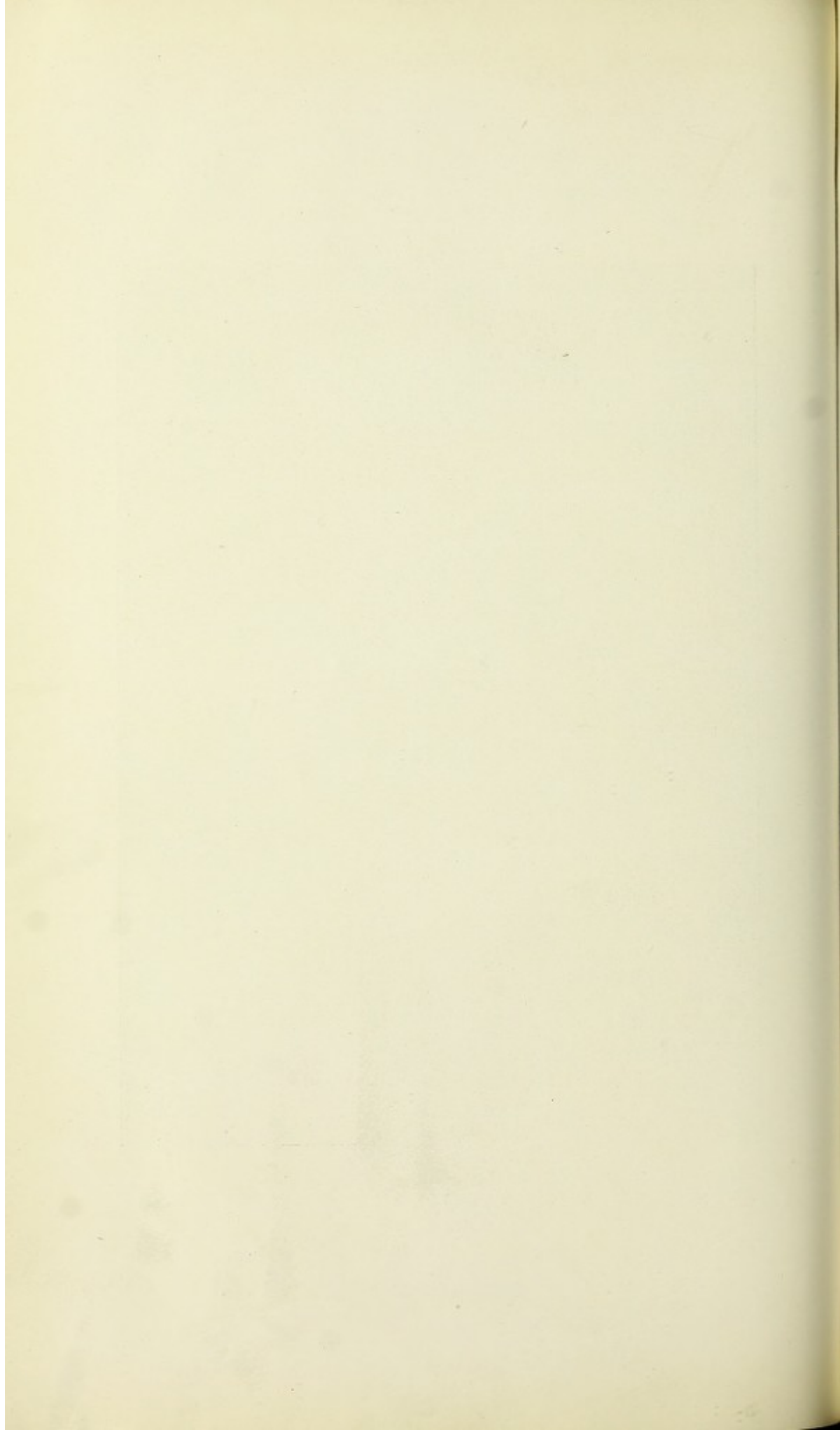
Load line, 7 feet 4 inches. Horse-power, nominal, 700; indicated, 3,600.

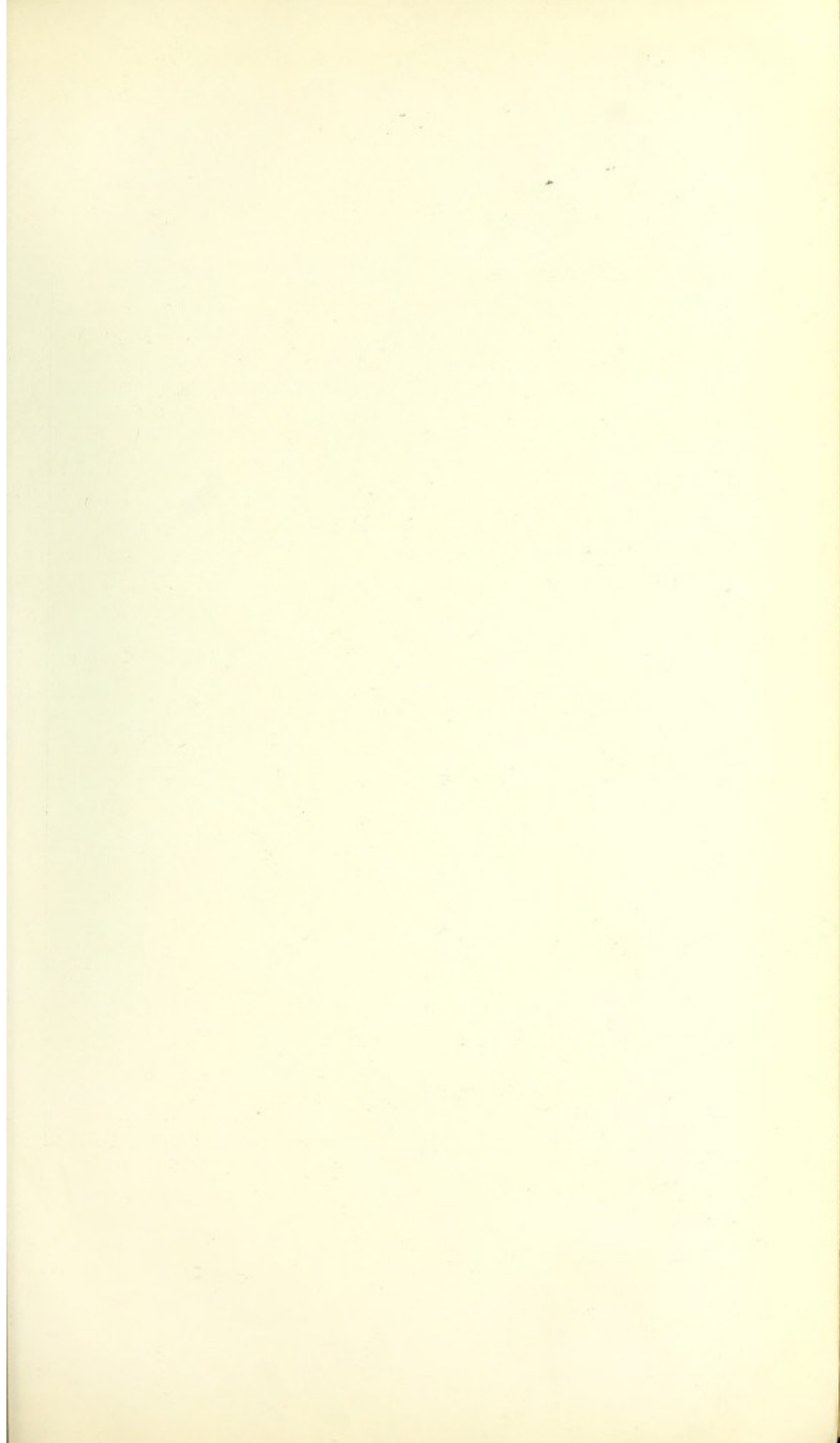
Number of crew, Europeans, 99; natives, 85.

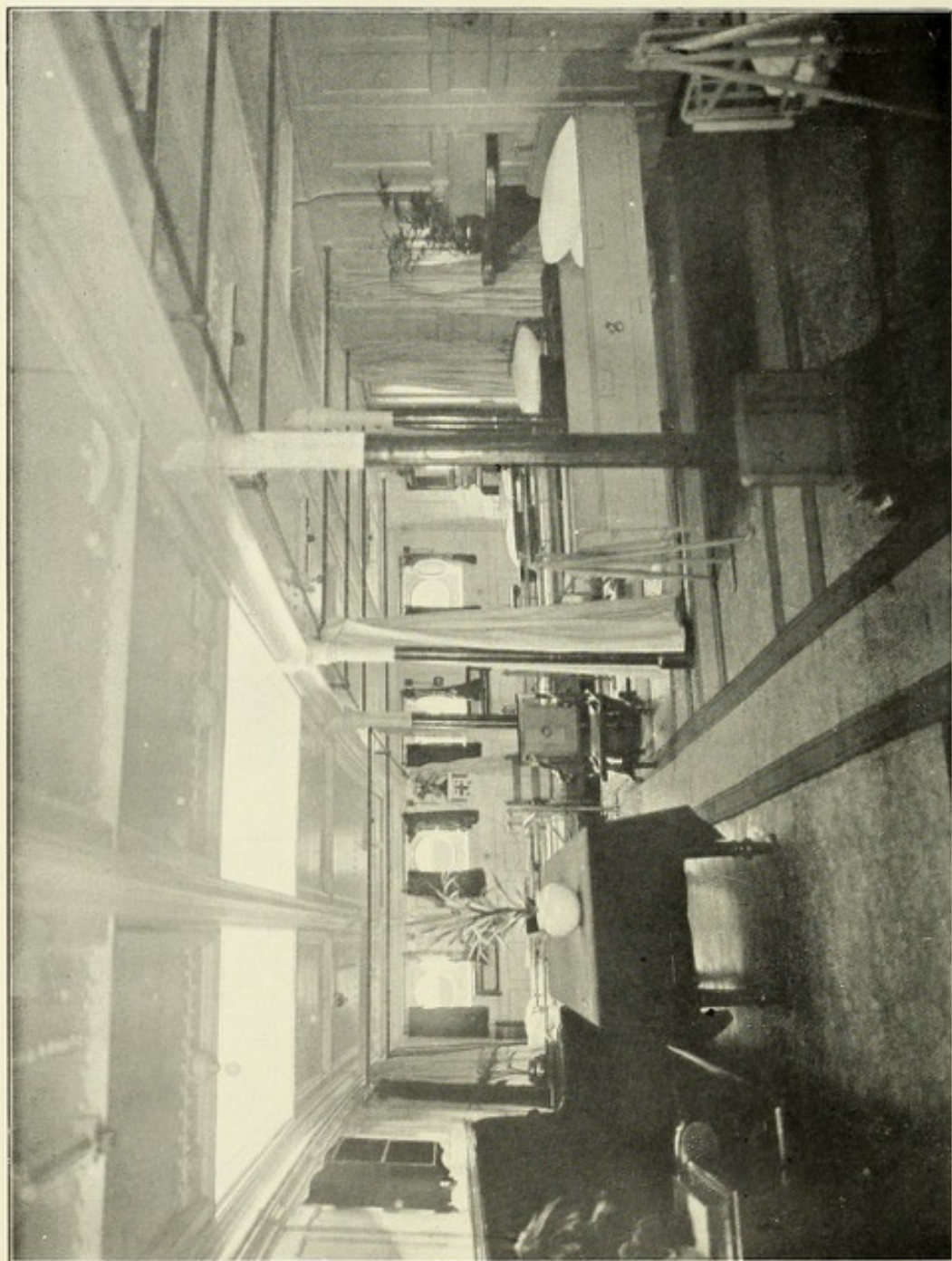
History.—This ship was built at Greenock by Messrs. Caird and Co., early in 1895, for the Peninsular and Oriental Steam Navigation Company, and was employed on passenger service between London and India until July, 1897, making nine completed voyages. In September, 1897, she commenced trooping and made eight voyages to India and the Mediterranean. She continued as a troopship until March, 1899, when she resumed passenger service, making a voyage to China. In September, 1899, she was again used as a transport and proceeded to South Africa, arriving at Durban on November 25th. There she was fitted as a base hospital ship, and remained at that port until March, 1900, when she sailed as a hospital ship



No. 4, E WARD EQUIPPED WITH BEDDING AND READY FOR RECEPTION OF INVALIDS.
(One table on right is shown across the bed, remainder are on the side rails. The dispensary is on the left. Life-belts are shown above cots.)







No. 6.—Officers' Ward.
(Showing Electric Radiator x, Invalid Chair O, Portable Electric Fan *, and one extra size Swing Cot 8.)

for Southampton. Since March, 1900, until the present date, she has made 16 voyages to South Africa. Latterly she has been used as a hospital ship on the homeward and as a transport on the outward voyages.

Engines.—The chief engineer, Mr. C. W. Ferguson, informs me that she is fitted with triple expansion engines, with Weir's pumps. These engines were of the latest pattern at the time the ship was built, viz., 1895, and are similar to those now being placed on steamships. He also informs me that these engines are in excellent condition, and capable in smooth water of steaming between 13 and 14 knots.

Fresh Water.—The ship's tanks hold 426 tons of fresh water: 26 tons can be made daily by the condenser. Our average consumption is, roughly, 25 tons daily. This allows a constant supply for every requirement, drinking, washing, and baths, scrubbing decks, washing clothes, &c.

Refrigerator Chambers.—The ship is also fitted with Hall's refrigerating engine, which circulates brine cooled by carbonic acid gas through pipes in the cooling chambers: 200 lbs. of ice can be made every 24 hours in addition to keeping the temperature of the chambers at -2°C . These chambers are four in number. The purser, Mr. A. D. Young, informs me that when properly and carefully stowed they are capable of holding about 13,500 lbs. of fresh meat, 2,250 head of poultry, and 1,600 lbs. of fresh fish, besides fresh vegetables. This amount of meat would be sufficient for 50 saloon passengers, 500 troops, and a ship's crew of 190 for about 19 or 20 days. In addition to this, in cool weather 2,000 lbs., or nearly three days' supply, may be hung in the butcher's shop for first use. Dry stores, tinned and salt meats, can of course be stored in large quantities in adjacent store rooms. The 2,250 head of poultry and 1,600 lbs. fish would be sufficient for a round voyage, say, to South Africa and back.

Construction.—Figs. 1 and 2 (at end of report) show diagrams of sections of the ship. The former is taken vertically, while the latter gives details of cabins, &c., on the hurricane deck and four horizontal sections in which details of each deck are depicted. If these plans are used in conjunction with the photographs in the body of the report, it is hoped that the following description will be made clear:—

Working by Fig. 1 and commencing on the highest deck, and proceeding from the forward to the aft extremity, afterwards dealing with each successive deck below in the same manner, the following is a brief description:

- (1) *Boat Deck* (marked ① in Fig. 1).—On the forepart of this deck are the bridge and cabins of the ship's officers, the aft portion being nearly filled by boats. These boats are of interest, as it has occasionally been found necessary to make use of them for isolating cases of infectious disease. The boat being covered in by a tarpaulin and a bed laid on boards placed across the thwarts, makes a comfortable quarter. Thorough disinfection is, of course, carried out after removal of the patient.
- (2) *Hurricane Deck* (marked ② in Fig. 1).—This is immediately below the boat deck, on a level with the upper decks of the forecastle and poop, but separated from by the fore and aft well decks. It is used chiefly as a promenade and lounge deck, on the starboard side by saloon passengers and on the port side by the troops. Amidships, on the forepart of this deck, is the captain's cabin, the music saloon, and the saloon companion, opening on to which are two Medical Officers' cabins. Further aft are two cabins, one on either side. Beyond these are the saloon galley and engine casing. Then follow six cabins of various sizes for convalescent Officers. Aft of these is the smoking room, which is the last house on this deck.

On the poop deck there is also a promenade for use of invalids, but when women and children are carried, the starboard side is, as a rule, given for their use only. Amidships, on the poop deck, are winches and hatchways, and aft of these a deck house covering the companion way to G and F Wards, and forming an orderly room for the hospital.

- (3) *Upper Deck* (marked ③ in Fig. 1), commencing at the bow, is the fore-castle which is occupied by the berths for the ship's crew. Gangways and hatchways, centrally placed, communicate with the Royal Army Medical Corps quarters and A Wards.

Proceeding further aft is the fore well deck in which are placed the cookhouse and bakery on the starboard side and amidships. A small laundry, fitted with a washing machine, wringer, &c., occupies the fore portion of the port side, behind which at a slight interval are the troop latrines (*see* Photo No. 1). These are provided with 10 seats and the regulation urinals necessary for 500 troops. In addition to these there are water closets for use by patients in the cot wards, which will be referred to when describing the decks on which they are situated. Centrally are booby hatches, gangways, ventilators, &c., leading to B, C, and D Wards. Immediately aft of the well deck is the saloon, which extends across the whole breadth of the ship. Leading from the saloon to the aft well deck are long alley ways, one on either side, into which the cabins for the staff and convalescent Officers open. The cabins are nearly all "outside," *i.e.*, communicating by means of scuttles with the outer air, the greater part of the centre of the ship being taken up by the casings of the engines. Bath-rooms, w.c.'s, and lavatories, for saloon passengers, are also situated in these alley ways.

The aft well deck is chiefly taken up by a booby hatch and hatchway looking to E Ward. In this hatchway there is a lift for conveying helpless patients either to or from the ward (*vide* Photo No. 2), which also shows the cot in which patients are raised from a lighter and transferred to this lift when loading cannot be carried on by orderlies. On the port side is the operating room (Photo No. 3).

A mortuary is situated aft of this under the fore part of the poop, also small baggage rooms and latrines for the Officers' ward which is immediately behind. This ward is fitted with nine swing cots which, by means of curtains, can be made more private than those in the other wards.

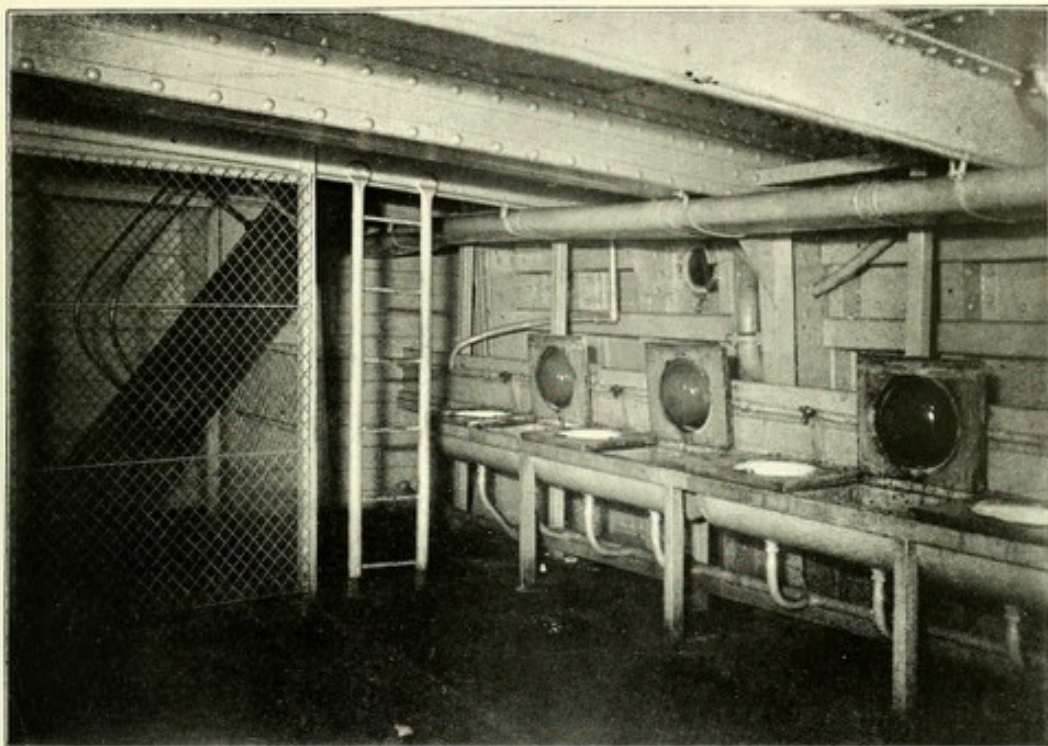
Aft of the Officers' ward is G Ward, cubic capacity 12,229 cubic feet, and superficial area 1,483 square feet, which is now divided by a fore and aft partition. Originally this ward could take 88 hammock cases. It has also at one time been fitted for 24 cots.

Aft of G Ward are three baths, one of which is for disinfecting purposes. There is also a wash-house with eight basins; three w.c.'s, a hopper, and a linen room take up the remainder of this deck.

- (4) *The Main Deck* (marked ④ in Fig. 1).—The fore peak on this deck forms the ship's steward's quarters, immediately aft of which are the Royal Army Medical Corps quarters. These have a cubic capacity of 5,659 cubic feet and superficial area of 808 square feet, and accommodate 40 men. Aft of this is a small ward (A) of cubic capacity of 7,262 cubic feet, superficial area of 1,037 square feet taking 40 hammock invalids. This ward is only suitable for convalescent cases. Between it and B Ward is an iron bulkhead with water-tight doors.

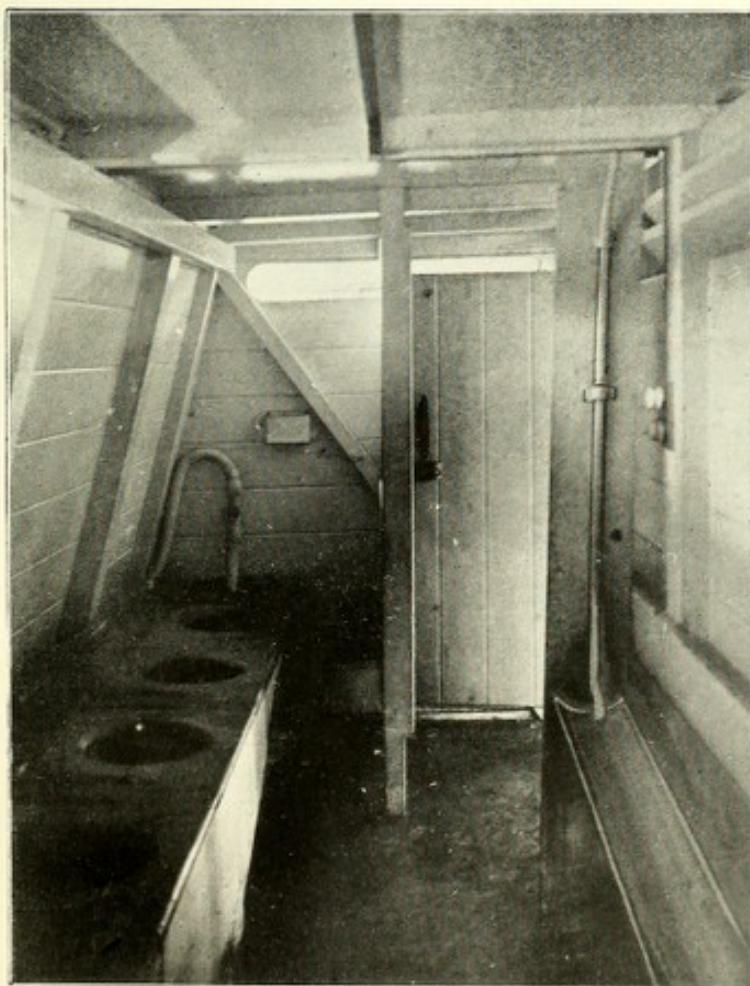
B Ward, cubic capacity 19,687 cubic feet, superficial area 2,812 square feet, has room for swinging 130 hammocks, and is therefore suitable for that number of invalids. It formerly was a cot ward in which 38 swing cots were located. If used for healthy troops the number allotted is 196. In this ward there is a lift for raising helpless patients to the deck. This ward is separated from D Ward by an iron bulkhead, in which are two water-tight doors.

D Ward is aft of B Ward, and is fitted with 46 iron and wood (fixed) cots. In this ward are electric fans both large and small. The cots do not swing. Large dressers and ice chests are

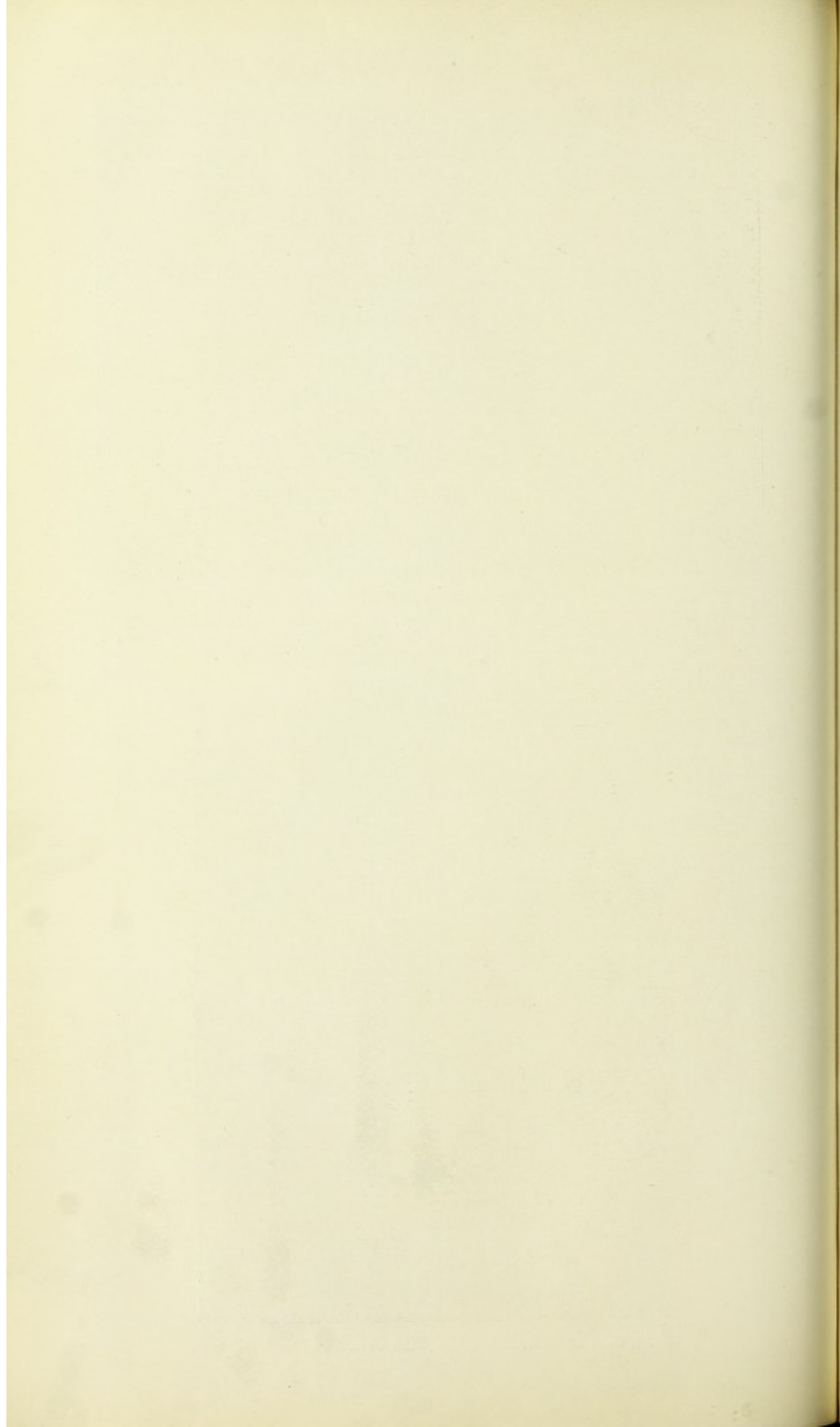


NO. 7, WASH-HOUSE ON PORT SIDE ALLEY-WAY LEADING FROM D TO E WARD.


Basins on hinges, and can be emptied easily. A wooden flap, in which the basin is hinged, can also be raised, and the zinc-lined trough underneath used for washing clothes. Three basins and flaps are shown raised, those in the intervals being in the usual position. The floor here is concreted. The gang-way on left leads to the upper and hurricane deck, and is termed the emergency ladder.



NO. 1, PART OF TROOP LATRINE SHOWING URINAL ON RIGHT OF PHOTO.



placed in the ward. The arrangement of the cots is, as a rule, in pairs, and so the ward is not so suitable for acute cases as those further aft. Iron bulkheads separate this ward from B ward and from the engine casing. Two broad alley ways approached through water-tight doors lead aft from the ward. In the starboard alley way are situated two cells for prisoners and accommodation for a guard, and on the port side bath-rooms, including a spray bath and 17 wash-hand basins (Photo No. 7), each provided with tap and sink. In either alley way there is also a zinc-lined soiled linen room. The engine casing occupies the central part of the ship, and attached to this is a steam extractor.

The alley ways from D Ward lead through water-tight doors in an iron bulkhead to E Ward. This ward (Photo No. 4), which has a cubic capacity of 20,797 cubic feet, and superficial area of 2,773 square feet is fitted with 40 swing cots. These swing cots, which measure 6 feet 1 inch by 2 feet 2 inches, are slung on iron supports, have iron side rails, and the mattress rests on iron laths. A small sliding bolt fixes the cot where necessary. Each cot has a small wooden table 8 inches broad fixed by a hinge to the side rail so that it can be placed across the bed if required. A circular hole in the table receives a tumbler. The ward is fitted with a large dresser and ice chests. As in D Ward, two large electric propulsion fans (*vide* Photo No. 5) draw fresh air through the air trunks marked , and propel it into the ward. These fans are placed as far away from the hatchways as possible and deliver air against the bulkheads so that no draught is felt by patients. Four portable electric fans are fitted, two on either side of this and the other cot wards. Electric kettles and electric sterilisers for instruments are also provided in these wards. Steam radiators are fitted on all decks, *vide* (S.R.) in Fig. 2.

The dispensary is placed on the starboard side of E Ward. This has a superficial area of 192 square feet and cubic capacity of 1,488 cubic feet. It is furnished with bottle racks, drawers, cupboards, counters, &c., and meets all requirements. Both salt and fresh water are laid on; it has also a sink. An electric kettle is also available.

Aft of E Ward, through water-tight doors in another bulkhead, is F Ward, which is fitted with 31 swing cots and other appliances similar to E Ward. It has a cubic capacity of 17,242 cubic feet and superficial area of 2,299 square feet.

Aft of F Ward are two baths and two w.c.'s, beyond which is a ship's steward's peak.

- (5) *Orlop Deck* (marked ⑤ in Fig. 1).—The fore part of this deck is occupied by native steward's quarters. Aft of which and just below A Ward are the armoury, magazine, canteen, and general issuing rooms, and the bread store.

Further aft but not communicating with these rooms is C Ward, which is approached by a central hatchway from B Ward.

C Ward has a cubic capacity of 18,281 cubic feet, a superficial area of 2,812 square feet, and is practically a similar ward to B Ward. It is fitted for 196 healthy troops or 130 invalids. At one time this ward was fitted with 50 fixed cots, but this would seem somewhat too crowded for any but mild cases of illness. The ventilation in this ward is accelerated by a steam extraction pipe.

Through a hatchway from C Ward the hammock, bedding, and hospital linen rooms are approached. These are situated on the flats below the orlop deck, where there are also stores for hospital clothing, helmets, &c. The space further aft is filled by the engines, baggage rooms, purser's stores, refrigerating chambers, &c., as far as the poop bulkhead. Beyond this and approached by a hatchway through G are F Ward are hospital pack and linen stores and ship's linen stores.

Incidental Remarks.

The ship is fitted throughout with electric light supplied from two dynamos in the engine room.

The cabins for invalid Officers are good and roomy, but are only fit for treatment of patients that can walk, as the narrow entrance makes conveyance of helpless patients inconvenient and distressing to such patients. The nine berths in the Officers' ward are suitable for any kind of case (Plate No. 6). The ward is approached by wide doorways, and meets all requirements. It is supplied with portable electric fans, electric radiators, &c., and is a cheerful, well ventilated ward.

Berkefeld filters are used in the dispensary, but water for drinking has not hitherto been filtered, as the sources of supply from the shore have proved satisfactory, and distilled water should not generally require filtration.

Mess table accommodation is sufficient and comfortable. In hammock wards the number of men allotted are, as a rule, calculated by the number that can be seated at the tables, *i.e.*, for healthy troops. The number of invalids is estimated from the number of hammocks that can be swung. A proportion of healthy troops sleep on the decks.

In the cot wards there is table and seating room for over three-fourths of the number of cots, and in some cases room for all.

The arrangement of cots is shown in Fig. 2. The fixed cots are shown in the photo of E Ward No. 4. These have wooden sides. Iron laths support the mattress. Tables similar to those for swing cots are attached.

Both cot and hammock wards are supplied with fresh water taps and drinking cups, and a receptacle for overflow. A waste pipe from this receptacle to the scupper would be an improvement. All the water-tight doors on board measure 40 inches or more in width, so are well adapted for hospital requirements.

All baths are full size, made as a rule of enamelled iron; hot water can be supplied to all. Cold salt and fresh water are also available. The w.c.'s for cot wards have enamelled porcelain pans with a hinged seat. They are of the pattern supplied by Messrs. Doulton and Co. especially for the Peninsular and Oriental Company.

Hooks are fitted all round the decks for hanging patients' clothing, &c.

Diet boards are hung on hooks in lower part of deck over the cots.

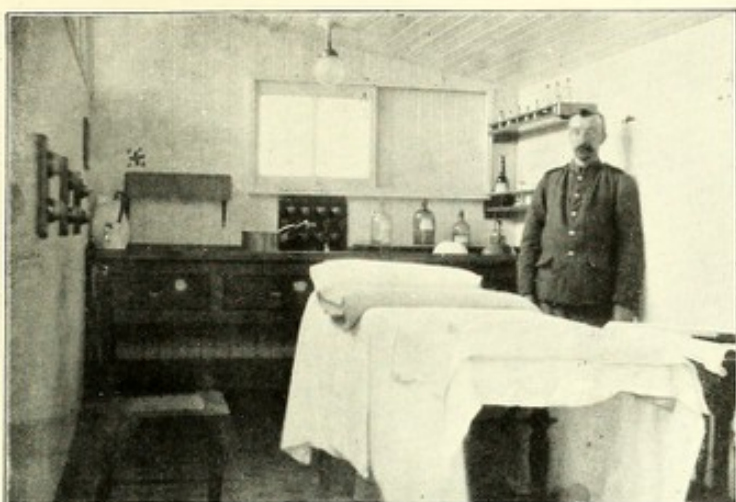
Life belts are provided and placed in a rack over every patient.

Present accommodation for invalids:—

		35 convalescent Officers in cabins.
		9 invalid " Officers' Ward.
143 cots	...	{ 71 invalids in swing cots in E and F Ward.
		{ 46 " fixed " D Ward.
		{ 26 " " " G " (two tiers).
		(When not used for women and children.)
344 invalids in hammocks.	{	44 invalids in hammocks in G Ward.
		40 " " A "
		130 " " B "
		130 " " C "
		R.A.M.C.—40 in R.A.M.C. quarters and 10 in guard room quarters amidships.

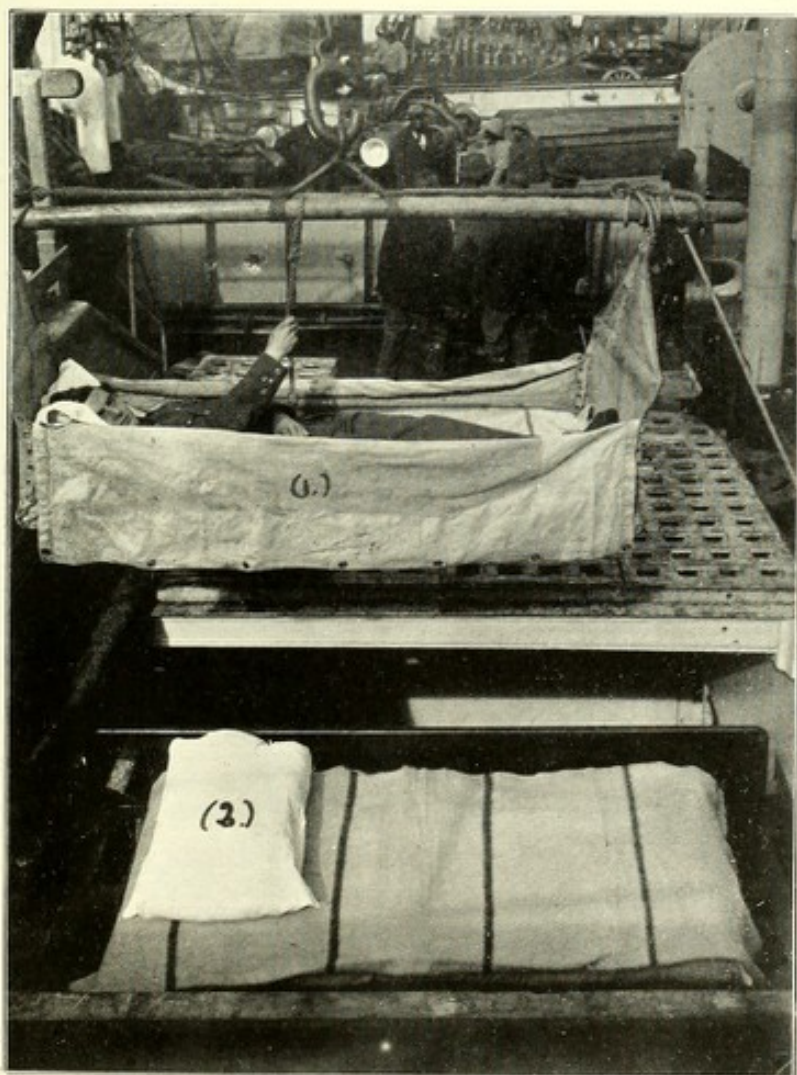
At Durban in 1900 when employed as a hospital ship at the base, the accommodation on board varied somewhat from the foregoing, there being a considerably larger number of cots. The actual distribution was as follows:—

35 convalescent Officers in cabins.
9 invalid Officers in Officers' Ward.
40 hammocks in A Ward.
38 swing cots in B "
50 fixed cots in C "
46 " " D "
40 swing cots in E "
31 " " F "
24 " " G "

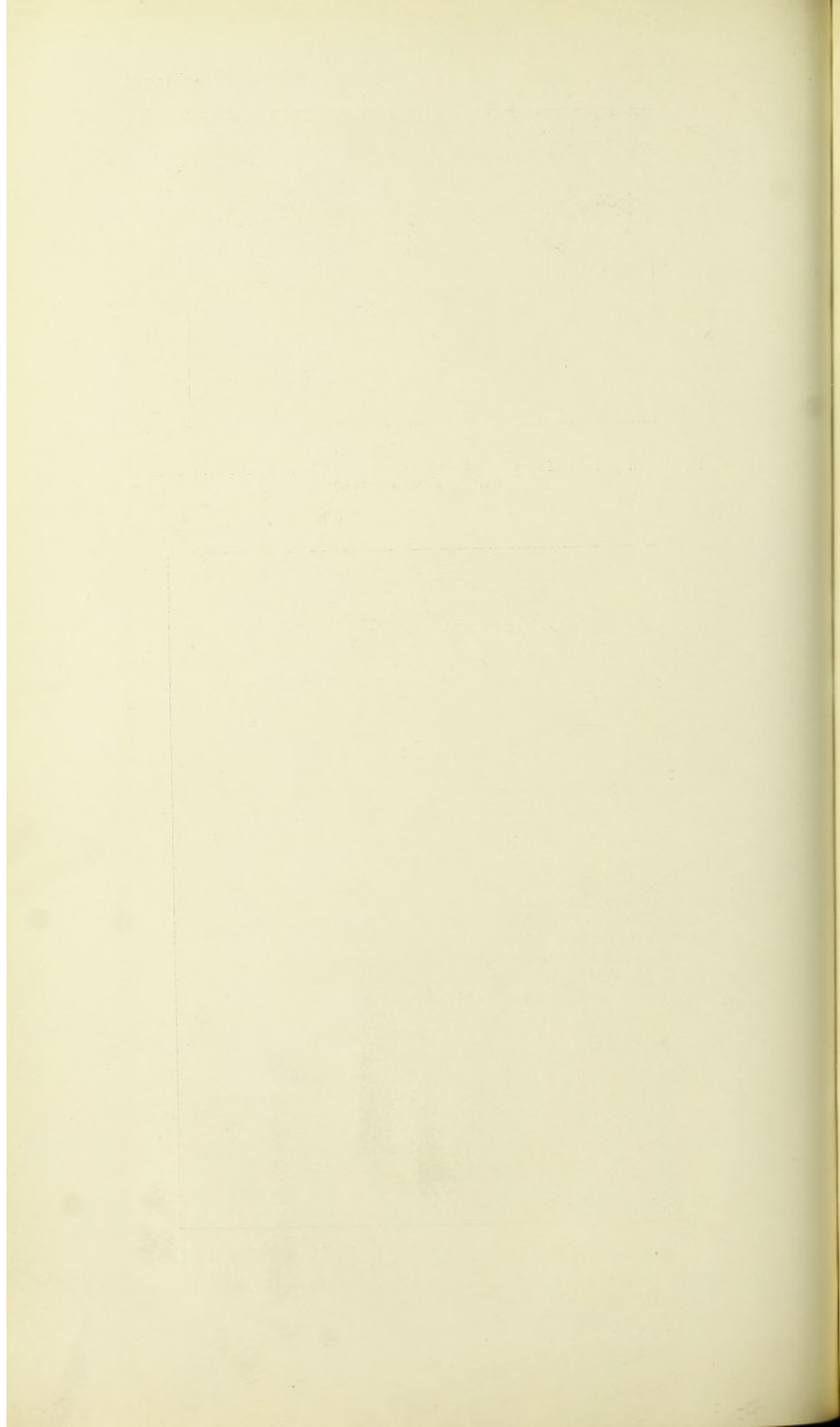


NO. 3, OPERATING ROOM.

(Situated on port side of aft well deck, close to lift from E Ward shown below. Electric steriliser shown on left *.)



No. 2 shows (1) Sling Cot, in which patients are lifted from a lighter by the steam crane and brought on board to be transferred to the lift (2) and then lowered in the lift to E ward below. Sling Cot is sent down with the patient in it if necessary.



making a total accommodation for 313 patients, viz., 44 Officers' berths, 133 swing cots, 96 fixed cots, and 40 hammocks.

The Medical Officers, nursing Sisters, and 50 Royal Army Medical Corps being also provided for. It will be noticed that C Ward has a larger proportion of cots with regard to cubic space than the other wards, but this arrangement was made with a view to providing for mild cases and convalescents.

General Working.

Permanent Staff—

- 1 Medical Officer in charge.
- 1 quartermaster.
- 1 Warrant Officer as chief wardmaster.
- 1 staff-sergeant as clerk.
- 1 " " steward.
- 1 sergeant as compounder.
- 1 " " pack-store keeper, linen, &c.
- 1 " " wardmaster.
- 1 corporal. General duty.
- 1 lance-corporal. General duty.
- 8 privates as ward orderlies.

Additional Staff.—The number required must of course vary with the number and class of invalids embarked. As a general rule—

- 4 Medical Officers,
- 4 nursing Sisters,
- 30 N.C. Officers and privates

are necessary. Of the N.C. Officers three should be above the rank of corporal as they are to perform the duties of wardmasters and have considerable responsibility.

This would make a total of 45 N.C. Officers and men, a number which should meet the requirements on the voyage, also those of embarking and disembarking invalids, which often involve considerable labour.

Permanent Staff—Pay and Clothing.—A pay list is rendered at the end of each voyage to the Station Paymaster, Southampton. This is as far as possible closed on the date of returning to England. Clothing is requisitioned for direct from Pimlico and a clothing ledger kept. Occasionally small quantities are obtained at ports of call.

Equipment, Royal Army Medical Corps.—Equipment is taken on ledger charge in the usual manner.

Ordnance Equipment.—Filters, diet trays, cups, feeders, invalid chairs, &c., are also held on ledger charge.

Fixtures and Sea Equipment.—Cots, tables, life belts, &c., are held on charge by the ship's troop deck Officer.

Bedding.—Mattresses, pillows, blankets, and hammocks are drawn from the troop deck Officer on receipt, and are returned to him when no longer required.

Linen.—Sheets, pillow slips, towels, tea cloths are drawn on receipt from the purser and are returned when no longer wanted. Articles which are soiled during the voyage are exchanged by the purser for clean ones.

Ward Equipment.—Knives, forks, spoons, mugs, plates, kettles, dishes, salt jars, mustard pots, pepper castors, tubs, tumblers, corkscrews, and bread bags, &c., are also drawn from the purser on receipt and returned when no longer required.

Soap.—Soap for patients' personal use is drawn from the purser on receipt and is served out as required up to the regulation allowance.

Cleaning Materials for Wards.—These are drawn from the troop deck Officer as found necessary.

Disinfectants.—These are also drawn from the troop deck Officer and a certificate of the quantity issued given at the end of the voyage.

Hospital Clothing.—Blue serge gowns, waistcoats, trousers, flannel and cotton shirts and drawers, neckerchiefs, socks, and slippers are obtained from the Army Ordnance Department at Southampton, and held on charge in the

equipment ledger. At the termination of the voyage all soiled articles are handed back to the Ordnance Officer for washing and written off on voucher. A similar number of clean articles being obtained on requisition to replace the soiled ones.

Diets and Extras.—All cooking is done by the ship's staff. Diet sheets are used as for a hospital ashore. Summaries are rendered by wardmasters to the quartermaster who demands daily from the purser on Army Form I 1218.

All issues are accounted for on Army Form 735 which is signed daily by the Medical Officer in charge. This together with Army Form F 736 is made up monthly or to the end of the voyage as the case may be. Army Form F 736 is rendered to the disembarking Medical Officer at Southampton, also diet sheets, at the end of the complete voyage out and home.

Pack Store.—A pack store cheque book Army Book 182 is kept. This is checked during the voyage home. Kits of men who die on the voyage home are handed to the Embarking Staff Officer at port of disembarkation.

Valuables.—Army Book 191 is kept and all valuables locked up in a safe in the cabin of the Medical Officer in charge. On arrival home the valuables are handed over to the Medical Officer in charge of the hospitals to which the patients are transferred.

Medical and Surgical Stores.—As a rule these are drawn from the Medical Store Depot at Southampton, supplemented when necessary by requisitions at ports of call.

Routine.

Embarkation of Invalids.—(1) From the shore. As a rule the number of invalids to arrive is notified the day previous to their embarkation. Cots are equipped with bedding, &c., and hammocks held ready for issue as required. When the hospital or other train comes in the invalids are seen by the Medical Officer in charge of the ship, who hands each a ticket showing the ward to which the patient is to proceed and the diet he requires. In the meantime the sergeant-major with a fatigue party unloads the kits and places them separately on the platform. Those patients whom the Medical Officer considers capable of walking on board are directed to claim their kits and fall in close at hand, when their names are checked by the embarking staff. Beef tea and bread is handed to any wishing for refreshment while this is going on. The patients are then marched on board where the quartermaster sends them with orderlies to their wards, and the steward notes their diets. Their kits are taken on board at the same time and are again identified by the owners in their wards.

Patients not considered fit to walk are detrained on stretchers refreshment given them and their kits found and brought to them by the orderlies. After being noted by the embarking staff they are carried on board and lowered to their wards by means of one of the lifts. Their kits are brought on with them.

In the wards the patients are received by the wardmaster and orderlies, and, if necessary, at once placed in bed. A Medical Officer supervises and orders whatever extras or medicine cases may require.

Documents and valuables are taken over as soon as the invalids have embarked. The kits of all cot cases are handed over to the pack storekeeper. Those of hammock cases are retained by the men and stored in racks provided for the purpose over their mess tables.

As soon as the chief wardmaster reports that ward arrangements are completed the Medical Officers and nursing Sisters, if not detained there by their previous duties, go to their wards and every case is inquired into. Fire station orders are read, and attention is drawn to the standing hospital and ship's orders which are hung up in the wards. Diet sheets are made out by wardmasters and at the first opportunity are sent to the office for comparison with the invaliding documents and A. and D. book.

Routine on Voyage.—Patients breakfast at 7 a.m.; have dinner at 12 noon; tea at 4 p.m. One pint of beef tea is ordered for them at 11 a.m., and one pint at 7 p.m., in addition to the ordinary diet. This, of course, does not refer to acute cases.

Nursing Sisters commence duties at 9.30 a.m. Medical Officers go round at 9.45 a.m. The Medical Officer in charge visits all wards between 10 a.m. and 11 a.m.

The captain of the ship, as a rule, goes round at 11 a.m.; after which patients who are not required to remain in their wards are allowed to go on deck if they wish. They have also the same opportunity after breakfast until 9.30 a.m., and at any time during the afternoon and evening up to 9 p.m. if marked "Up" and "Up B.D." on their diet sheets.

An Orderly Medical Officer is detailed daily who goes round meals, &c., as on shore. There is also a nursing Sister on duty.

An orderly wardmaster is detailed for duty after 5 p.m., up to which time all N.C. Officers and men on ward duty are in attendance. One private, Royal Army Medical Corps, is placed on duty in each ward as an orderly who can be called in case of emergency unless special orderlies are employed in that particular ward.

Lights out sound at 9.15 p.m., after which no talking is allowed.

Periodical inspections of the pack store are made by the Medical Officer in charge with a view to ensuring accuracy in the entries in the pack store book.

Diet sheets are frequently checked with the summaries sent in by wardmasters.

All instruments and surgical appliances are inspected weekly, as exposure to sea air has a tendency to cause steel to rust quickly.

Amusements.—Deck quoits and bull boards are provided. Concerts and other entertainments are held once or twice a week. An ordinary transport library of 100 books is allowed by regulation. Periodicals, &c., which are sent by Mr. Dalton on behalf of the Mill Hill Unitarian Guild of Service, 10, Claremont Street, Hanover Square, Leeds, who is mentioned for his kindness in sending a large supply (500 magazines besides other books), and promises for further help—chess, draughts, solitaires, and other similar games, cards, &c., are available in each ward, but are not infrequently badly damaged before return.

When passing through the tropics a sail bath is provided on deck between 5 a.m. and 7 a.m.

Disembarkation.—As soon as the hour of disembarkation is ascertained arrangements are made for checking equipment, &c., all stores not actually required are handed back to the troop deck Officer and purser. The hospital clothing of cot cases is withdrawn and their own substituted, and all held in readiness to disembark and entrain for their destinations. As a rule a cablegram has been received at Las Palmas re the homeward journey specifying the destination of the invalids, and so previous preparation can be made. Patients are given their last meal as late as possible before disembarking, so that they may not feel the want of food until after arrival at their stations.

Arrangements are made by the disembarking Medical Officer for any food necessarily required on journeys, and for medical attendance, &c. A Medical Officer from the ship being generally detailed by him if parties proceed to other stations than Netley, so no further arrangements are made for them from the ship.

Army Form B 179, medical transfer statements and medical history sheets are completed for every patient. When any invalids are proceeding to Netley the Medical Officer in charge accompanies them.

General Remarks.

The ventilation of the ship throughout is very good. Seldom, if ever, even in the tropics is any smell detectable in the lower wards, and the cot wards are always pure.

She is a good sea boat and fitted with bilge keels which minimise her rolling. The decks overhead average about 7 feet 5 inches high, so that they never interfere with free movement in attending sick.

Extra cots can be fitted up in the hammock wards by ship's carpenter in emergencies. Twenty-four spare ones are at present on board.

The photographs were taken by Mr. E. V. Harris, the ship's electrician.

A few Suggested Alterations.

1. The addition of a disinfecting chamber. There is a drying cupboard on board, which is seldom if ever used, and which could be converted with very little expense.
2. The provision of a hinged door at the side of the operating room would enable the transference of patients from the lift with much greater facility, as at present the door, which is narrow, is placed at the end where the deck is very uneven, and other structures interfere with the safe transport of the patient.
3. The lifts are not sufficiently long to take a regulation stretcher, but meet requirements where the ship stretchers are used. The hatchways give sufficient space for these lifts to be elongated.
4. No special portion of the ship has been set aside for isolation purposes. This has been carried out by placing patients in boats as before described, or in such parts of the ship as happened to be unoccupied at the time. A small isolation ward would be advantageous. This could be erected on the boat deck.
5. Two or three padded rooms might be added with advantage, as at present there is no provision made for conveyance of insane patients.

(Signed) O. R. A. JULIAN,

*Major, R.A.M.C.*Medical Officer in charge of
hospital ship "Nubia."Cape Town,
August 12th, 1903.

PART XI.

REPORT ON EMBARKATION, DISEMBARKATION, AND MANAGEMENT, FROM A MEDICAL POINT OF VIEW, OF TROOPS AND INVALIDS PROCEEDING TO AND FROM ACTIVE SERVICE ON BOARD SHIP, BASED ON THE EXPERIENCE OF THE SOUTH AFRICAN WAR, 1899-1902.

(Major C. J. W. TATHAM, R.A.M.C., late Embarking Medical Officer, Cape Town.)

The transport of 400,000 men, their horses, arms, and baggage a distance of over 6,000 miles by sea and back again to their own country is a feat which has not hitherto been attempted by any nation. England has sent out many previous expeditions, but none on so large a scale as that necessitated by the recent war in South Africa. The experience, therefore, gained in this campaign will be of use in all branches of the service in the future. As regards the medical arrangements in connection with the transport of troops by sea it should be particularly useful, as in recent years the improvements and comforts on board ship have been so much increased.

It will be convenient to consider the subject under the following headings :—

Section 1.—Embarkation of healthy troops—

- (1) Class of ship.
- (2) Accommodation of the men.
- (3) Hospital arrangements and defects.
- (4) Disposal of sick on disembarkation.
- (5) Accommodation for healthy troops on the homeward voyage

Section 2.—Embarkation of invalids—

- (1) Class of ship.
- (2) Method of selecting and fitting a ship.
- (3) Accommodation of the invalids.
- (4) Arrangements for berthing them.
- (5) Hospital arrangements and classification.
- (6) Diet.
- (7) Disposal on disembarkation.

SECTION 1.—EMBARKATION OF HEALTHY TROOPS.

(1) *Class of Ship.*

The transport of the troops to South Africa was carried out either in ships chartered by the Transport Department of the navy, transports proper, or in ships in which accommodation for a certain number of Officers and men was engaged for the voyage only at a fixed sum per head, this including rations; but such vessels were not chartered, and the owners were not precluded from carrying certain kinds of cargo and taking other civilian passengers, if all the accommodation was not required for the troops. Such ships are known as troop-freight ships.

Transports.—The transports proper were of two kinds—those for carrying infantry, and those which conveyed cavalry, both men and horses. A certain number of vessels are almost always in use, such as the “Assaye,” “Plassey,” and “Dilwara,” employed in the Indian trooping service. They are specially selected for the service, and their fittings are practically permanent. They make most excellent transports, and the troops have every comfort. In addition to these a number of large liners are scheduled as suitable, and taken up and fitted as occasion may require. A great number of these were employed

during the first year of the war. The majority of them were suitable for the purpose, but in many the work was new to their personnel, and in their early voyages they were not so comfortable for the men as they subsequently became. SS. "Orotava," "Canada," "Bavarian," and "Tagus" were among the best.

Horse Ships.—The horse transports for cavalry carried smaller numbers of men, and in these ships the horses were the first consideration. The troop decks were below the horse decks, and in many cases were stuffy, hot, and dark; and from the fact of the troop decks being so near the water line, there was a difficulty in always keeping the ports open. The personnel of such ships also was frequently of an inferior class, the cooking and galley arrangements were bad, the saloon accommodation for Officers and the saloon stores were indifferent; as a rule there was no refrigerator, and as a consequence there was a difficulty about carrying sufficient fresh dead meat, particularly as they were slow ships, and took three or four days longer on the voyage than the large liners, and several times a week a ration of tinned beef and biscuits was issued. This did not matter so much on the outward voyage, when the men were healthy. But these ships had one great advantage over the infantry ships, which carried larger numbers of men, in that there was in the horse transports more deck space for air and exercise.

Troop-Freight Ships.—Troop-freight ships were, as a rule, satisfactory if for that voyage the vessel only carried troops, but this was seldom the case. If there were first and second class passengers in addition, the deck space for the troops was curtailed, and the ship appeared more crowded than she really was. The food and cooking were generally good, but the troop decks were small, difficult to ventilate, and their fittings were rough and temporary. Of this class of ship the best were the larger type of the Union Castle Company's intermediate steamers, such as the "Braemar Castle," "Avondale Castle," "German," and "Galician"; they were better suited for the purpose than the mail ships of the same company. Some of the troop-freight ships bringing Colonial contingents from the Colonies were of a very inferior type, and would not have been passed as suitable for the purpose in England.

(2) Accommodation of the Men.

There is no authorised amount of space for each man on board ship at present laid down in the "Naval Transport Regulations."

The carrying capacity of any troop-deck is practically estimated by the number of men for whom sitting accommodation can be provided at the mess tables.

This is shown by the opening paragraph of Appendix I of the "Naval Transport Regulations," which runs thus:—

"Every man must have a seat at a mess table, therefore, the maximum number of men a deck will accommodate is governed by the number of mess tables that can be fitted. When, however, seamen are carried each man must have a hammock berth."

The last sentence of the above extract also shows that it is never contemplated to give *every soldier* a hammock berth. In fitting out ships at Cape Town during the late war, the naval transport and embarking staff took as a rough rule that hammock accommodation must be provided for 60 per cent. of the troops any given vessel would carry. But in many of the transports it was possible to give more, though never 100 per cent.

Probably 80 per cent. would be better than 60 per cent., but it must be remembered that every increase of this kind raises the expense and decreases the carrying capacity of the vessel, and it is an undoubted fact that many soldiers much prefer sleeping on the mess tables and the decks to lying in a swing hammock. And further, all the men messed on a given troop deck are not expected to be below at the same time every night, as the guards and watches furnished take a large number of men. In warm weather and in the tropics a large number of men sleep on deck (paragraph 1583 "King's Regulations"), and if protected by awnings from damp and dew this is not prejudicial, and further diminishes the number of men who would be below.

I do not, however, agree with the regulation as to slinging hammocks

laid down in Article 4 of "Specifications for fitting hired ships." There it is laid down: "Hammocks hung from hooks 18 inches apart for seamen and marines, 16 inches apart for troops." I consider the space allowed should be the same (18 inches) in both cases. The average size of the men in many of the regiments sent out to South Africa was equal to, and often greater than, that of the average seaman or marine.

The "Naval Transport Regulations" lay down (Appendix I) that "Mess tables are to be 5 feet 6 inches from centre to centre on decks with side lights, but 6 feet 6 inches on decks not so provided, and that there should be a clear 2 feet 6 inches from the ends of the tables to the coamings of the hatchways." Decks without side lights are now practically never used for troops, and I consider the above gives sufficient space.

The length of the mess table depends on the beam of the ship; they are either 6 feet tables, 7 feet 6 inches, or 9 feet tables; but whatever the length of the table, the sitting accommodation per man works out at 18 inches each; the Regulations further add "by special authority two more men can be added to each table." I should say this was practically impossible. The 18-inches a man is not sufficient for large men. I have seen regiments of Guards on board ship and Colonial contingents, of whom it was impossible to seat six men aside at a 9-foot table, and the numbers had to be reduced and more space allowed.

Eighteen inches should be the *minimum* seating accommodation which must be provided, and provision should be made for giving more where necessary to certain classes of troops. For it must be remembered that the amount of cubic space per head depends (as at present arranged) on the seating accommodation.

Article 72 "Naval Transport Regulations" lays down that "as a rule men will be berthed only on decks well provided with ports or other side lights, and having a clear height from top of deck planking to underside of beam of 6 feet 6 inches."

For anything but a very short voyage the above should be definitely laid down as a minimum. In some ships a deck with a height of 7 feet 6 inches may be obtained, and on such a deck with the sitting accommodation per head as already described (18 inches), the cubic space per individual would be about 75 cubic feet.

The sufficiency of this or otherwise as regards the health of the men depends on a variety of circumstances. If the vessel is clean and dry, the deck solid, well ventilated, and well lighted, with large port holes, which can be carried open in most weathers, if the hatchways are sufficiently large, the weather favourable, the food good, and discipline and cleanliness observed, I think, judging by the results of the transport of troops in the late war and the amount of sickness on arrival after a three weeks' voyage, it is sufficient, with the exceptions I have noticed above, provided that the troops embark in good health and there is no infectious disease amongst them. Any infectious disease occurring would, of course, have a tendency to spread amongst men so close together, and it was curious, too, to note the difference between the sick rate of troops who had packed up, entrained, and embarked in England *in wet weather* and those who had been favoured with fine. Amongst the former there were frequently a comparatively large number of cases of pneumonia, particularly amongst the cavalry and artillery, who had to embark their horses as well.

In horse ships, however, the space for men per head should be rather more. Appendix I, "Naval Transport Regulations," states that in such ships "it is generally necessary to accommodate them (the men) in orlops without side lights, so special attention must be paid to the ventilation"; and this being acknowledged I think there is no doubt the space per head should be increased. Some of the worst cases of illness came from these ships on disembarkation. But if the arrangements described above are to be considered sufficient they should also be defined as being the minimum amount of space which is to be provided.

It is highly desirable that the amount of cubic space per head ultimately decided upon by the naval transport authorities as necessary for troops on board ship should be *definitely* and *precisely* laid down in their Regulations. By these means a minimum standard to go by would be provided.

At the present time cubic space, as such, is not referred to in the "Naval Transport Regulations."

The troops having embarked, their bedding and mess gear is issued to them either before or after sailing. The "Specifications for Fitting" direct that hammock *boxes* should be provided on the upper deck. In practice this was never done.

Hammocks and bedding were stowed on most transports in open crates cleated to the deck, and these were *usually* placed on the orlop deck. There is no objection to this if care is taken to see that the bedding is brought on deck frequently enough for the purpose of airing it. But there is a *great* objection to placing these large crates on the troop decks themselves, as was frequently done (till attention was drawn to it) in the troop-freight ships of the Union Castle Line. They take up, when full of bedding, a large amount of cubic space, they impede locomotion, and obstruct both light and ventilation, besides often making the troop decks smell close and objectionable.

The arrangements for stowing bedding on the permanent Indian transports are now very good, and there is sufficient space to move when carrying out the daily issue. But on every transport each man's hammock and bedding should be numbered and labelled, and the regulations that are in force on these Indian transports as to stowing and issuing, strictly enforced in all, so that there may be some certainty that a man will use the same bedding every night and stow it in the same compartment with that of men sleeping near him. Then, if infectious disease breaks out, it is possible for the Medical Officer to be able to obtain the bedding that has been used by the man affected and that of men considered as "contact" cases, and disinfect it, and so prevent the spread of the disease.

The mess utensils issued to the troops should be of enamelled ware; the tin vessels become rusted, are difficult to clean, and are not durable.

Cloths for wiping the utensils (as directed by regulation) should be provided on all ships, and the troops made responsible for them.

(3) *Hospital Arrangements.*

(a) *Hospital Accommodation.*—The regulations lay down that hospital accommodation is to be provided for 3 per cent. of the troops embarked, and on the outward voyage this is sufficient. On the homeward voyage from South Africa it became necessary to double it after the first few months. This was done partly because experience showed that there was more sickness amongst the troops on the return voyage, and partly to avoid overcrowding in case enteric fever or plague should occur.

Although 3 per cent. hospital accommodation may be considered sufficient on the outward voyage, it should be modern and well arranged.

With the exception of those in the permanent Indian transports (and in these they were subsequently much improved), the ships' hospitals were, at the beginning of the war, almost uniformly out of date, badly situated and arranged, and altogether out of keeping with modern ideas. In no other department in the transport service were such great improvements and alterations made, as time went on, as in the hospitals. Vessels that are selected and placed on the list as suitable for use as transports, when required, should at the time of selection have special attention paid to the hospital accommodation which is to be provided. If arranged for in the first instance the hospital would be located in the most suitable part of the ship, and care and forethought would be expended in the fittings. Nothing can better illustrate my meaning than, for one who knows them, to compare the hospital accommodation on the three ships, ss. "Orient," "Britannic," and "Orotava," with that on ss. "Ortona," "Orissa," and "Staffordshire." In this connection I purposely do not bring into comparison the hospitals on the permanent transports; but in the first three ships mentioned no alteration could make their hospitals satisfactory. They were in the wrong part of the vessel, while in the last three (which were only fitted towards the end of the war), there was evidence throughout of every possible care and forethought to select the most suitable part of the ship and adapt it for the requirements of a hospital, with eminently satisfactory results. The points to be specially noted are (a) that the hospital should *not* be a series of first or second class cabins as it was in

most of the transports at first, and in some throughout the war, and is still recommended to be in the "Naval Transport Regulations." Ss. "Orient," "Orotava," "Roslin Castle," "Hawarden Castle," "Lake Erie," all excellent transports in other respects, failed in this particular. And there were many others. Steerage bunks in cabins was the usual hospital accommodation provided in the troop-freight ships of the Union Castle Line, and in their mail ships. It is impossible to keep such cabins, when occupied by the sick, clean and well ventilated, not to mention the difficulties of ingress and egress of the patient.

(b) *Position*.—The hospital should *not* occupy a corner of a noisy troop deck, or be right aft, or right forward as it was in many of the horse ships. It should always be quite shut off from the troop decks, and have a separate entrance and exit. When no lift is provided the mode of entrance should be such that it is possible to get a man into or out of hospital on a stretcher without taking him off it. In the ss. "Bavarian," for instance, a fine transport, scheduled to carry something like 2,000 men, with a hospital of 60 beds, it was quite impossible to carry a man off or on the ship on a stretcher.

The hospital should occupy the whole beam of the ship, and be situated in as quiet, well-ventilated, and cool a part of the vessel as can be selected.

(c) *Arrangement of Berths*.—There should be only one and not two tiers of berths, and they should be the new pattern iron swinging cot. At first the berths were invariably arranged in double tiers, but in all the best transports this was subsequently altered. It was simply a question of space and expense. This arrangement of one sick man above another is one of the great objections to cabin berths. Most of the third-class cabins held four berths, and some six, or even nine (when in three tiers), and it was at first supposed that each one of such berths would do to be counted as part of the 3 per cent. reserved as hospital. Of course, any such arrangement was quite impossible.

(d) *Hospital to be Fitted on a Solid Deck*.—The deck the hospital is fitted upon should never be a false one. This is always objectionable. Slops, dust, and other organic matter get beneath the false deck, and cannot be got at. In a ship taken up as a troop-freight ship, and fitted temporarily for *one* voyage, it may perhaps be admissible, but never in a chartered transport, and if so it should be laid in sections, which could be lifted for cleaning purposes. This was another fault of ss. "Bavarian"; after she had been running some time it was noticed that every voyage the cases of sickness she brought into port were increasing in number, and after taking home invalids (among these enterics) she began to have such cases amongst the outward bound troops. She was laid up at Simon's Town for a time, and thoroughly cleaned and overhauled, and then it was discovered that the deck on which the hospital was placed was a false one, and several gallons of foul smelling fluid were removed from beneath it. She was sent home, and this defect remedied, and from that time the ship was remarkably free from sickness.

(e) *Hospital Mess Table*.—There should always be at least one large table provided, at which men who can get up to their meals can sit. This was absent in nearly all the transports, the theory being that a man in hospital would always be in bed.

(f) *Hospital Baths and Ablution Room*.—Baths, ablution room, and w.c.'s should be at one or other end of the hospital, and there should always be a sink provided for washing up glasses and mess utensils, and a plate rack or sideboard.

The arrangements in this respect in the hospitals on board ss. "Assaye" and ss. "Plassy" are very good.

(g) *Dispensary and Office*.—The dispensary, if not on the same level, should be as near as possible to the hospital. The Medical Officer usually has to use it as an office, and it is the only place in which he can see men reporting sick, it should therefore be as large as possible. It should have drinking water laid on from the tanks for dispensing purposes, and a sink should be provided. It should be lined throughout with bottle racks of different sizes, and if in the future the army medicine chest is to form part of its equipment the door should be wide enough to admit it.

(h) *Hospital Store Room*.—There should be a store room provided for hospital clothing and utensils, and a pack store either adjacent to or below the

hospital, and the keys should be handed over to the Medical Officer in charge.

(i) *Isolation Ward for Infectious Disease.*—There should always be an isolation ward for infectious disease (or doubtful cases) containing two or three beds. It should be placed on the upper deck as far aft as possible, and in a part of the ship from which the rest of the troops can be excluded without interfering with their duties or their comforts. Nearly all the transports when in their ordinary trade have such hospitals for the treatment of cases of infectious disease amongst emigrants, but in fitting them up for troops the authorities, in most cases (ss. "Tagus" and "Orotava" were exceptions) did away with them or converted them to some other purpose. Even the permanent transports have no such isolation ward. The so-called "separate" ward in them is meant for severe cases that are better by themselves, and is not an isolation ward at all, but opens into the main hospital.

The provision of such a ward in the future is a most urgent necessity; without it, it is impossible to cope with infectious disease. A number of transports arrived at Cape Town with measles, scarlet fever, or diphtheria on board; six ships arrived with smallpox either amongst the troops or crew, and in the effort to isolate the case, the patient, in the absence of such a ward, has to be put into very poor extemporised accommodation. In ships not fitted with a disinfectant a small cabin or bunk which could be hermetically sealed for use as a fumigating room would be a most useful adjunct.

(j) *Special Accommodation for Lunatics.*—All the larger vessels, which are likely on the return voyage to be used for convalescents or invalids should, when being fitted, have proper arrangements made for accommodation of from four to six lunatics. The permanent transports all have this accommodation, but it was not nearly enough. Great expense was caused in having to put in such fittings in many ships at Cape Town or Durban, and the work was not done satisfactorily. A movable framework which could be erected on deck in order to provide a protected exercise space is also required, and invariably had to be made locally.

(k) *Accommodation for Sick Officers.*—One of the best, quietest, and best ventilated of the first-class state rooms should be appropriated as an Officers' ward and should not be shown on the plan of the ship as available for berthing accommodation. There should be a private w.c. near by. Such accommodation is already given on the permanent transports.

(l) *Permanent Hospital Staff.*—The working of the hospital would be greatly facilitated by the provision of a man ranking as second steward from the ship's company for permanent hospital duty; he should have charge of the hospital stores, all of which (except medicines and hospital clothing) should be arranged for by the Naval Transport Department, and should act as intermediary between the temporary Royal Army Medical Corps staff and the purser's department of the transport. In a ship thus furnished a temporary trooping party of the Royal Army Medical Corps consisting of one N.C. Officer and two or three men, one of the party being a compounder, would be sufficient.

(m) *Medical and Surgical Equipment.*—The equipment of the dispensary should consist as far as possible of drugs in tabloid form, both because they occupy less space, and because there is less risk of loss through breakages. In Appendix XXVII is given a list (with quantities) of the drugs and material which were found most useful in ships carrying over 500 or less than 1,000 men for a three weeks' voyage, and in Appendix XXVIII a similar but larger list for ships carrying over 1,000 and up to 2,000 troops. This scale is in addition to the contents of the medical chest. I consider that by the use of tabloids it could be greatly reduced—in bulk at all events. The concentrated stock mixtures should, however, always be supplied, they were reported upon by Medical Officers most favourably as being invaluable in the early days of the voyage when there was much sea sickness, and before the men and the hospital staff had settled down to the routine of sea life. A regulation antiseptic case would be a most useful addition as a means to keep unused dressings clean and free from contamination.

(n) *Hospital Clothing.*—The Regulations for Army Medical Services lay down that hospital clothing for 3 per cent. of the troops embarked is to be provided for healthy troops, and 10 per cent. for invalids. The quantity

allowed is sufficient, and it is distinctly useful; even in slight non-febrile cases it is an advantage on board ship to be able to give a man a clean set of clothing and thereby avoid his wearing in hospital uniform which is often soiled and dirty. During the late war the necessary quantity of clothing was always put on board—in South Africa often with considerable difficulty. I consider Medical Officers did not make sufficient use of it, many transports arriving with considerable numbers of sick, but with the hospital clothing almost untouched. The main reason for this was that in so many vessels there was no store room available where a man's kit could be put away after he had been admitted.

(o) *Towels*.—One constant difficulty on board ship is the provision of a sufficiency of towels for use in hospital. A soldier admitted to hospital is expected to use his own, this never works in practice. If the man has one it is generally very soiled, he has nowhere to keep it and will probably lose it. Towels should be part of the hospital equipment. All the hospital bedding for the transports is issued by the Naval Victualling Department to the purser of the ship, who issues it in turn on requisition to the Medical Officer as required. The simplest procedure would be to include towels in this issue. If this could not be arranged, then they might be issued by the Army Ordnance Department with the hospital clothing. This latter method was tried during the late war, but did not answer well, the towels became mislaid, and Medical Officers were chary of issuing them on that account. But the hospital sheets, &c., were never lost, and it is in this kind of work that a representative of the purser's department alluded to above as a second steward would be so very useful. The method usually adopted was to borrow a certain number of the first saloon towels from the chief steward for use in the hospital, but some chief stewards objected to issuing them in this way, and if the saloon passengers were numerous he frequently could not spare any.

(p) *Disinfectants*.—The disinfectants supplied to a transport are drawn in part from the Naval Victualling Department, and in part are supplied by the owners according to a scale laid down. The authorised amount is not large, and frequently had to be increased. It does not include perchloride of mercury, which consequently during the late war (at Cape Town at least) had to be provided by the Barrack Department or from the Base Medical Stores. Formalin, though not included in the list, was supplied by the navy during the last two years of the war.

(q) *Hospital Utensils*.—Hospital utensils are supplied by the owners in accordance with a list in the Naval Transport Regulations. This includes a certain number of bed-pans, urinals, and spit cups. The number supplied for ships carrying healthy troops is sufficient, but those in use were generally metal and of a very antiquated pattern. They require to be renewed nearly every voyage. Other articles which are absolutely necessary are not provided, and throughout the war constant inspection was necessary, to see that the local orders for their provision had been attended to before the ship sailed. Such are: enamelled ware hand-basins for washing serious cases, enamelled ware feeding cups, and bowls of the same material for lotions and dressing surgical cases. A few mackintosh sheets are also required for bad cases, and are not provided for in the regulations.

(r) *Diet*.—The diets available for the use of the sick on board ship will be dealt with fully in the second part of this report when referring to the diets provided for invalids.

(4) *Disposal of Sick on Disembarkation.*

Small-pox cases were sent to the civil small-pox hospital at Cape Town; all other infectious cases and all ordinary cases were sent to the base hospitals. As a rule they were separated into classes (not including the infectious diseases): slight, non-febrile, or convalescent cases were sent at Cape Town usually to Wynberg, at Southampton to Woolwich or Aldershot; the more serious lying-down cases at Cape Town were sent to the base hospital at Woodstock, and at Southampton to Netley. The ambulance train running between Southampton and Netley for the conveyance of sick was very well arranged and most comfortable.

(5) *Accommodation for Healthy Troops on the Homeward Voyage.*

In most respects this was similar to that described for the outward voyage; but at the end of the war, when large numbers of men were sent home in ships temporarily fitted at Cape Town or Durban, the arrangements for them were not so good as in the regular transports. On the homeward voyage the amount of hospital accommodation was fixed at 6 per cent; some ships' hospitals had as many as 100 or 120 beds. Although this was usually more than was required, it was better to have too much space rather than not enough. The numbers in these troop-freight ships were never allowed to exceed that authorised by regulation, but frequently they came very close up to it. In my opinion they should always be from 100 to 200 less, for serious illness is more frequent than on the outward voyage, and if the ship is full the men do not get enough deck space. This was particularly so on the mail ships, where first and second class passengers were also carried, and the troops were confined to certain definite parts of the deck. All men were carefully medically examined previous to embarkation, and ultimately it was decided that no man who was found to be suffering from fever in any form should be allowed to proceed. In this way many cases of commencing enteric fever were kept back, and the inspection was very necessary, as men, in their anxiety to get home, would not report sick however ill they felt.

SECTION 2.—EMBARKATION OF INVALIDS.

(1) *Class of Ship.*

A fifth part of the carrying capacity of a fleet of transports taking a force should be detailed, when being taken up, for the purpose of subsequently being used as transports for invalids or *temporary* hospital ships.

The largest and best ships, provided with a refrigerator, should be chosen for this purpose. Good types of such vessels are ss. "Plassey" and ss. "Assaye." Horse transports should never be used for *invalids*.

All ships detailed for use as invalid transports should have a second steward and two ordinary stewards provided for hospital duties, in addition to the temporary Royal Army Medical Corps staff, while invalids are on board. The "invalid carrying power" of such a transport may be reckoned to be equivalent to about half her full complement of healthy troops, as on an average an invalid requires twice the space of a healthy man.

A lunatic ward for from four to six patients should be provided as explained on p. 244. There should be an isolation ward, and where possible "a separate ward" with one or two beds for cases that may become seriously ill. A lift should be provided in transports carrying invalids to facilitate the embarkation of stretcher cases, and to enable such patients to be brought on deck during the voyage. The ships selected should have accommodation of the best type specially reserved for three or four Officers, who may be helpless cripples or seriously ill. As at present arranged, the best accommodation is always reserved for the Officer Commanding and perhaps other senior Officers going home. The medical authorities should be able, if they consider it necessary, to obtain the best cabin in the ship for a sick Officer whom it is necessary to send home.

(2) *Method of Selecting and Fitting a Ship for Invalids.*

When the Principal Medical Officer, Base, considers a ship necessary, he applies for one to the Officer Commanding at the base, giving the number he proposes to send, and roughly the number of cot cases. This request is transmitted to the Principal Naval Transport Officer, who details the transport. The vessel is inspected by a naval Officer, the Embarking Staff Officer, and the Embarking Medical Officer, the best deck chosen for the cots, and orders given for all the mess tables and seats on that deck to be removed with the exception of sufficient to mess the occupants of the cots. The remainder of the invalids will be allotted to hammocks on the other troop decks.

The naval transport authorities are entirely responsible that the ship is ready and clean, the tables removed, and the cots slung.

At the time a vessel is asked for by the Principal Medical Officer, Base, that Officer forwards copies of nominal rolls (*see* Appendix XXX) to the Officer Commanding Base, Embarking Staff Officer, and Embarking Medical Officer; separate rolls for Officers and men. The cot and hospital cases average generally about one-fifth of the whole.

(3) *Accommodation of the Invalids.*

Invalid Officers.—The majority of these would be convalescent, and could occupy ordinary cabins and mess in the saloon. Where the case is more serious, special arrangements as to accommodation should be possible, as above stated.

Insane Officers are always a difficulty; as a rule, they cannot be trusted to have their meals with the other passengers, and as they must necessarily pass so much time in their quarters, the cabins allotted should be large, and not adjoining another cabin.

Invalids, Rank and File.—These are accommodated in the troop hospital and on the troop decks. The hospital takes the worst amongst the cot cases; the remainder are detailed to occupy naval canvas swing cots slung in double rows, with intervals between them, on the best ventilated and most comfortable of the troop decks.

A large transport such as is now being referred to would have about 40 to 60 permanent cots in her hospital, from 80 to 100 swing cots would also be provided, so that she could carry from 120 to 160 men unfit to be berthed in hammocks, and in addition in the permanent Indian transports the quarters for married families are also available. But the greater the number of cots required the smaller is the total number of invalids the ship can carry as the cots take up so much more space.

The remainder of the invalids would be "hammock" cases, that is, men sufficiently convalescent to be able to sleep in hammocks. But every two invalids should be given the space of three healthy men. They would be berthed on the remaining troop decks. From one-quarter to one-fifth of the cot accommodation would not be filled, so as to keep down the number of serious cases and enable the Medical Officer in charge, if relapses of fever or other illness occurred amongst the occupants of the hammocks, to accommodate them in cots. In the late war the general average has been about one cot or fixed berth to every five or six invalids.

"Invalid" Warrant Officers.—In most of the transports all second class accommodation had been removed in the process of fitting. As a rule, therefore, there was no place to berth an invalid Warrant Officer (and a great many were sent home) except in the hospital, unless he was kept back for a ship that had second class accommodation. It would be advisable that all the larger transports should have three or four second-class cabins.

(4) *Arrangements for Embarking and Berthing Invalids.*

The Embarking Medical Officer should receive his copy of the nominal roll of invalids (both Officers and men) whom it is proposed to send in any given ship three or four days before the date fixed for sailing. A specimen of the rolls that were in use in South Africa is given in Appendix XXX.

The Embarking Medical Officer is acquainted with the accommodation and arrangements on board, as he was present as a member of the Board at the original inspection to decide how many invalids she could carry.

With this knowledge at hand he proceeds to berth the sick from the information as to their disabilities furnished on his roll, writing in against each name in the last column to the right the kind of accommodation to be given, either "hospital," "swing cot," "married quarters" berth (if available) or hammock. Having completed this and having been careful to leave a certain proportion of hospital berths and swing cots unoccupied in case of unforeseen contingencies, he forwards his copy of the rolls to the office of the Embarking Staff Officer, and in that office before the morning of sailing an index book is compiled from the roll, in which the men's names appear by corps and have

entered against each name the kind of berth allotted. In addition in the same office a series of tickets is provided for each class of accommodation, specimens of which are given in Appendix XXXI.

The day previous to embarkation the Embarking Medical Officer arranges with the railway authorities for a special train, giving the accommodation required, and warns the various base hospitals (from which the invalids are to come) of the arrangements.

When the train arrives in the dock, sick Officers and stretcher cases amongst the rank and file are first put on board, and then the invalids who do not require to be carried are detained in parties of 50 and marched to the gangway. As each man passes the embarking sergeant-major standing at the head of the gangway, he gives his name and regiment, which are turned up in the index book, his accommodation found, and a ticket corresponding to that accommodation bearing, in the case of swing cot or hammock accommodation, the number of a mess is handed to him. By this method it is possible to embark quietly and expeditiously a large number of men belonging to different corps without the presence of Officers or N.C. Officers in charge of them, and yet to be able to say exactly who are and who are not on board.

The medical and nursing staff for duty during the voyage usually embarked the day previous, had already taken over the hospital equipment, and were waiting to receive the invalids.

The embarkation was always superintended by the Embarking Medical Officer, and through the kindness of the Principal Naval Transport Officer there were always available at Cape Town a gang of native boys who were in his employ to carry the stretcher cases on board, and when this was done to put on board all the kits of the invalids.

If possible the embarkation was completed before the dinner hour, and the invalids had their dinner on board. When the numbers were large and two trains were necessary, the first was arranged for the morning, and the second for the afternoon. In the latter case the men coming by that train would have their dinners at the hospitals before starting.

(5) *Hospital Arrangements and Classification.*

As stated above the Medical Officer appointed to take charge, and the medical and nursing staff under his orders should embark the day previous to the invalids. On that day also the medical and surgical equipment, previously requisitioned for from the base medical stores by the Embarking Medical Officer, is placed on board, checked and handed over to the Medical Officer in charge. The necessary army forms and documents are gone through and explained, all the bedding is issued, except the hammocks, and the beds made, and the purser's department informed of the number of dinners required next day. It was usual also to requisition for 20 pints of milk and 20 pints of beef tea to be ready for the more serious cases by the time they would arrive on board. Any special information, drugs, or appliances, that the Medical Officer in charge thought he might require, could be asked for at this time and supplied, and having ascertained that he had everything that he was likely to want, he signed a certificate to that effect which was forwarded to the Principal Medical Officer, Base.

Medical and Nursing Staff.—The medical and nursing staff consisted of from two to five Medical Officers, a similar number of Sisters, and 10 to 20 N.C. Officers and men Royal Army Medical Corps, including a compounder, according to the number of invalids and the proportion of serious cases amongst them.

Arrangement of the Sick.—It was usual, as far as possible, to keep the serious surgical cases together, and men on crutches or who had lost a limb were berthed near the upper deck. But owing to the exigencies of space it was impossible to keep the surgical and medical cases entirely apart. Tubercular cases and convalescent enterics were, however, berthed in separate parts of the troop decks from the rest of the invalids and messed at separate tables. But complete separation was impossible, as bad cases of either disease had to be treated in the hospital, in order to be efficiently nursed.

Issue of Hospital Clothing.—All patients in the hospital proper, all confined to bed, all insanes, and any other cases for whom the Medical Officer

might consider it desirable from any cause, were placed in hospital clothing and their kits taken over, but the great majority of the invalids were not issued hospital clothing and were expected to look after their own kits in the racks provided on the troop decks.

Provision of Knives and Forks.—On transports carrying invalids home, knives and forks should be provided for all. On board ship troops are supposed to use the knife and fork in their kit, but invalids (in the course of their long journey from the front through various hospitals and trains) had almost always lost them. No provision has been made by regulation for their issue on board and their absence was a constant source of friction and trouble, till the Principal Naval Transport Officer issued an order to masters of transports to provide them. They should be issued like other mess utensils, and damage and loss made good at the end of the voyage in the usual way.

Towels.—The provision of towels for hospital use has already been alluded to in the first part of this report; they are even more necessary, and in larger quantity, in ships carrying invalids.

Library, Games, &c.—A library, old newspapers and periodicals, and games, should be provided for the use of the invalids, particularly when the voyage is as long as three weeks. At present there is no means of doing this, except through the kindness of the outside public, and the supply available at Cape Town (through the "Absent-Minded Beggar Fund" and the War Office Parcels Agency) was limited and frequently exhausted.

Duty on Board.—A certain amount of routine duty in connection with guards, fatigues, and the cleaning of the troop decks, must necessarily fall upon the troops, whether invalids or not, and for this reason it was sometimes necessary to embark a certain number of time-expired healthy men in the same vessel with the invalids. But one of the columns in the nominal rolls of invalids shows whether each individual is fit for duty on board or not. One of the first duties of the Medical Officer in charge after embarkation is to furnish a nominal roll of invalids certified as "fit for duty on board" to the Commanding Officer, compiled from this roll, and the latter Officer then has a sufficient number of these men warned for various duties. But on the homeward voyage the work is made as light as possible.

Dispensary.—The hospital dispensary should be fitted up with the surgical matériel, appliances, and medicines as detailed in Appendix XXIX of this report. These are provided on requisition from the base medical stores by the embarking Medical Officer, and put on board and handed over to the Medical Officer in charge the day previous to embarkation. In ships carrying invalids it was always advisable to provide one or two air or water beds.

(6).—*Dieting.*

The troop's hospital on board ship is non-dieted, extras being given to supplement or take the place of rations. But the scale laid down in paragraph 6 Allowance Regulations for the issue of extras in such hospitals, and the reference in the notes to Appendix XIV, Naval Transport Regulations, as to provision of supplies in transports carrying invalids, require modification and expansion. In Appendix XXXII of this report there is given a list of articles of diet that might with advantage be authorised on board transports and freight ships, for the Medical Officer in charge to requisition from the purser's or steward's department in special cases. As a matter of fact, in many of the transports there was no difficulty in getting such extras, but in horse ships the stewards and cooking arrangements were always unsatisfactory, and in all there seemed to be no authorised scale of charges. Authority for this issue is given in paragraph 362, Regulations for Army Medical Services, but in small transports, unless the purser is made aware of it beforehand, and where the ship has no refrigerator, he may not have a sufficient supply. In any case, whether the vessel is carrying healthy troops or invalids, these supplies would be drawn as extras, and not as the diets of a regular dieted hospital. There should be a uniform rate of charges for them laid down for all vessels employed as transports or troop-freight ships.

Hospital ships were the only units in the naval transport service in which the regular service diets were issued.

In South Africa during the late war there was so much difficulty and

trouble in ensuring that the purser's department of some vessels was properly equipped in this way, and not cut down to the lowest possible minimum, that I obtained the permission of the Principal Naval Transport Officer to send to the master of every ship a few days before sailing a demand note with the headings given in Appendix XXXII, and, inserted against each, the quantity I considered it necessary should be taken for hospital supplies alone, apart from consumption in the saloon. This demand note was returned to me certified by the master that the supplies asked for were on board. When the Medical Officer in charge embarked I went through it with him, that he might know what supplies there were available for him to draw upon, and he was given a copy. I also found it advisable, with the sanction of the Principal Naval Transport Officer, to frequently inspect these supplies as to quality until the personnel of the purser's department came to know what was expected of them in this respect. The same system was carried out in victualling ships that were to carry invalids, only the demand note sent to the master required rather more articles and in considerably larger quantities.

The Naval Transport Regulations (Article 51) state that "Government will provide all 'provisions,' 'medical comforts' . . . , but may call upon the owners to supply them."

In the late campaign (except as regards the medical comforts in a few ships at the very commencement) they were always supplied by the owners. I consider this is the better plan.

The vessels usually belonged to large companies having contracts for the supply of provisions of the best quality for saloon use, and the supplies for the hospital were of the same quality and obtained from the same source. They were therefore distinctly better than those supplied by Government under the old system. It was only in the horse ships (the personnel of which were unaccustomed to the scale of victualling for saloon use, as they do not carry passengers in their ordinary trade) that difficulties sometimes arose.

The method of indenting and accounting for the use of the extras required in hospitals on board ship is explained in the notes to Appendix XXXII.

In ships carrying invalids the system of dieting bad cases by the issue of extras was the same. But the great majority of the invalids were convalescent, and, as regards these, experience soon showed that the ration for troops on board ship as laid down by regulation was not suitable, even when including the daily issue of fresh meat, vegetables, and bread allowed in the regulations (Appendix XIV) for the naval transport service. The scale was limited and the type of invalid was just that case which, after the strain and stress of hard work, followed by illness, required during convalescence good food and plenty of it, and this could not be met by supplementing the rations with extras without greatly increasing the expense and the labours of a limited medical staff. In the copy of the nominal roll in use for invalids (given in Appendix XXX) is a column showing whether the invalid could or could not eat troops' rations. The information there rendered showed that quite 60 per cent. of the invalids when fit to embark for home were considered unfit to be dieted on the ordinary ration. The Principal Naval Transport Officer therefore recommended to the Admiralty that invalids on the homeward voyage should be rated as third-class passengers. In Appendix XXXIII is given a detail of a diet which, in some of the larger and better ships (used in carrying third-class passengers) was provided for 1s. 6d. per diem per head. This was found to meet the difficulty, and in all the transports where this system was carried out there was a good and sufficient diet provided.

If the Medical Officer considered that some invalids in addition required alcohol in some form he requisitioned it, and accounted for it as an extra.

(7).—*Disposal of Invalids on Disembarkation.*

Only a few words are required to explain the system adopted during the late war.

Owing to the number of invalids proceeding home, and the duration of the campaign, the Royal Victoria Hospital, Netley, became inadequate to deal with them, and besides, a large number, though unfit for active service, did not require further hospital treatment.

Instructions were therefore issued to the Medical Officer in charge of a

transport taking home invalids that between the date of sailing and the arrival of the ship at the intermediate port (St. Vincent or Las Palmas) he should arrange his invalids into three classes—(a) those fit for the discharge *dépôt*; (b) those convalescent and able to proceed to hospital at Woolwich, Aldershot, or elsewhere; (c) all insanes and serious cases requiring to proceed to Netley (the termination of the voyage being Southampton); and that, having so classified them, he should cable the numbers in each class to the War Office from the intermediate port. At that port he would receive telegraphic instructions as to which station Class (b) would go to.

He was thus able to have his patients and their documents arranged and ready by the time the vessel reached the wharf at Southampton. To increase the rapidity of disembarkation, each class of invalid was made to parade (except the Netley cases) on the day of arrival with a special piece of coloured ribbon attached to his coat to indicate to which class he belonged. The Medical Officer in charge invariably accompanied the serious cases to Netley. Another Medical Officer would proceed with Class (b) to their destination, and Class (a) were usually sent to the discharge dépôt in charge of a combatant Officer doing duty on board.

When the vessel sailed from Cape Town the names of the Officers invalidated, the number of the rank and file, and the number of serious cases were at once cabled home.

PART XII.

MEDICAL STORE DEPÔTS.

A.—INTRODUCTORY.

Previous to the outbreak of war there was one medical store at Cape Town which supplied all the military hospitals in South Africa. Just before the date of declaration of war, all the stores in it, together with others purchased locally, were distributed to Ladysmith, Kimberley, and Mafeking, so that on the arrival of No. 2 Base Medical Depôt at Cape Town the store rooms were empty, and were handed over to the depôt with its fresh supplies from England.

The following base medical depôts and advanced depôts were organised in England :—

No. 1 Base Depôt, stationed at Durban, Major R. J. McCormack in charge.

No. 2 Base Depôt, stationed at Cape Town, Major R. C. Thacker in charge.

No. 1 Advanced Depôt, stationed in Natal, afterwards moved to Volksrust, Quartermaster J. B. Short in charge.

No. 2 Advanced Depôt, stationed at De Aar, afterwards moved to Pretoria in July, 1900, Major C. W. H. Whitestone in charge.

No. 3 Advanced Depôt, stationed at Bloemfontein, Captain J. C. Connor in charge.

Three small depôts were organised in South Africa, and were stationed at Kimberley, Kroonstadt, and at Harrismith.

All stores received from England were landed at Durban and Cape Town, were taken over by Nos. 1 and 2 Base Depôts, and were distributed by them to the advanced depôts, or to the hospitals in the neighbourhood of the base depôts.

B.—MAINTENANCE.

Up to the end of November, 1899, supplies arrived from England every fortnight; during December some arrived weekly, the remainder every fortnight, but after December, 1899, all medical supplies were despatched in weekly consignments. Frequent intimation regarding future requirements was given by cable to the War Office, and invariably complied with. Large local purchases were also made in Cape Town and Durban.

As most of these stores were landed at Cape Town, and distributed by the base depôt there, a detailed account by Major Thacker, R.A.M.C., is attached (p. 254), showing the mode in which this important and onerous duty was carried out. As the work of an advanced depôt differs considerably in kind a report from the Officer in charge of No. 2 Advanced Depôt (Major Whitestone, R.A.M.C.) is also attached (p. 260).

C.—PERSONNEL.

The necessity of having a Medical Officer in charge of these depôts has been questioned. During the campaign in South Africa there was a scarcity of Medical Officers, and so, whenever it was possible to do so, these depôts were placed in charge of a quartermaster. No. 1 Advanced Depôt arrived from England without a Medical Officer, so that Lieutenant and Quartermaster Short was placed in charge. Towards the end of the war, when the work at No. 3 Advanced Depôt became light, Lieutenant and Quartermaster A. H. H. Niblet was placed in charge of it. For some time previously indeed the Officer in charge of this depôt, Captain J. Connor, had been also employed in other duties.

In the smaller subsidiary depôts at Kroonstadt, Kimberley, and Harrismith, the duties were carried on by Officers doing duty at the hospitals in these places.

As regards these depôts, No. 1 Advanced Depôt was of minor importance, while the changes in the administration of No. 3 Advanced Depôt followed the steady diminution of its work.

But the experience gained in South Africa shows distinctly the absolute necessity of having an experienced Medical Officer in charge of every depôt on which large demands are likely to be made. The base depôts invariably come into this category, while in such cases as No. 2 Advanced Depôt the necessity is equally great.

The subordinate staff as detailed in the Field Service Manual for these depôts was not sufficient. The work at the base and advanced depôts was of course altogether abnormal owing to the large demands from the burgher camps and the civil administration generally. But while the present staff may be sufficient for the base depôt in one of our small wars, it is quite inadequate to the wants of a large force.

There is no doubt that the subordinate staff of these depôts require to be carefully selected. There is no necessity for their being highly-trained sick attendants, but they must be trustworthy. Many of the details of the work must be carried out away from the direct and personal supervision of the Officer in charge, and it is of the greatest importance that urgent and very important demands should be complied with both speedily and accurately, otherwise very serious results may ensue. Carpenters and cutlers are both necessary for these depôts.

D.—SUPPLIES.

The equipment, as laid down in Appendix XLIV Regulations Army Medical Services 1900, requires considerable alteration and many additions. This was fully recognised at the outbreak of the war, and everything additional that was required was obtained without difficulty, the surgical equipment in particular of the general and stationary hospitals was largely supplemented.

The same remark applies to drugs. All were of the best quality and were up to date. Tabloids were largely used. There was no scarcity of drugs or surgical instruments at any time, and the troops at the front and far off the railways were never without the necessary medicines.

Arrangements must, of course, always be made from the very beginning of a campaign for replacing the articles most commonly used by regular consignments, as no depôt of any description can carry enough of these articles to meet a continued demand for them. There was no difficulty in this respect. But there was, and probably always will be, a difficulty as to the variety of drugs. The question will always arise as to how far the schedule (which must exist) should be exclusive. In this campaign practically everything that was asked for was supplied, either by local purchase if the article was available, or by requisition from England. But it seems doubtful whether a method which is satisfactory in the hospitals of a community during peace is altogether the best for the army during war. There was a good deal of unnecessary complication in the supply of drugs by the desire of many of the Medical Officers (particularly the civil surgeons) to use some more modern preparation in lieu of the older remedy, and there is much doubt as to whether the patients gained any material advantage thereby. On the other hand, many articles might be omitted from the present schedule without detriment.

It would seem advisable to prepare a comprehensive list of drugs to be supplied which should be revised at comparatively brief intervals, so as to take advantage of any real advances in pharmacology and therapeutics. If this were done, there should be no difficulty in confining the supply to the articles included in this list, without impairing the efficient treatment of the sick.

The use of the "tabloid" form in place of the older preparations has everything to recommend it for field use, and, although the initial cost may be greater, the saving in waste, carriage, and general complications more than counterbalances this.

E.—REPORT ON NO. 2 BASE DEPÔT MEDICAL STORES, CAPE TOWN.

(Major R. C. THACKER, R.A.M.C.)

In submitting this report on the working of No. 2 Base Depôt Medical Stores, which arrived in South Africa on November 21st, 1899, I desire to point out that the scale of equipment laid down for this unit was arranged to meet (in Cape Colony) the requirements of the regular troops originally detailed to proceed from England. But this scale was, I consider, never contemplated (either through expansion or elasticity) to meet the demands, medical and surgical, of a great army of irregular troops from South Africa, and Colonials from the British dominions beyond the seas, very much larger than could possibly have been foreseen on the outbreak of hostilities.

Just one instance to illustrate the strain which was placed on this unit early in the campaign. The 5,000 Australian Bushmen, who touched at Cape Town *en route* to Beira to form part of the Rhodesian Field Force, were medically and surgically equipped from the base medical stores.

Storage Accommodation.—The site for the medical store depôt was at Woodstock Military Hospital, about three miles from the docks, where two corrugated iron sheds were provided. As this storage accommodation proved totally inadequate to meet the requirements, the Royal Engineers were requested to erect four others, which, together with certain permanent buildings appropriated in the hospital compound, proved satisfactory, giving a superficial area of 15,044 square feet.

The following gives in detail the area of the various sheds, huts, and permanent buildings utilised for this purpose :—

Sheds and Huts—

		Originally Provided.			
1.—	Corrugated iron	60' × 15'	...	900	square feet.
2.—	"	60' × 15'	...	900	" "
		Additional Accommodation.			
3.—	Corrugated iron	100' × 20'	...	2,000	" "
4.—	"	48' × 30'	...	1,440	" "
5.—	Portable hut	75' × 18'	...	1,350	" "
6.—	"	75' × 18'	...	1,350	" "

Permanent Buildings—

Store	25' 6" × 16' 6"	...	...	420	" "
"	23' 6" × 16' 6"	...	...	388	" "
"	17' 6" × 11'	...	...	192	" "
"	16' 6" × 11'	...	...	182	" "
"	16' 6" × 11'	...	...	182	" "
"	35' × 16' 6"	...	...	577	" "
"	16' 6" × 7'	...	...	115	" "
"	16' × 10'	...	...	160	" "

Wards unused for Hospital Purposes—

1	...	48' × 24'	...	1,152	" "
2	...	48' × 24'	...	1,152	" "
3	...	48' × 24'	...	1,152	" "
4	...	48' × 24'	...	1,152	" "
5	...	14' × 10'	...	140	" "
6	...	14' × 10'	...	140	" "

Total area ... 15,044 " "

Transit of Stores.

The method of despatch of medical and surgical stores from the base depôt to the various units, general, field, and other hospitals of the South African Field Force are as follows :—

Rail.—Handed over to the Railway Transport Officer, Way Bill (A.B., 10A, as per specimen attached), the counterfoil being signed by him and

FOR CARRIER.

Received 190, in good order and condition, except*

FOR CONSIGNEE.

Received 190, in good order and condition, except*

FOR CONSIGNOR.

Received 190, in good order and condition, except*

and will be found credited in my { Supply
Equipment }
account for the month of 190.

{ In charge
at }

* Deficiencies, Ac., to be inserted above.

Terms of agreement of Hired Transport to be here stated.

and will be found credited in my { Supply
Equipment }
account for the month of 190.

{ In charge
at }

* Deficiencies to be inserted above. The cause to be diligently enquired into, and immediately reported, with a view to striking the deficiency off charge. Credit must be given to the Consignor for the whole consignment as Way Billed, and the whole must be taken on charge by the Consignee; any deficiency, whether chargeable to a Carrier or not, must be struck off charge on a separate voucher.

The value of deficiencies chargeable to Carriers and others, are to be recovered by Consignee.

In the case of Specially Hired Transport, this Voucher to be attached to the Transport Account.

and will be found credited in my { Supply
Equipment }
account for the month of 190.

{ In charge
at }

* Deficiencies to be inserted above.

This Voucher is to be signed and returned to Consignor immediately after receipt of the Supplies.

retained in my office as a receipt for the number of cases forwarded. It also showed the truck number for reference in cases of loss or delay in transit, so that inquiries could be instituted and the missing items traced.

All large consignments were loaded in the ambulance trains if available, or in large covered box-trucks, which were obtained from the Cape Government Railway authorities, and conveniently placed alongside the military hospital siding, Woodstock, the loading being carried out by the employés at the base dépôt.

The ambulance trains were utilised to the fullest possible extent for this service, and proved both safe and expeditious, as these trains had practically a clear line and ran right through when returning to the front. Passenger and mail trains were also utilised for small consignments in cases of emergency.

Sea.—By sea to the coast ports, transit vouchers were prepared in duplicate, giving the total number of cases, cubic measurement, and approximate value of the stores. The consignment was then handed over to the Ordnance Officer, Docks, for despatch to its destination.

From Docks to Base Dépôt.—In the early stages of the campaign considerable difficulty was experienced in obtaining sufficient transport for the conveyance of the stores from the docks (on arrival from England) through the Ordnance Department. However, as soon as the pressure for transport up country diminished to a certain extent, this trouble became less acute.

Personnel of Base Dépôt.—The cadre for a base dépôt medical stores, as laid down in the "Field Service Manual, A.M.S.," p. 13, should, in my opinion, be considerably increased to make the unit efficient. The following table might be substituted:—

Cadre for a Base Dépôt, R.A.M. Corps.	Lieut.-Colonel or Major.	Quartermaster.	Compounders.	Trained Clerks.	Staff Sergeant.	Sergeant or N.C.O.	Packers and Store- men.	Total.
Officer in charge.. ..	1	—	—	—	—	—	—	—
Quartermaster	—	1	—	—	—	—	—	—
Compounders	—	—	2	—	—	—	—	—
Clerks, Trained	—	—	—	2	—	—	—	—
Staff-Sergeant	—	—	—	—	1	—	—	—
Sergeant or N.C.O.	—	—	—	—	—	1	—	—
Packers and Storemen	—	—	—	—	—	—	8	—
Total Base Dépôt	1	1	2	2	1	1	8	16

The duties of the compounders would be—one to look after the store containing the surgical instruments and various appliances, also to get out and check the requirements on the requisitions; the second to re-equip the medicine chests and arrange the extra supplies of medical and surgical material for hospital ships and transports. In this connection it may be interesting to note that up to May 31st, 1902, from the commencement of hostilities, 250 medicine chests were completed at the base dépôt medical stores.

Two trained clerks required, one to take charge of the abstract of receipts and issues; the other, correspondence and local purchase ledger.

Staff-sergeant's duty would be (as ledger clerk) to keep the books accurately posted up to date.

Sergeant or N.C. Officer to generally supervise the packers, minimise mistakes as far as possible, and initial the packers' book for reference later in case of loss in transit, or otherwise.

The packers should be trained experienced men from the Woolwich Medical Stores, one, if possible, to be a carpenter.

Under no circumstances whatever, unless through misconduct, should the personnel of a base dépôt be interfered with during a campaign.

Area of Supply.—No. 2 Base Dépôt Medical Stores supplied the various columns, units, hospitals in the Cape Colony, Orange River Colony, and the greater part of the Transvaal with medical and surgical material, besides the refugee and concentration camps, either directly or through the dépôts at East London, Kimberley, Bloemfontein, Kroonstadt, and Pretoria.

Appendix 44, Field Medical Service.—The equipment scale of medicines and surgical material, as laid down in Appendix 44, "Regulations for the Army Medical Services," for a base dépôt of medical stores might, I consider, with advantage be thoroughly revised, and materially added to, in order to make this important war unit efficient and in keeping with modern requirements, both as regards extra supplies of drugs, surgical instruments, and appliances. To this scale I would limit requisition demands by a hard and fast rule, and so prevent, as far as possible, a recurrence of the experience of this campaign, where practically every drug of any known therapeutic value in "Martindale and Westcott's Extra Pharmacopœia" was asked for. Some of these drugs were unquestionably most useful, but as for others I have no reasonable doubt that equally good substitutes could have been found in the ordinary official scale.

Attached are two fairly complete lists of extra drugs, surgical instruments and appliances, which I consider might reasonably be included in the scale of equipment laid down in Appendix 44 for a Base Dépôt Medical Stores.

With reference to Appendix No. 43A, "Scale of Medical and Surgical Equipment" (1898 pattern) for units in the field, the following might be substantially increased: *surgical saddle bags, field medical panniers, and antiseptic cases.* The substitution of Willesden canvas as a covering for the medical panniers and companions in lieu of hide is commended.

List of Extra Drugs suggested to be added to Scale for Base Dépôt Medical Stores.

- | | |
|---|---|
| 1. Lysol. | 32. Tinct. Podophylli. |
| 2. Creolin. | 33. Liq. Picis Carb. |
| 3. Urotropine. | 34. Amyl. Nit. Capsules. |
| 4. Trional. | 35. Tinct. Jaborandi. |
| 5. Menthol. | 36. Formalin. |
| 6. Medicinal Izal. | 37. Hazeline. |
| 7. Liq. Trinitrini. | 38. Liq. Bismuthi et Ammon. Cit. |
| 8. Resorcin. | 39. Protargol. |
| 9. Urethane. | 40. Codein. Phosph. |
| 10. Paraldehydum. | 41. Diuretin. |
| 11. Calcium Chloridum. | 42. Eucaine A and B. |
| 12. Calcium Hydras. | 43. Pilocarpin. Nit. |
| 13. Ethyl Chloride. | 44. Tablets— |
| 14. Lithiæ Citras. | Urotropine. |
| 15. Scott's Emulsion. | Hypophos. Co. |
| 16. Kepler's Ext. Malti et Ol. Morrhuæ. | Bismuth. Salicyl. |
| 17. Sodii Citras and Bromidum. | Potassii Chloras. |
| 18. Thymol. | Hyd. c. Cretæ et Doveri. |
| 19. Ozœnic Æther. | 45. Butyl Chloral Hydrate. |
| 20. Terebene. | 46. Cough Pills. |
| 21. Bismuth. Salicylas and Carb. | 47. Liniments: Opium, Turpentine, and Chloroform. |
| 22. Quinin Salicylas. | 48. Ext. Tarax. Liq. |
| 23. Quinin Hydrochl. | 49. Acid. Chrysophanic. |
| 24. Quinin Hydrobrom. | 50. Ung. Picis Liq. |
| 25. Liq. Carbonis Detergens. | 51. Ung. Hyd. Ammon. |
| 26. Glycerin Pepsini. | 52. Ung. Hyd. Ox. Flav. |
| 27. Fairchild's Peptonising Powders. | 53. Liq. Arsenici Hydrochlor. |
| 28. Tinct. Buchu. | 54. Alcohol Absolute. |
| 29. Tinct. Kino. | 55. Oxygen Gas Cylinders, with Inhalers. |
| 30. Tinct. Strophanthi. | 56. Homatropin Hydrobrom. |
| 31. Tinct. Gelsemii. | |

List of Extra Surgical Instruments and Appliances.

1. Cripps' Irrigators, with and without stands.
2. Ecraseurs, small and large.
3. Plaster of Paris Bandages.
4. Glycerine Enema Syringes.
5. Forceps, various.
6. Scissors—surgical, straight and blunt-pointed, curved on flat.
7. Hooks—wound, single and double.
8. Basins—dressing, kidney-shaped, large.
9. Volckmann's Spoons.
10. Bone Drills, gouge.
11. Periosteal Elevators.
12. Hey's Saws.
13. Douches, aural.
14. Ear Channels.
15. Ophthalmic Lamps.
16. Clover's Clutches.
17. Leiter's Tubes.
18. Transfusion Apparatus.
19. Trephines, small and medium.
20. Surgical Hammers and Mallets.
21. Tracheotomy Cases.
22. Douches, nasal.
23. Ligature Troughs, 4 and 6 reels.
24. Glass Trays for Catheters.
25. Jacques' Catheters and Channel.
26. Jacques' Oesophageal Tubes, with funnels.
27. Needles and Needle-Holders (Hagedorn).
Needles, suturing intestine (round).
Needles and Holders—combined, slot, McEwen's, Lister's.
28. Retractors, wound, large and small.
29. Elastic Stockings and Knee-caps.
30. Bladder Sounds.
31. Paquelin's Cautery.
32. Test Lenses and Holmgren's Wools.
33. Lithotrite and Evacuator.
34. Rib Shears.
35. Tourniquets, I.R., for bloodless operations.
36. Polypus Snare.
37. Chloroform Inhalers and Drop Bottles.
38. Mouth Gags.
39. Syringes—exploring, antitoxin, and typhoid.
40. Crutches, spring, French pattern.
41. Trays, surgical, glass, and enamel.
42. Hot Water Bottles, I.R., and covers for same.
43. Urethrotome.
44. Wheelhouse Staff, probe gorget.
45. Ahl's Poroplastic Splinting.
46. P.M. Gloves.
47. Silver Wire, thick, for bone suturing.

Extra Articles of Ordnance Equipment.—The following extra articles of Ordnance Equipment might, I consider, with advantage be included in the scale laid down for a base dépôt medical stores, Appendix 44, "Regulations for Army Medical Services," being practically to all intents and purposes a medical supply, though held on charge by the Ordnance Department:—

Operating tables, theatre requisites (such as operating coats, aprons, towels, and nail-brushes), also first field dressings, brassards, with the various appliances necessary for restraint on those mentally afflicted.

My reason for suggesting this transfer is that during the campaign Officers and civil surgeons concerned invariably requisitioned on the base

medical stores for the supply of the articles enumerated, thus entailing responsibility without control. Comments were made as to the quality of the operating aprons, towels, &c., supplied not being quite in accordance with the requirements of aseptic surgery. A number were purchased locally to meet demands.

X-ray Stores.—Four complete sets of Röntgen-ray apparatus were sent out to the base medical stores in 26 cases. In this connection it is only necessary to point out, for future guidance to the firms concerned, the importance of having the contents of each case clearly stencilled on the outside, so that, when required, a complete set could be selected for despatch without difficulty, and so minimise the risk of having to open each individual case and re-adjust the contents, which occurred in this instance. A liberal supply of X-ray photograph requisites should also be furnished to meet requirements.

F.—REPORT OF NO. 2 ADVANCED DEPÔT OF MEDICAL STORES DURING SOUTH AFRICAN CAMPAIGN 1899 TO 1903.

(Major C. W. H. WHITESTONE, R.A.M.C.)

The personnel of No. 2 Advanced Depôt of Medical Stores left England in the s.s. "Servia" on November 2nd, 1899, and arrived at Cape Town on November 23rd, 1899. Owing to the stores themselves having been sent out in another ship, packed beneath 2,000 tons of cement, it was impossible to obtain them immediately on arrival. A staff sergeant was left behind at Cape Town to bring on the stores when landed, the remainder proceeded at once to De Aar where a temporary depôt, under Major Wade, R.A.M.C., had already been established by Colonel Supple, P.M.O., South Africa. No. 2 Advanced Depôt took over the contents of this depôt and commenced work on November 26th, 1899.

From this on the work increased daily both in scope and importance till this depôt, while at De Aar, eventually supplied the troops on the western line from De Aar to Mafeking, the army at Paardeberg, and later at Bloemfontein and Kroonstadt, besides the medical units in the east and the midlands of Cape Colony.

Upwards of 100 cases of medical stores were sent to Kimberley from No. 2 Advanced Depôt, to start an Advanced Depôt there after the relief. Subsequently an Advanced Depôt (No. 3) was opened at Bloemfontein. The formation of these depôts relieved No. 2 at De Aar, which was ordered to be ready to move to Kroonstadt or Pretoria, and filled up from the base depôt at Cape Town for this purpose.

The depôt left De Aar on July 22nd, 1900, for Pretoria, arriving there on July 27th, some delay being caused by the burning of a supply train north of Bloemfontein by De Wet. Only three trucks were allowed in which to transport the stores, some 450 cases in all. As the demands were likely to be great, owing to the extent of the operations in the field, in order to avoid the possibility of running short a large requisition was sent to the base, so that more stores might reach Pretoria shortly after the arrival of the depôt. This requisition was sent on the day the depôt left De Aar, and the stores arrived at Pretoria a few days after the depôt and were most acceptable.

A small five-roomed cottage was occupied as a store close to the Pretoria railway station, but as this accommodation proved to be inadequate the adjoining cottage together with the yards of both cottages and some waste ground were requisitioned.

As time progressed, owing to the difficulty of obtaining medical and surgical supplies elsewhere, the civil hospital, gaol, leper asylum, Government dispensary (all in Pretoria), Imperial Military Railway, and Transvaal Constabulary drew their supplies from No. 2 Advanced Depôt, in addition to the demands from the army. Later 23 burgher camps with a population of between 60,000 and 70,000 men, women, and children, and 21 native refugee camps with a population of 32,000 had also to be supplied. Finally, to these were added three divisions of South African Constabulary, so that by the spring of 1902 the depôt was supplying the wants of over 200,000 souls.

As an example of what the work eventually amounted to, it may be stated that in the month of May, 1902, 900 cases and parcels of drugs and equipment, weighing approximately 30 tons, were distributed in all directions from Mafeking to Komati Poort, and Bloemfontein to north of Pietersburg. The expenditure of bandages alone at this time approached 30,000 a month.

As the cottages in which the dépôt had at first been quartered were too small and inconveniently built to enable this amount of work to be carried on, the dépôt was removed to the Old Dopper Church, which it filled, with in addition three marquees. As this church was a considerable distance from the railway station, transport consisting of one buck wagon and a Cape cart with eight mules was provided to carry consignments to and from the railway for dispatch by the various trains.

Much additional transport was requisitioned for as occasion arose to convey the large consignments from the railway station to the dépôt. The Superintendent of the Native Labour Camp kindly lent fatigue parties of from 30 to 100 natives weekly to load and unload trucks, &c.

On application to the Assistant Adjutant-General, Pretoria, sanction to sign railway warrants and deal direct in all matters relating to the receipt and despatch of medical stores was obtained. This proved most important throughout the war, as it had been found impossible to carry on such a volume of work otherwise: unless the dépôt possessed all the documents and warrants relating to the dispatch of stores it became hopeless to endeavour to trace lost or undelivered consignments, as any attempt only led to endless correspondence with Railway Staff Officers. It would seem to be most important that medical store dépôts in war time should be permitted to keep all work of this nature in their own hands, as it is otherwise impossible for them to deal quickly and satisfactorily with the dispatch of consignments.

At the close of the war, owing to the breaking up of the numerous hospitals and units, enormous quantities of equipment and medicines were returned to store. Not a few consignments reached the dépôt in such a state that the source from which they came could not be ascertained at all, moreover, some equipment was doubtless such as had been lost or captured during the campaign and finally picked up, or handed back by the Boers themselves. It was dealt with in the usual manner by periodical boards of survey.

The stores were again moved on October 3rd, 1902, and following eight days to a camp and store in the vicinity of No. 7 General Hospital, and a nine months' supply distributed to all the remaining permanent hospitals, &c., the remainder being sold to civil institutions and the Health Department of the Transvaal. The stores were closed on May 9th, 1903.

Remarks.

Staff.—The regulation staff for an advanced dépôt is sufficient under ordinary circumstances. It must be composed of reliable men, as a rule, not third class orderlies. In small dépôts a Medical Officer is not necessary, as supervision by an Officer from one of the adjacent stationary hospitals would be sufficient; but in dépôts such as No. 2 Advanced, or anything approaching it in size, an Officer is needed.

Supplies.

To base an estimate for the initial supply of future advanced dépôts on the experiences of No. 2 is useless, but it proves that such a dépôt can be expanded without difficulty so as to meet all possible demands by the exercise of a reasonable amount of forethought. Any probable requirements in addition to the normal equipment at the commencement of a campaign should be at once reported. This was done by order of Surgeon-General Sir W. D. Wilson, K.C.M.G.

With regard to the equipment the following notes may prove of use:—

The supply of pills and tabloids was much too small for the actual demands even at the very commencement, and later as many as 46,000 of those were issued in one day. All the common drugs in everyday use were supplied in quantities far too small to meet demands from large general

hospitals, the quantities of these should be greatly increased from the commencement. Demands for supplies to complete had to be sent at once to the base depôt at Cape Town.

Field medical panniers, companions, and haversacks are required in large numbers to equip small temporary hospitals and posts on railways and lines of communication, units requiring to be refitted, irregular and Colonial corps and newly formed columns.

More selected surgical instruments should be at hand, together with spare cases of surgeons' instruments.

Refills for panniers should be in bulk. The reserve field medical panniers are of little use at depôts. In the case of No. 2 Depôt, certain articles were rapidly expended, the other panniers remaining complete were used in lieu of field medical when these ran short by adding a case of surgeons' instruments to them.

Field surgical panniers were seldom required. From time to time certain articles were borrowed from these to complete hospital equipment, but all the articles that are usually required might much more economically be supplied in bulk, and the panniers themselves discarded with the exception of a few pairs to replace those of field hospitals, &c., in case of loss. All panniers should be covered with some durable material so that the wooden packing cases might be discarded at the base. Much additional work was caused by the weight and unwieldiness of panniers screwed up in these ponderous wooden cases. The present so-called "hide" with which these panniers are covered is not leather, but merely the cuticle and hair of the cow, and tears easily. The new canvas covers may prove better.

Grain scales and weights should be added to all medical panniers unless all drugs are supplied in tabloid form.

Large sets of tooth instruments for all regiments should be supplied. There was a large demand for these during the war, and sets of three and four forceps were refused by medical men doing duty at posts and with regiments.

The old pattern fracture box was in great demand; very few appeared to appreciate the perforated zinc sheeting supplied in the new boxes, and there were demands for large numbers of splints to be made in addition to those in the fracture box. A large assortment of all kinds of ordinary splints and material for making splints (especially Gooch scored splinting and poroplastic sheeting) seems to be required.

A very large supply of X-ray requisites, such as plates, chemicals, P.O.P., had to be arranged for; up to May, 1902, 1,500 plates, at least, had been issued from No. 2 Advanced Depôt.

A small supply of microscope accessories, such as slides, cover glasses, stains, and spare lenses is required.

If dentists are employed, an assortment of drills, stopping material, mercury, and other dental requisites should be arranged for. This was done, but the articles arrived so late in the campaign that very few of them were ever used owing to the sudden ending of the war.

A few remarks are necessary on the equipment based on what Medical Officers actually seemed, in my experience, to require and use.

Transfusion Apparatus.—These are necessary at large general hospitals and depôts.

Œsophageal Tubes, Jacques', Soft Rubber.—These are necessary at large general hospitals and depôts.

Bandages, for bloodless operation, with rubber tourniquet; some surgeons still insist on having these available.

Batteries, Storage, X-ray.—A large reserve of these appeared to be necessary, owing to their constantly going out of order or becoming spoiled and the difficulties connected with their repair. The Royal Engineers should be in a position to repair and look after them.

Spamer's Batteries.—Ditto.

Ligatures.—A good supply of at least four to six sizes in tubes, aseptic, silk, catgut, carbolic, silkworm gut, chromic catgut, kangaroo tendons; in fact, all reasonable kinds should be provided.

Chisels, gouges, drills, hammers, small trephines, stout silver wire, in fact, complete sets of instruments for dealing with injuries to bones are required,

including screws and pegs, ivory. All the above were demanded and used at the larger hospitals.

Paquelin's cauteries and clamps for piles, gags, tongue forceps are all required.

A set of instruments for urethral operations, *stiffs, probes, gorgets, lithotomy and lithotripsy instruments* may be wanted at short notice; also *urethrotomes*.

Oxygen gas apparatus, with mouthpiece and bag cylinders of oxygen gas, were very often required.

Irrigators, Cripps', required for general hospitals.

Surgeons' Needles.—A good supply of all varieties together with needle holders should be supplied.

Stomach Syphons.—Useful.

Exploring Syringes.—It must be possible to sterilise these.

Scissors.—A large supply of different kinds is needed.

Stethoscopes.—Officers should have their own, but a large number will be required for renewals.

Volckmann's Spoons.—A supply for large hospitals.

Surgical Saddle Bags.—The present bag is too heavy except on a led horse. The leather supporting it is too weak for the weight of the bags.

Trusses.—Over 700 were issued, but this included those for women, children, civilians, &c. In order to obtain a proper fit a very large assortment was kept in stock.

Focus Tubes, X-ray.—Many of these prove unsatisfactory, so that at least six per machine are required.

Anti-toxines.—Must be at hand, such as anti-venin, anti-diphtheritic, anti-tetanic, anti-streptococcus, plague, &c., according to circumstances and modern knowledge.

The supply of medicine required was so large owing to the burgher camps, &c., that it would be misleading to base any future demand entirely upon it. It will always have to be modified according to circumstances, and it would appear impossible to have all the depôts equipped with every article necessary for a campaign like the late South African War, but all extra articles and drugs required should be obtainable for them at once on the demand being put forward.

G.—SUGGESTIONS FOR BASE DEPÔT OF MEDICAL STORES FOR AN ARMY CORPS.

(Staff-Sergeant BUCKLAND, R.A.M.C.)

Base Medical Stores.—The accommodation required for the base medical stores would be two offices, each 20 feet by 15 feet; a medical store 50 feet by 20 feet; a surgical store 50 feet by 20 feet, with deep beaded shelves.

Scale of Drugs for an Army Corps.—The scale laid down in Appendix No. 44, "Regulations for the Army Medical Services, 1900," contains sufficient of some of the drugs and surgical equipment, but the following might with advantage be increased:—

Drugs.	Appendix 44.	Suggested increase.
	lbs.	lbs.
Acid, boric	40	80
Acid, carbolic	20	60
Bismuth. Subnit	4	6
Emp. Belladonnæ	4	6
Ext. Ergot Liq.	1	9
Ferri et Quin. Cit.	6	4
Glycerin	30	50
Hydrag. Perchlor.	4	16
Iodoform	12	18
All liniments (Lin. Saponis and Camph. Co.)	—	40 each.
Liq. Plumbi Sub.	6	10
Mist. Sennæ Co. conc.	8	22
Ol. Morrhuæ	30	30

Drugs.	Appendix 44.		Suggested increase.
	lbs.		lbs.
Ol. Ricini	50		50
Paraffin Molle... ..	12		18
All pills and tablets, especially Pills Nos. 8 and 9 and Tablets Nos. 10 and 15.			
Sinapis Charta	No. 30		No. 70
Sodii Salicylas	10		20
Sp. Methylated	50		50
Easton's Syrup	6		14
Syr. Scillæ	12		18
Tr. Camph. Co.	12		18
Tr. Nux Vomica	3		7
Tr. Scillæ	4		16
Ung. Acid Boric	12		18
Vin. Ipecac	16		14

Surgical Materials—The following should be largely increased :—Wools, bandages, gauzes, jaconet, lints, drainage tubing, pins safety, sheeting, and waterproof cloth.

Medical Material.—Bottles, corks, labels, pill boxes, measure glasses, and clinical thermometers.

The following articles would form a useful addition to the scale mentioned :—

Medicines.—

Bismuth. Carb.	} Prepared for use. Found to have been most useful in the late Boer War.
Bismuth. Salicylas.	
Liq. Morph. Hydrochlor.	
Liq. Strychnin	
Lin. Terebinth	
Ung. Zinci	
Ung. Sulphur	
Ung. Galli cum Opio	}
Tabloids Formalin (160 lbs.).	

N.B.—Chloroform should be supplied in one or two ounce hermetically sealed tubes to prevent evaporation.

Surgical Materials, Appliances, and Instruments.—Plaster of Paris bandages prepared for use; surplus pads for the various kinds of splints; a few pairs of spring crutches for Officers' use; Jacques' soft rubber catheters; œsophageal tubes and funnels for feeding lunatics; chloroform drop bottles; thick silver wire for bone suturing; Hoffman's chisels, surgical mallets, and Murphy's buttons.

Medical Material.—Dispensing bottles should be sent washed, corked, and dried ready for immediate use. A supply of common commercial wide-mouth bottles ($\frac{1}{4}$ lb., $\frac{1}{2}$ lb., and 1 lb.) should also be sent for putting up dry drugs, also spare sets of empty bottles for field medical panniers and medicine chests, formalin lamps and spray producers.

X-ray Apparatus.—Spare plates of sizes, printing out paper, light tight bags, ruby and black fabric, chloride of gold in tubes, platinum studs, ammon. sulphocyanide, pyrogallie acid, soda hyposulph., soda sulphite, and other spare articles for the upkeep of the apparatus.

Ledgers.—If the pages of these were printed and indexed in the same order as the requisition forms (giving two pages for each kind of drug and surgical material) it would save a considerable amount of clerical labour. As the ledgers now stand in their blank state hours of work must be done to prepare them before a start can be made in the actual booking of receipts and issues.

Requisitions.—Army Forms I 1213, 1210, and 1209 should be made in book form, perforated, and carbon paper used. This would save having to

make duplicates, and at the same time ensure an accurate copy of the original being in possession of the Officer who sends the order.

Issue and Receipt Vouchers.—These should be clearly marked in red ink showing the abstract number in which the voucher appears, viz. :—

Issue Voucher No. 100—Abstract No. 1 of Issue.

If the above suggestions were adopted the account could be very easily audited. The ledgers should be constantly checked to note expenditure so that requisitions would be sent in ample time to replenish supplies before they become exhausted.

PART XIII.

CLOTHING.

Except among the troops from India and some arriving early in the war, khaki serge was issued. Drill is not suitable for such a climate as that of South Africa; the serge clothing was quite satisfactory.

Coat.—The “coat, British, warm,” was a most satisfactory issue. For general use it is far more useful than the greatcoat, even with the disadvantage that it does not protect the legs. The issue of a skirt or kilt, to be worn when required, would meet this objection.

Trousers.—Several Officers point out that knee-breeches are more useful than trousers when putties are to be worn. Trousers drag at the knee and in the fork, and so wear out easily.

Hat.—The ordinary soft felt hat was the best head covering used in South Africa.

Officers in charge of hospitals were held personally responsible that every patient travelling to the base or discharged from hospital to duty was in possession of the following articles:—

1 serge suit	} Army Order 6, dated 7.8.00.
1 jersey...	...	...
1 greatcoat	...	...
2 blankets	...	...
Necessary underclothing			

The necessary supplies were drawn from the Ordnance Department by the Officers in charge of hospitals who were accountable for them.

PART XIV.

SUPPLIES.

1.—TROOPS IN THE FIELD.

As a rule, the supplies were good. The quantity was at times reduced owing to military exigencies, notably in the advance to Bloemfontein, and in the operations of the 8th Division in the east of the Orange River Colony.

The scales are given in Appendices XXXIV and XXXV, the former amended to May 31st, 1900, the latter to April 1st, 1902. This last shows the modifications possible during the later stages. As regards these scales:—

Biscuit.—The ordinary brown ration biscuit was the best. A whiter biscuit was also issued, which was not so good, and a sweeter form issued in certain districts was not liked. The ordinary biscuit is hard, and requires a good set of teeth to dispose of it. It was said to be most palatable when put in a stew with meat.

Flour was made into rough chuppaties as well as loaves. Both the biscuit and the chuppaties are blamed for causing digestive troubles and dysentery. Where practicable, the issue of fresh bread is certainly desirable, but under many conditions some other issue must necessarily be substituted.

Bacon and cheese, pickles, and jam were much appreciated, and the scale of equivalents, generally speaking, allowed of considerable variety. Fresh fruit (mostly peaches or apricots) was very useful for cooking. The compressed vegetables were not more successful than formerly; the process of preservation seems to take all the flavour out of them.

Lime-juice.—The lime-juice issue was frequently useful to overcome any scorbutic tendency.

The *spirit ration* has proved useful under certain circumstances as before, but experience has again shown that under the ordinary service conditions it is not necessary, and that the men are just as well without it.

Tea.—The allowance of tea should be increased. Many Officers think that a larger issue would induce men to wait till water was boiled if they had more tea to use. This increased issue was suggested, but proved impracticable at the time. The Colonial contingents appear to have suffered less from enteric fever than our men, and they very largely use tea instead of drinking unboiled water.

Meat.—The preserved meat was almost invariably good, as were Maconochie's rations, which are very palatable, though too rich for continued use.

The frozen meat was usually excellent. The fresh meat varied greatly. Practically none was from slaughter cattle; most was from underfed and overworked animals, old cows or trek oxen, many of whom also for a time had been over-driven. In Pretoria, particularly for some time in 1901, the beef and mutton was much under the proper standard in quality, and the additional quantity issued in compensation did not make up for this.

The ration scale was perhaps the best ever allowed to an army in the field, particularly as the recognised equivalents gave so much opportunity for a change of food.

2.—HOSPITALS.

The original scale of extras, &c. (Appendix XXXIV) was largely increased later (*see* Appendix XXXV). But practically everything that was wanted was obtained if it were at all possible, independent of the actual scale, which was taken merely as a guide. The Officer's hospitals in particular were exceptionally well supplied, both as regards delicacies and wines and spirits.

A few brands of wines and spirits were rejected as unsuitable, and curiously one brand of port wine, after having been the cause of a good many complaints from some Officer's hospitals, was pronounced by a connoisseur (an Officer of high standing in the service) to be better than he could get elsewhere.

Milk.—The milk supply has already been spoken of. In Bloemfontein during the epidemic it was deficient, but any increase was impossible. In other places it was usually a source of some anxiety, and in many places, as in Bloemfontein and Pretoria, a central milk depôt was established, where all the milk was received from the contractors, sterilised, and issued to the hospitals in proportion to their needs. Some of the hospitals were able to keep their own cows, and dairy farms were instituted where possible. (See Appendix XXXVH.)

One must always be prepared for a similar deficiency, and certainly the Army Service Corps should keep up a stock of unsweetened milk for issue. There is no use for the sweetened milk in hospitals.

A sterilised milk was on sale in small quantities in Natal and Cape Town before the war. This is shipped from Australia in the refrigerating rooms of the ships of several lines. It is excellent milk, rich and full of cream, but not altogether suitable for hospital use. The cream separates and clots during the voyage, and although the milk is excellent for cooking it is not pleasing to the eye, nor indeed very nice to drink on account of this clotting. It was used to a small extent in some of the hospitals, but was objected to for the reasons given above. If this difficulty could be overcome it would be an excellent supply; it was not more expensive (in Natal) than fresh milk.

Preserved Eggs.—Several brands were sent for trial, some were preserved in the shell, in others the yolks only were bottled. These were only useful for cooking, in the making of puddings, and similar articles. They do not replace fresh eggs. Fresh eggs were obtained in sufficient quantities as a rule, but often with difficulty during the winter season. The local supply is never large; poultry farming is very risky work owing to the prevalence of various diseases, and even in time of peace the supply is not large; much of the supply for hospitals was imported.

Fish.—During the later stages a supply of fish was obtainable from Durban at irregular intervals for the hospitals in the Transvaal. The supply at Durban is at all times very uncertain, depending as it does on the weather conditions prevailing at that port. The supply at Cape Town is more varied, and can be depended on; the hospitals there were well supplied in this way.*

3.—CONVALESCENT CAMPS.

A scale of diet for the men in these camps was authorised by line of communication Order No. 10 of September 8th, 1900, and amended later when the proportion of men with defective teeth increased, by the substitution of oatmeal (for porridge) and milk. (See Appendices XXXVE and K.)

* A report from Major W. W. O. Beveridge, D.S.O., R.A.M.C., in charge of the laboratory in Pretoria, shows the work done by him in this connection during the war. (Appendix XXXVII.)

PART XV.

THE GENEVA CONVENTION.

(By Lieut.-Colonel W. G. MACPHERSON, C.M.G., R.A.M.C.)

The existing Convention has remained in force since 1864 without revision. Although additional articles were drafted in 1868 they were not ratified. Since that time the conditions of warfare have enormously altered, and the experiences of the South African campaign have brought into prominence many points which illustrate the necessity of considerable modification of the Convention. The Convention, in fact, failed in several directions to meet what both belligerents seemed to demand of it. The following notes may be taken as indicating the various questions that were raised in connection with its working during the war.

From all sides complaints were received that the personnel and transport material of field units were fired upon by the enemy during action. The incidents, so far as can be ascertained, depended mainly on the fact that the Red Cross on the ambulance wagons and the brassard worn by the personnel were not distinguishable at long ranges. But, apart from this, ambulance wagons were suspected of being used on occasions for the purpose of sheltering or covering important tactical positions. In order to meet the first of these difficulties, it has been suggested that stretcher bearers who have to enter the fighting line should wear over their uniforms a loose white coat marked conspicuously with the Red Cross, and that a large Red Cross flag should be carried by them when they are collecting wounded. It has been also suggested that the ambulance wagons should be painted a distinctive colour, and that the Red Cross on them should be as large as the vehicle permits. With the present long range weapons, it is obvious that unless the Red Cross can be made more conspicuous than is possible on a brassard, it is difficult to avoid bearers in the fighting line or anywhere within the range of fire being fired upon. With regard to the ambulance wagons too it may be noted that after our troops had arrived at Bloemfontein it was found necessary to paint as large a Red Cross as possible on the outside, but even this was not sufficient to prevent their being fired upon in action. It is doubtful, therefore, whether any Convention can effectually provide for the protection of the medical personnel and transport in the fighting line, and it is better that it should not attempt to do so, if it is likely to lead to recriminations and reprisals. Further, as regards the collection of wounded during an action under cover of a large Red Cross flag by men wearing a conspicuous Red Cross uniform, there may be tactical objections to anything that might indicate during the action where the enemy's fire had been most effective. As regards the second difficulty it is equally impossible to provide an article in the Convention which will remove suspicion when medical units take up important tactical positions with their ambulance transport. They must then take the risks of being fired upon. As an exceptional instance of the use made of ambulance wagons to cover a tactical situation, the Boers are reported to have been unable to move their guns at the battle of Brakenlaagte, fought on November 2nd, 1901, until our ambulance wagons went out when, under cover of them, the guns were taken away.

The Convention failed in several instances to afford protection to and obtain respect for field units when arms or ammunition were found in the ambulance wagons or stored in the hospitals. The Convention does not necessarily exclude the reception and carrying of the arms and ammunition of the sick and wounded by field medical units. In this respect Article 1 appears to have been constantly misinterpreted by both belligerents. Thus, Captain Longhurst was made a prisoner on July 17th at Lindley because the arms and ammunition of his patients were found, according to regulation, in his pack store. No explanations were accepted, and he was ordered

to be tried and punished for hoisting the Red Cross flag under the circumstances. On August 6th of the same year a party of the enemy under General Delarey took possession of Lichtenburg, where the left half of the 24th Field Hospital had been left behind under Captain Thom, R.A.M.C., on the evacuation of the town by our troops on July 28th. The only arms and ammunition in the hospital were a Lee-Metford rifle and 100 rounds of ammunition belonging to a patient, who had been admitted after the evacuation had commenced, and a sporting shot gun belonging to Captain Thom. In consequence of this, however, the transport and other material were seized, the personnel made prisoners and armed sentinels placed over the hospital. Eventually permission was given, on August 11th, for the removal of the sick and wounded to Mafeking, but only such medical and surgical material as was required for the journey was allowed to accompany them, and the necessary transport was only lent. In this case it is doubtful whether Article 4 of the Convention was actually transgressed or not. The term "ambulance" in the Article is ambiguous, although in the definition given to it, in the additional Articles framed in 1868, it is held to include all mobile units which follow the troops for the purpose of succouring the wounded. Under this definition the equipment of the hospital would have been allowed to accompany it on its withdrawal, but if the field hospital is regarded not as an ambulance but as a military hospital in the terms of Article 4, then General Delarey would not have transgressed the Convention in retaining its equipment, even had there been no arms or ammunition in it. The actual cause, however, of the action taken by General Delarey does not appear to have been any special interpretation of the Convention on his part. It was due, rather, to an act of retaliation or reprisal, for Captain Thom received a letter on August 18th from State Attorney Smuts to the effect that the equipment of the hospital had been detained because the British had detained one of their ambulances at Bloemfontein, in consequence of a few cartridges having been found in it. The ambulance in question was that of Dr. Hofmann, a member of the Cape Legislative Assembly. Ammunition was found in it, and our military authorities considered that its equipment became, therefore, the property of His Majesty's Government, its members being eventually sent down country.

Incidents like these clearly indicate the necessity of more precise wording of the Convention. It has been suggested that the care and collection of the arms and ammunition of the sick and wounded should form no part of the duty of those who are protected by the Red Cross, and that they should never be kept in any ambulance wagon or taken on charge in any hospital. One has to remember, however, that too stringent a regulation on this point might lead to far greater complications in the working of the Convention than exist at present. It might not be always possible, for example, to avoid placing in an ambulance wagon a wounded man, whose pockets or bandolier contained cartridges, without adding greatly to his suffering in attempting to remove them. Under such circumstances, were the Convention so framed as to prohibit the presence of ammunition in an ambulance wagon under penalty of forfeiture of neutrality, it would act as a distinct hardship instead of being beneficial. It seems more reasonable to suggest that if arms and ammunition, which are *bona fide* the property of the sick and wounded, are found in an ambulance wagon or with bearer companies and field hospitals, neutrality shall not be forfeited, provided, of course, they are not used for acts of hostility. At the same time, there should be some better organisation for the earliest possible removal of the arms and ammunition of the sick and wounded to ordnance depôts or regimental units. They would, of course, be liable to seizure and confiscation if the unit fell into the hands of the enemy, but the fact of their being there should not be made an excuse for interfering with the transport, medical or surgical equipment, and personnel.

The personnel of some of the medical units seemed to consider that they had a right under the Geneva Convention to return immediately to their own army if they were captured by the enemy. On this point the Convention is vague, and its interpretation is practically impossible. Whatever the tactical or strategical views may be, it is necessary that they should be clearly stated in the Convention, not only as regards the withdrawal of personnel, but also

as regards the conditions under which complete units, with transport and material, may be returned to their own army.

With regard to the terms of the existing Convention, under which medical units are protected only when sick or wounded are found with them, a revision is clearly demanded. It is obviously impossible for a bearer company or field hospital, or indeed any hospital, to afford that assistance to the sick and wounded for the purpose of which the Convention has been framed, unless it is at all times ready to receive patients without fear of capture or interference. In fact, a state of empty readiness is one of the chief functions of a field hospital.

As regards stationary or general hospitals, there is no record of incidents illustrating difficulties in the working of the Convention. Questions arose regarding the selection of sites for general hospitals on the lines of communication, the possibility of their being captured by the enemy under Article 4 of the Convention acting as a deterrent. This Article distinctly states that the equipment of such hospitals remains subject to the laws of war, and the personnel attached to them cannot, in withdrawing, carry away any articles that are not their own private property. The Article is no doubt intended to provide for the maintenance of fixed hospitals as definite establishments in a particular locality, whether the belligerent to whom it originally belonged occupies the locality or not. It seems desirable that the Convention should not be framed in such a way as to act as a deterrent to the establishment of a stationary or general hospital wherever it may be of most advantage to the sick and wounded of either side.

The amount of protection afforded by the Convention to personnel, medical and surgical material, general equipment and transport of medical units, as separate items, requires better definition. As regards personnel, for example, there is the case of Major Burtchaell, R.A.M.C., who was sent out on December 13th, 1899, to the Magersfontein battlefield to attend to the wounded. He proceeded under the Red Cross flag to the Boer lines, and while engaged in searching for wounded, he left his horse. Some Boers, apparently, examined the wallets and found an unloaded revolver in one of them. Major Burtchaell was thereupon made a prisoner for being armed contrary to the rules in the Boer army, under which Medical Officers do not carry weapons. Although there is nothing in the Convention to prohibit anyone wearing the Red Cross brassard and at the same time carrying arms for personal protection, it seems necessary that the wording of the Articles should be sufficiently precise to prevent misinterpretation of this kind. Further, the personnel required for transport and purposes other than direct attendance on sick and wounded have sometimes been regarded as not coming directly under the protection of the Convention. Article 2, however, seems perfectly clear upon this point, and in this respect there should have been no misinterpretation of the Convention. As regards protection of medical and surgical material, the Convention appears to require expansion in order to cover the case of medical depôts, and to ensure that the material is at all times available for the sick and wounded. It may not be possible to avoid material in fixed hospitals becoming the property of the enemy under Article 4, but the Article might be so modified as to state that the material should not be diverted from the use of the hospital in question so long as there are sick and wounded to succour there. As regards transport material, considerable difficulty is likely to arise. The last paragraph of Article 6 alone bears upon the point, but it is quite vague as to the manner in which it is intended to regard, for example, transport animals, wagons, railway engines, railway ambulance carriages, &c. The suggestion on this point is to neutralise in precise terms all the elements required for the conveyance of sick and wounded from the field hospitals to the fixed or base hospitals, provided they are acting as separate medical units, and not as part of other convoys. As a matter of fact, this was the manner in which the Convention worked during the war. On the enemy's side, our hospital trains were invariably respected, and it should be the practice to remove, or cover over, the Red Cross painted on ambulance wagons or railway carriages, trucks containing medical stores, &c., when they are mixed up with convoys of troops or war material, in order that the Red Cross should not appear to be acting as a cover for such convoys. It is advisable, indeed, in mixed trains not to paint the Red Cross on trucks

with medical stores, but to adopt some other mark by which they can be distinguished.

Finally, there is a wide group of incidents which bear more or less upon the abuse of the badge of neutrality either through ignorance or on purpose. Incidents of this kind will, of course, occur in connection with any Convention that may be made, but if the terms of the Convention defined precisely the position of independent societies and individuals who take part voluntarily in the work of succouring the sick and wounded, the extent of this abuse would be diminished. The existing Convention, in fact, encourages abuse. It recognises no organised Red Cross Societies, such as might be kept under control by military authority, but under Article 5 it affords protection to independent individuals who bring help to the wounded in the area of operations, and to the houses where they may be entertained. The insertion of this Article has probably led to more abuse of the Convention than anything that has been omitted from it. The inhabitants of Jacobsdal and Johannesburg, for example, are stated in reports by members of Continental Red Cross Societies, who were with the Boers, to have made general use of the Red Cross brassard and flag for the protection of their persons and houses at the time of the British advance on these places, depending, no doubt, on Article 5 to justify their conduct. The badge was also much abused through the ignorance that prevailed with regard to it amongst members of private hospitals and individuals who went out independently to the seat of war. They not only wore brassards without having received them from the military authorities, but they were able to buy them openly in the towns.

But one of the great difficulties that arose was the absence of any definite rule in the Convention under which persons entitled to wear the brassard should be obliged to carry with them a written authority to do so. The existing Convention merely states that the delivery of the brassards shall be left to the military authorities. It says nothing about having them officially stamped, numbered, and registered, and of identifying the persons possessing them by identification cards or other documents. Military regulations provide for this in Continental armies but not in ours. The consequence was that the Boer officials, who had become acquainted with the Continental practice through the Red Cross ambulances sent to the Transvaal from Europe, caused our medical personnel much embarrassment by demanding their authority to wear the brassard. It is obvious that in order to prevent confusion in the working of the Convention, the Convention itself and not the regulations of individual countries should determine points of this kind.

An important question arose during the war in connection with the rights, under the Convention, of Red Cross Societies of neutral States, some of whom claimed protection and, in one case, at any rate, the right to hoist over their ambulances their own national flag. On this point the Convention, as ratified in French, is clear. Red Cross Societies are not recognised, only military hospitals and military ambulances, although the English translation might make the Convention appear to protect all ambulances. The Red Cross Societies were, in fact, intentionally left out, and the national flag, which may be hoisted under Article 7, has been declared by international jurists to be the flag of one or other of the belligerents only. Incidents occurred showing the necessity of caution in dealing with Red Cross ambulances from a neutral State. The most notorious of these were the International Red Cross Ambulance, organised in Antwerp, and the American Red Cross Ambulance, organised in Chicago. In both these cases there was flagrant abuse of the Geneva Convention, most of the members having joined the organisations with a view to entering the Transvaal under its protection, and afterwards joining the Boer forces as combatants. The Netherlands Ambulance, known as the "Koster" Ambulance, also threw suspicion on the good faith of neutral ambulances by carrying letters to the enemy after receiving permission from our military authorities to join the Boers.

The circumstances under which the Convention failed during the war, and the suggestions for its revision may be briefly summarised as follows:—

1. The Articles are insufficient to meet the requirements of modern warfare so far as the protection of medical units during an action is concerned. It is probably impossible to frame a Convention that will make matters better in this respect.

2. The Articles have been misinterpreted with regard to the forfeiture of neutrality when arms and ammunition are found with medical units or in the possession of individuals entitled to wear the Red Cross brassard. All difficulties that might arise in this direction would be removed by the introduction of an Article distinctly stating that arms and ammunition belonging *bona fide* to sick and wounded under the care of a medical unit may be carried and retained by it, and that the medical personnel are permitted to carry arms, &c., for their own protection.

3. The Articles are ambiguous especially with regard to the words "ambulances and military hospitals." These two expressions do not cover all the medical formations, which in the interest of the sick and wounded should be protected by the Convention. This difficulty can be overcome by applying the Articles to all medical formations instead of as at present to one or two of them only.

4. The Articles do not define with sufficient precision the conditions under which the personnel, material, and transport of medical units, separately or as a whole, may be detained by the enemy or withdraw to their own lines. This should be clearly left to the judgment of the Military Officers who are responsible for tactical and strategical movements.

5. The Article under which medical units are protected only when sick or wounded are found with them unnecessarily restricts the working of the Convention, and in the interest of the sick and wounded it should be expanded to afford protection at all times.

6. There is not sufficient provision for the protection of the badge of neutrality from abuse or misuse. In this respect the Convention to be effective should define the conditions necessary for preventing any but official badges being used, and any individuals wearing them without being in possession of official authority to do so.

7. The Article granting protection to the inhabitants of a country and their houses under certain circumstances operates harmfully. It should be replaced by an Article defining the position of Voluntary Aid Societies which are organised to supplement the Army Medical Service under military control.

8. The exclusion of neutral States from having any rights under the Convention requires to be more precisely stated.

9. Finally, ignorance of the Convention on the part of responsible Officers or, at any rate, of its meaning and the extent to which it can be applied, was one of the chief causes of failure. Knowledge of the Convention should form part of the education of all Officers and men, and the terms of the Articles and their meaning should be known practically by heart.

PART XVI.

THE ADMINISTRATIVE MEDICAL STAFF OF AN ARMY IN THE FIELD.

A.—HISTORICAL.

The administrative staff of the Army Corps, as originally detailed, consisted of the Principal Medical Officers of Divisions; the Principal Medical Officer, Lines of Communication; Principal Medical Officer, Natal Field Force; and the Principal Medical Officer, Base; all acting under the central authority of the Principal Medical Officer, Army Corps Headquarter Staff. But, for reasons which have been referred to in the general account, the medical administration in Natal became practically separated from the jurisdiction of the Principal Medical Officer, Army Corps; and, later, when Lord Roberts decided to advance towards Kimberley and Bloemfontein, a "Principal Medical Officer, with headquarters," was detailed to accompany him, as representative of the Principal Medical Officer, Army.

The following Officers were originally detailed for field force:—

Corps Staff—

Principal Medical Officer, Surgeon-General W. D. Wilson.
Secretary to P.M.O., Major W. G. A. Bedford.
Orderly Officer, Captain M. L. Hughes (killed in action).

1st Division Staff—

Principal Medical Officer, Colonel E. Townsend, C.B.
Secretary to P.M.O., Major C. H. Burtchael.

2nd Division Staff—

Principal Medical Officer, Colonel T. J. Gallwey, C.B.
Secretary to P.M.O., Major W. Babbie, C.M.G.

3rd Division Staff—

Principal Medical Officer, Lieut.-Colonel J. D. Edge.
Secretary to P.M.O., Major G. E. Twiss.

Cavalry Division Staff—

Principal Medical Officer, Lieut.-Colonel W. Donovan.
Secretary to P.M.O., Major H. G. Hathaway.

Staff of Headquarters (L. of C.)—

Principal Medical Officer, Colonel W. F. Stevenson.
Secretary to P.M.O., Major G. H. Sylvester.

Natal Field Force—

Principal Medical Officer, Colonel R. Exham.
Secretary to P.M.O., Major J. F. Bateson.

Of the remaining Divisions from home the Administrative Officers were:—

5th Division Staff—

Principal Medical Officer, Lieut.-Colonel W. B. Allin.
Secretary to P.M.O., Major E. Davis.

6th Division Staff—

Principal Medical Officer, Lieut.-Colonel W. L. Gubbins.
Secretary to P.M.O., Major B. M. Skinner.

7th Division Staff—

Principal Medical Officer, Lieut.-Colonel J. A. Gormley.
Secretary to P.M.O., Major J. F. Morgan.

8th Division Staff—

Principal Medical Officer, Lieut.-Colonel W. A. May.
Secretary to P.M.O., Major J. W. Jerome.

Of the Divisions formed in South Africa :—

9th Division—

Principal Medical Officer, Lieut.-Colonel J. C. Dorman.*

11th Division—

Principal Medical Officer, Surgeon Lieut.-Colonel J. Magill.*

Mounted Infantry Division—

Principal Medical Officer, Colonel W. D. C. Williams,* New South
Wales A.M.C.

Colonial Division—

Principal Medical Officer, Lieut.-Colonel Hartley, V.C., Cape
Mounted Rifles.

Base—

Principal Medical Officer, Colonel J. F. Supple.
Secretary to P.M.O., Major A. P. O'Connor.

Of the Army Corps Staff, Captain M. L. Hughes was killed in action at Colenso when accompanying General Sir Redvers Buller, V.C. This Officer was not replaced till in August, 1900, when Major R. J. S. Simpson was posted as Orderly Officer, and in November, 1900, on Major Bedford being invalided, Major Simpson took over the duties of Secretary, while Captain A. F. Tyrrell was posted as Orderly Officer. No further changes occurred in the Army Corps Staff during the remainder of the campaign.

Colonel T. J. Gallwey became Principal Medical Officer with General Buller, with Major Babbie as Secretary, while Lieut.-Colonel W. B. Allin became Principal Medical Officer of the Field Army in Natal, and Colonel Clery, Principal Medical Officer, Lines of Communication, Natal. Colonel W. F. Stevenson (with Major Sylvester) joined Lord Roberts as Principal Medical Officer with headquarters, while Colonel W. H. McNamara succeeded him as Principal Medical Officer, Lines of Communication ; and, later, when Colonel Supple proceeded to India, took over the duties of Principal Medical Officer, Base, also. After the relief of Ladysmith, Colonel R. Exham assumed the duties of Principal Medical Officer, Bloemfontein.

On the breaking up of the divisions, additional administrative Medical Officers were detailed for various sections of the lines of communication as already shown.

In consequence of the increase of the army in South Africa, and the enormous area covered by the operations, the work of the Principal Medical Officer, Army, became very much greater than was anticipated, while his staff was for a time reduced to one Officer.

* These Officers had no Secretaries, as Officers were not available for that duty.

B.—DUTIES OF THE P.M.O., HEADQUARTERS OF ARMY.

The Principal Medical Officer of an army in the field is finally responsible for—

- A.—(1) Field medical arrangements.
- (2) Lines of communication and base hospitals.
- (3) Transport of sick and wounded—
 - (a) On land.
 - (b) By sea.
- (4) Personnel of the medical service—
 - (a) Officers.
 - (b) Nursing Sisters.
 - (c) Warrant and N.C. Officers and men.
 - (d) Returns relating to personnel.
- B.—(1) Medical and surgical supplies.
- (2) Army Service Corps supplies } to hospitals, *vide* para. 635,
- (3) Ordnance } “ Regulations A.M.S.,” 1900.
- C.—(1) Sanitation—
 - (a) Field.
 - (b) Base and lines of communication.
- (2) Statistical returns of sick and wounded.

Before deciding on the staff required, the first question to be settled is the degree to which it is possible to decentralise the administration. The Principal Medical Officer, Army Corps, is able (to a degree dependent on the information given him by the General Officer Commanding-in-Chief) to decide on the general lines on which the hospital system and the arrangements for the transport of the sick should be developed; on the points where hospitals shall be established, and the amount of accommodation required at these.

This should generally be possible at the time the plan of campaign is devised, though, of course, the chances of war will often upset these arrangements, when the modifications of the general scheme must be arranged by the Principal Medical Officer under instructions from the General Officer Commanding-in-Chief; but the outlines of this scheme should be filled in by the various subordinate Principal Medical Officers under instructions from their General Officers Commanding. It should not be necessary for the Principal Medical Officer, Army Corps, to take personal action as regards the details of these arrangements; his proper function is to co-ordinate the efforts of his subordinates. The same thing in a lesser degree applies to the relations between the subordinate Principal Medical Officers and the Officers commanding the units under them.

The result is that after the general scheme for the development of the hospital system has been initiated, besides the important duty of supervising the working of the Medical Service as a whole, the Principal Medical Officer, Army Corps, should only require to arrange for:—

- (1) Further developments along *new* lines in conformity with the military situation.
- (2) The redistribution of reinforcements to the various divisions or districts, according to their requirements, to (a) replace casualties, or (b) open hospitals in addition to those originally provided.

The organisation of the medical arrangements for the army referred to above is, however, only a part of the work of the Principal Medical Officer. Much of this naturally is most important at the beginning of the campaign, as the success of later developments greatly depends on the scheme first devised. But the supervision of the working of the Medical Service as a whole, including

the adaptation of local means to necessities arising, often of an ephemeral though urgent nature, are of equal, if not of greater, importance, and with this important distinction, that the necessity never ceases while the campaign lasts. If the time and energy of the Principal Medical Officer are occupied by the elaboration of local detail, it is impossible for him to devote as much attention to the general efficiency of the whole system as is requisite. There is, of course, much that must be initiated from headquarters. The probability of future movements in certain areas is known to the Principal Medical Officer at an early stage, and it falls to him to make such redistribution of the hospital accommodation, either by evacuation down the line or by the establishment of new hospitals, as may be required. Similarly, although after the initial stages the regular evacuation of sick and wounded may be conveniently left to the Principal Medical Officers of districts, the Principal Medical Officer, Army, must take a general view of the whole area, and increase the rate of evacuation from such localities as appear to be suffering from over-pressure.

Speaking generally, as the campaign progresses, though the total amount of work increases with every increase of the area of operations, it should become possible to throw more and more of the actual carrying out of the details of the general scheme on the district authorities.

As a consequence the necessity of a competent and sufficient staff for the Principal Medical Officer, Army, is at least as pressing at the outset of the campaign as in later stages. There must be relatively more detail thrown on him in the earlier stages than later, and this at a time when there is all the confusion and uncertainty of the early stages of a campaign.

The mere routine work of the office of the Principal Medical Officer of a large army must always be very heavy; much of this cannot be neglected without serious detriment to the efficiency of the Medical Service; unless this item is satisfactorily provided for the whole arrangements must suffer.

These considerations apply to the different duties enumerated under Section A of the table given above.

As regards B (supplies), the same principle applies. The Principal Medical Officer, Army, should only be required to deal with the larger questions affecting the whole force, the special needs of individual districts or hospitals should be dealt with by the local Principal Medical Officers. It will, of course, occur that sanction from the General Officer Commanding has to be obtained for special local requirements, in which case the opinion of the Principal Medical Officer, Army Corps, is also necessary.

C.—STAFF REQUIRED BY PRINCIPAL MEDICAL OFFICER, ARMY.

For the efficient performance of the duties under "A" and "B," the Principal Medical Officer of an army corps requires three Staff Officers, whose duties would be as follows:—

- (1) Field medical arrangements.
Lines of communication and base hospitals.
Transport of sick and wounded.
- (2) Personnel.
- (3) Supplies. This Officer would also act as Orderly Officer, and accompany the Principal Medical Officer in his inspections.

The Senior Staff Officer would act as the representative of the Principal Medical Officer during his absence on duty, and have general control of all the work in the office. He should also deal with all matters relating to the Officers of the Royal Army Medical Corps as individuals, such as confidential reports, special applications from them, and the like.

The Medical Officer in charge of the headquarter staff should not be included among the staff of the Principal Medical Officer, which is available to assist him.

As regards "C" there is no doubt that a special Sanitary Officer should be on the staff of the Principal Medical Officer of the field force. Sanitary

questions of general application frequently arise, and should be dealt with as far as possible on a uniform principle, leaving the details to be modified according to the actual local conditions.

The most important feature, however, in having one central sanitary authority is, that the knowledge of what is being done throughout the whole field will frequently ensure that local objections to some proposal can be refuted, by showing that under similar conditions elsewhere the difficulties brought forward have been overcome. Further, a central authority, obtaining early information as to the incidence of disease, can note any unusual prevalence in one district as compared with the others, and can therefore at once take steps to have the cause of this inquired into and remedied. Local authorities have not the information necessary to show how their district compares with others.

D.—INFORMATION REQUIRED BY PRINCIPAL MEDICAL OFFICER, ARMY.

There seems to be little doubt that the main part of the statistical work should be carried out at the base. But the Principal Medical Officer and the Sanitary Officer of the army corps staff must have the earliest possible information that is obtainable of the numbers of sick and wounded, both for purely administrative purposes and for the protection of the health of the troops by sanitary precautions. From the end of 1900 the Principal Medical Officer, Army, received a weekly telegram from every hospital in South Africa giving the following particulars:—

Total number of sick in hospital.
Number of wounded.
„ cases of enteric fever.
„ „ simple continued fever.
„ „ dysentery.
„ „ malarial fevers.
„ deaths.
„ in convalescent camps.

In this way the Principal Medical Officer was kept informed of the local needs as regards accommodation and of the relative prevalence of disease, while the telegram also included a statement of the reason for any sudden increase in the numbers in hospital and the prevalence of any special disease.

At the beginning of the campaign, while the whole arrangements are to all intents directly under the Principal Medical Officer of the force, a daily telegram from each hospital, giving total numbers and the number of cases of infectious disease, is required to enable him to arrange the necessary accommodation. But as the campaign progresses, and the district arrangements become more complete, this information will be of more use to the Principal Medical Officers of districts or of the lines of communication, who should normally dispose the accommodation in their districts as required, while intermediate telegrams in the case of any emergency will enable the Principal Medical Officer of the force to take any action that may be necessary to enable the districts to meet the new conditions.

This is all the information that is immediately necessary for the purposes of administration or sanitation, and it adds very little to the work required from a hospital staff. The great point is that the information must be available as soon as possible.

E.—POSSIBILITY OF DECENTRALISATION.

Effective decentralisation of duties is the key to smooth working of a service. But in the late campaign, the Medical Service (in the executive ranks) was very largely composed of untrained men who were not interchangeable with the regular service; the result was that where, with a staff composed solely of trained men, the Principal Medical Officer of a district could have made all necessary arrangements to meet fresh necessities from the personnel serving under him, in this case a trained staff had to be collected from other districts for this purpose. This required the intervention of the Principal Medical Officer, Army, whose work was therefore very materially increased,

while at the same time as Officers of the Royal Army Medical Corps were urgently required for important duties in the field and on the lines of communication, none could be detached from these duties to increase his staff. This seems an important point, that the smaller the proportion of the trained Royal Army Medical Corps in the Medical Service, and the less adequate that service is numerically to the work required of it, the less possible it is to decentralise the administrative work.

When more than one army corps is in the field it would seem advisable to add a fourth Staff Officer to act as Orderly Officer and assist in the office in the branch where his services were most needed.

F.—PRINCIPAL MEDICAL OFFICER, LINE OF COMMUNICATIONS.

As regards the Principal Medical Officer, line of communications; in the section dealing with the line of communications it has been shown that the Principal Medical Officer requires Staff Officers for the following duties:—

- (1) To keep in touch with the Principal Medical Officers of divisions in the field and arrange for the pushing forward of advanced line of communication hospitals, and the evacuation of the sick and wounded from them. These may be provisionally termed "Field inspectors."
- (2) To supervise sections of the line of communication, especially as regards sanitation. These may provisionally be termed "Line inspectors."

Additional line inspectors will be required as the line of communication grows, but one at least should be detailed for this duty from the first.

The number of "field inspectors" necessary will vary with local conditions. One is required for each point of concentration, and should be detailed from a reserve of Officers of the Royal Army Medical Corps not attached to units, so that the general or stationary hospitals should not be disorganised by having their best men removed for these duties.

G.—PRINCIPAL MEDICAL OFFICER, BASE.

Principal Medical Officer, Base, requires—

One Staff Officer as Secretary.

" " Embarking Officer.

" " Commanding dépôt company, Royal Army Medical Corps.

One assistant matron, Q.A.I.M.N.S. to arrange for the reception of and accommodation for nursing Sisters as they arrive at the seat of war.

H.—PRINCIPAL MEDICAL OFFICER WITH HEADQUARTERS IN THE FIELD.

One Senior Officer with a Staff Officer as secretary should accompany headquarters in the field as Principal Medical Officer of the field army, in order to co-ordinate the divisional arrangements. It is not possible nor desirable for the Principal Medical Officer, Army, to do this.

J.—SCHEME FOR ADMINISTRATION.

The proposed scheme for administration is shown in the following tables:—

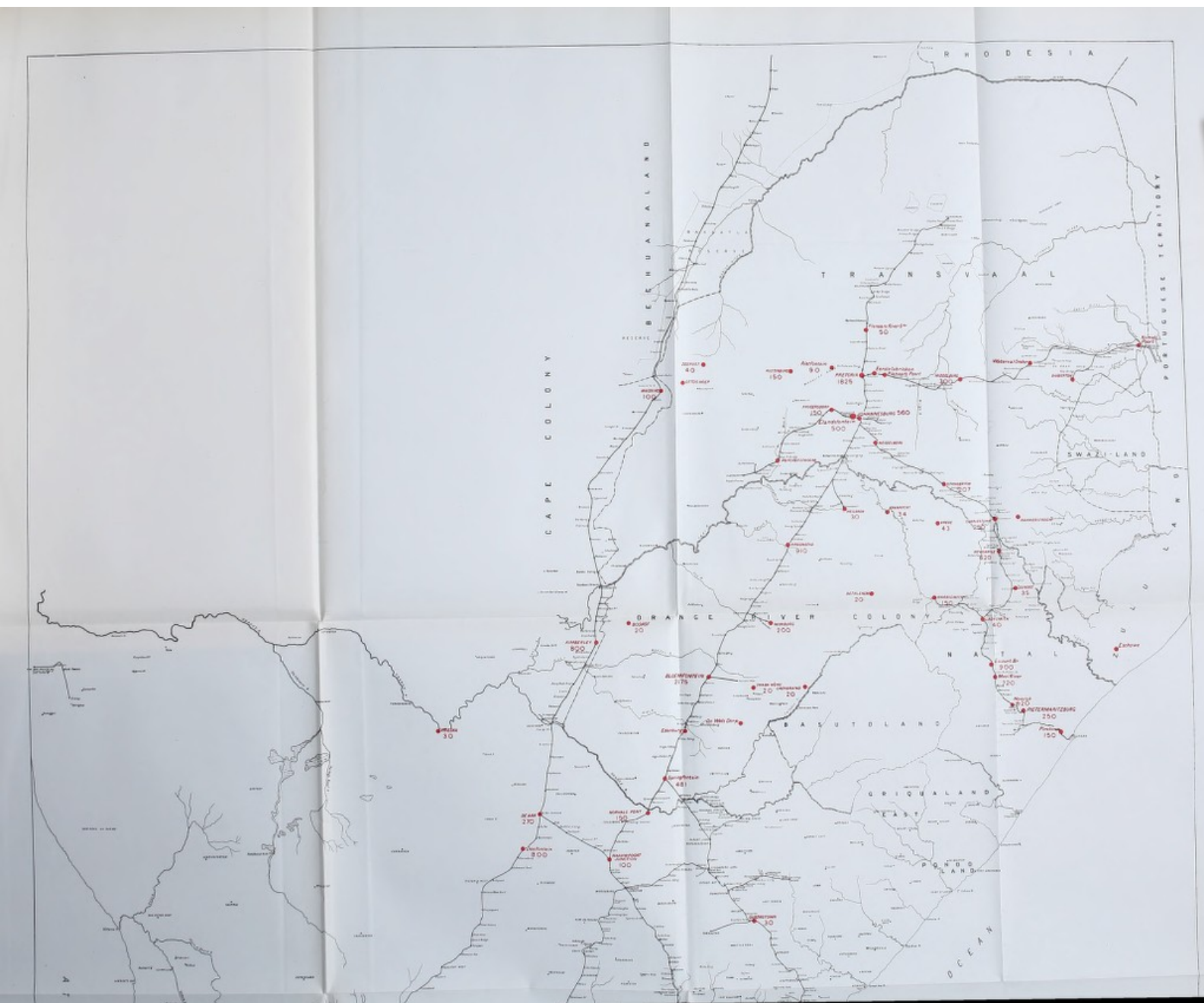
Principal Medical Officer of the Army.
Staff { Three Staff Officers.
One Sanitary Officer.

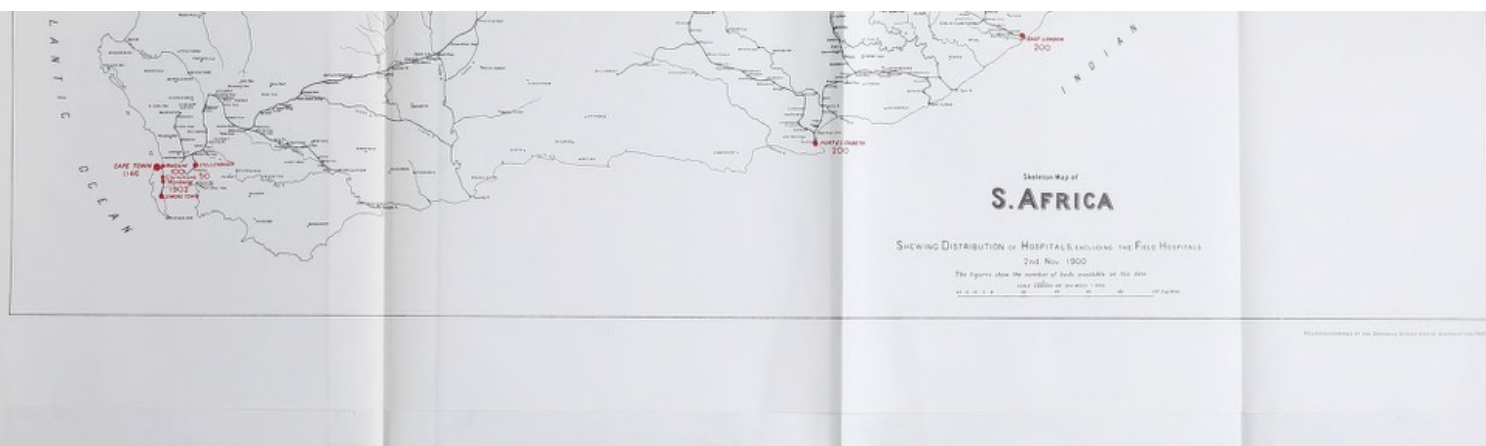
Statistical Office at Base, though under the Principal Medical Officer of the Army.

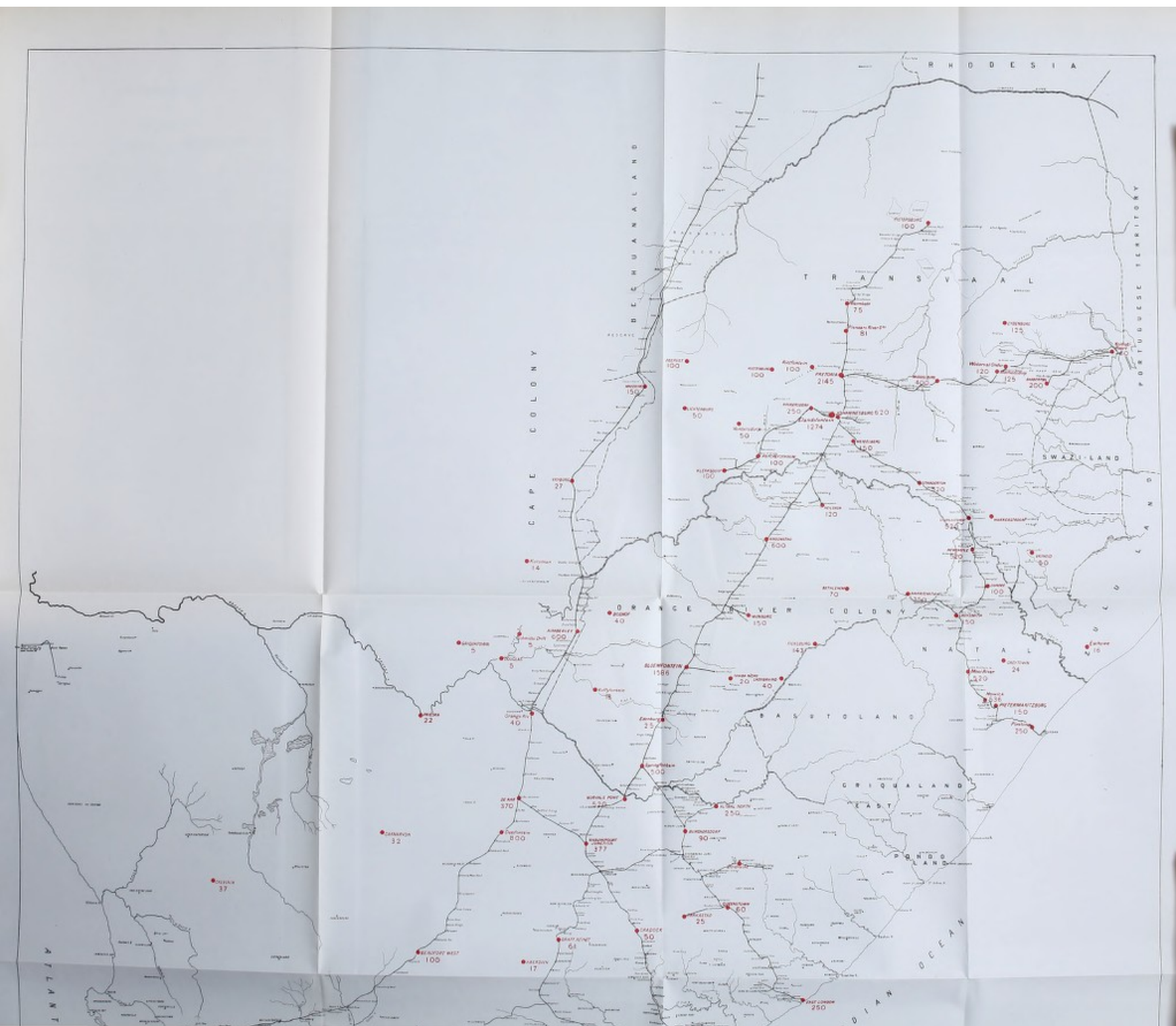
Principal Medical Officer—Field Army. One Staff Officer as Secretary.	Principal Medical Officer—Line of Communication. One Staff Officer as Secretary.	Principal Medical Officer—Base. One Staff Officer as Secretary.
Principal Medical Officers of Divisions. One Staff Officer to each as Secretary.	<p>Advanced line of communication hospitals.</p> <p>Sick convoy and hospital trains ... Field inspectors.</p> <p>Advanced depôts of medical stores.</p> <p>Small posts and detention hospitals ... Line inspectors.</p> <p>Stationary hospitals.</p> <p>General hospitals.</p> <p>Convalescent camps.</p>	<p>General hospital at base.</p> <p>Convalescent camp at base.</p> <p>Base depôt, medical stores.</p> <p>Embarkation duties ... One Staff Officer.</p> <p>Depôt, Nursing Sisters ... One Assistant Matron.</p> <p>Depôt Company, R.A.M.C. ... One Staff Officer in command.</p>

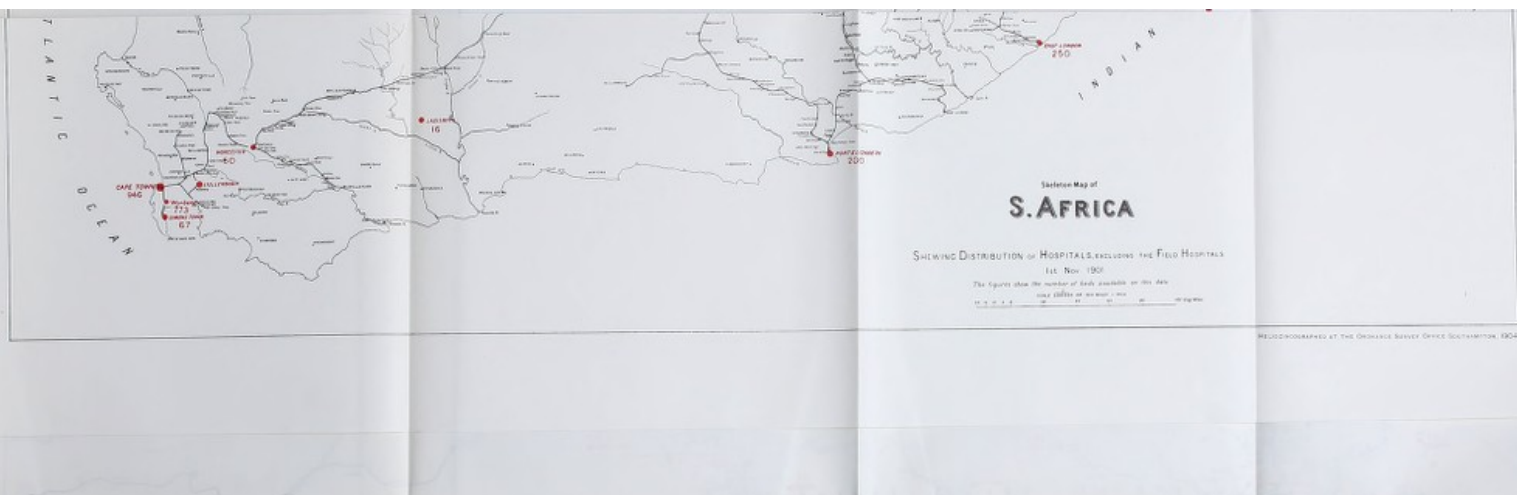
K.—SANITARY OFFICERS.

Under the existing system the Principal Medical Officer of a division or of the base or line of communication, is Sanitary Officer to the General Officer Commanding on whose staff he is. While it is desirable that he should be finally responsible in this as in other branches of his duties, it appears to be advisable to attach to his Staff an Officer whose sole duty shall be to deal with all sanitary matters, whether in the field or elsewhere. The duties of an Administrative Officer are too onerous to allow of his giving his personal attention to details, and it is only by attention to what may appear to be minor matters that satisfactory results can be obtained in sanitation. This can only be successfully carried out by an Officer who has no other duties to perform, and it does not appear that such an appointment need relieve the Medical Officers in charge of regimental units of their present responsibilities in this matter.









APPENDICES.

APPENDIX I.

REPORT ON MEDICAL ARRANGEMENTS OF THE NATAL FIELD FORCE BY COLONEL R. EXHAM, C.M.G.

Before leaving England on September 16th, 1899, I was informed that there were two bearer companies and two field hospitals in the Cape command, but that their locality at the time was not known; also that at Maritzburg and Ladysmith there were station hospitals for 200 beds (*i.e.*, 100 each). I was also informed that three and a half field hospitals for troops and one half native field hospital for followers would come from India, one field hospital from England, and also a stationary hospital (100 beds) to be located at either Durban or Pinetown as a hospital for the reception of sick on disembarkation or previous to embarkation. Further, that a general hospital of 520 beds would be established at Simon's Town (subsequently Wynberg was selected), and that two small sick transports would be provided to convey the sick and wounded from Durban to the general hospital. It was also suggested that the hospital at Maritzburg might be increased to 250 beds. On arrival at Cape Town on October 3rd, I ascertained that the necessities of Cape Colony were such that the strength of the Royal Army Medical Corps in Natal was far below what was required to provide for the station hospitals, and the two field hospitals and bearer companies which it was expected could be made available for the Natal Field Force.

I went carefully with the Principal Medical Officer, Cape Colony, into the question of what he could spare in the way of personnel and medical supplies. As a result he detailed six N.C. Officers and men, Royal Army Medical Corps (all he could spare), to proceed to Natal in addition to a small draft already sent, and also forwarded several boxes of surgical dressings, &c., from his store to supplement a supply already sent by him. I also telegraphed to the Senior Medical Officer, Natal, to at once take steps to extend the Station Hospital, Maritzburg, to 250 beds.

On arrival at Maritzburg on October 8th, I was informed that half of No. 26 British Field Hospital had arrived from India, and had gone to General Penn Symon's force at Glencoe, and that Nos. 18 and 24 British Field Hospitals had arrived that day also from India, and had gone to Ladysmith. I found that after providing one Medical Officer for each cavalry and infantry regiment and brigade division of artillery then in the command (excluding regiments of the Indian contingent which brought Medical Officers from India with them), there were available for the station hospitals and the Natal Field Hospital and Bearer Company only the following Officers, &c., of the Royal Army Medical Corps, *viz.* :—Officers, 8; Warrant Officers, 2; N.C. Officers and men, 97; and their distribution was as follows :—

	Officers.	Warrant Officers.	N.C.O.'s and Men.
Station Hospital, Maritzburg	3	1	28
Station Hospital, Ladysmith	2	0	18
No. 1 Natal Field Hospital	1	0	23
No. 1 Natal Bearer Company	1	1	25
At Eshowe	1	0	3

There were also the six N.C. Officers and men previously referred to *en route* from Cape Town. Out of this personnel of N.C. Officers and men (3959)

my clerical establishment and the staff of a hospital train had also to be provided for.

The hospital train made up of converted carriages, &c., was just completed and only required to be manned and supplied with stores. As regards an Officer for this train, this was met by obtaining from the Natal Government the services of an Officer of the Indian Medical Service then on plague duty (Captain Leumann, since dead).

As it was evident that with this personnel it was not possible to maintain an efficient field hospital and bearer company, it was decided not to keep the former mobilised after arrival of all the field hospitals from India, and with its personnel the bearer company and the station hospital at Ladysmith were somewhat strengthened. It was intended to work the bearer company with No. 12 Field Hospital when the latter arrived from England. The field establishment, therefore, at my disposal eventually were:—Three and a half field hospitals from India, half native field hospital for followers, also from India, one field hospital from England, and the bearer company above referred to, complete as regards Officers but not with N.C. Officers and men.

In consequence of the base being at Maritzburg instead of at Durban, and as arrangements were made for any sick from the transport who were unfit to proceed to the former place to be admitted to the civil hospitals at Durban, and also as it was considered best to send the sick straight from Maritzburg for embarkation, it was decided not to make use of the stationary hospital coming from England either at Durban or Pinetown as originally intended. When it arrived on October 28th it was therefore sent to Maritzburg, where its personnel was utilised in the station hospital there, setting free 10 men who were sent to Ladysmith.

In addition to the above establishment there were three nursing Sisters of the Army Nursing Service and five subsequently arrived.

Further arrivals of Officers of the Royal Army Medical Corps were only sufficient to provide for the increased number of regiments of cavalry and infantry, and to add one to the station hospital at Ladysmith and two to that at Maritzburg. The field hospitals from India arrived complete as regards personnel but not so as to ambulance transport. Each whole hospital should have 20 tongas, but before communications behind Ladysmith were cut the full number had not arrived, there were only six at Glencoe and 22 at Ladysmith for the three and a half British field hospitals with the force.

The field hospital (No. 12) from England, which arrived at Durban on October 27th, and which was sent direct to Ladysmith, was also almost complete, only three N.C. Officers and men being deficient (they were doing duty on transports coming out).

A field medical store depôt complete with personnel from India, and the stores of an advanced medical store depôt from England also arrived at Ladysmith.

In addition to the above-mentioned field hospitals, &c., the Natal Volunteers had a medical establishment sufficient to provide for that portion of the force.

The number of field hospitals with the force when it had assembled was sufficient for the ordinary field requirements of a force of the strength present, provided communication with the base remained open, but the stationary hospital at Ladysmith and the hospital at Maritzburg were deficient in personnel. These deficiencies were, however, partly met by the employment of civil medical practitioners and civil nursing Sisters (of whom a register had been kept) at Maritzburg on my arrival there, and subsequently at Ladysmith when it was seen they would be necessary.

The ultimatum from the Government of the Transvaal having been received on October 10th immediate steps were taken to clear the stationary hospital at Ladysmith, and for this purpose the hospital train and an ordinary train were sent up on the 11th, they brought to Maritzburg the whole of the sick, about 140. Arrangements were also made to send by returning transports to Cape Town a number of invalids at Maritzburg waiting to be sent to England, and also any more men not likely to be fit for service, and to extend the hospital at Maritzburg by taking over all the barrack huts there.

On October 11th I proceeded to Ladysmith with Sir G. White and staff

On the following day No. 18 British Field Hospital was sent to Glencoe as there was only a field hospital then there.

On October 14th No. 11 British Field Hospital, half No. 69 Native Field Hospital (for followers), and the Field Medical Store Depôt arrived from India. From the latter eight boxes of surgical dressings were got through to Glencoe and were of great value after the action there. When the force assembled at Ladysmith it was first located in and around the hut camp, and by taking over several of the barrack huts, as an addition to the hospital, accommodation was made for a large number of sick and wounded. A few days subsequently, however (October 18th), it became necessary to vacate the hut camp, so the hospitals had to be established in the town, where the number of buildings of any size was very limited. The town hall, two churches, and a large room in the convent, supplemented by marquees, were utilised for the stationary hospital, and the field hospitals were encamped on the adjoining ground. Subsequently the Dutch Church, with tents pitched near it, was utilised as a hospital for the Boer wounded (115) brought in after the battle of Elandslaagte. By these means and by rapidly transferring the wounded as far as possible to Maritzburg in the hospital train, provision was easily made for the large numbers of wounded admitted to hospital after the actions of October 21st, 24th, and 30th; 191, 91, and 234 respectively, in addition to the Boer wounded above referred to. Well fitted operating rooms, in which numerous operations were performed, were established, the churches, &c., were fitted with all necessary equipment, and the general arrangements for the care of the wounded were then most satisfactory, though when the Dundee column arrived on October 26th, having left its field hospitals behind with the wounded, the proportion of field hospitals to the increased force at Ladysmith was much reduced.

When it was anticipated that communications would be cut large supplies of surgical dressings were got up from the stock at Maritzburg, and by purchase from Durban, and the stock of drugs, &c., in the local chemists' stores was examined and found to be large.

As far as practicable the hospital personnel also was increased by employing civil medical practitioners (six) and lady nurses. At the commencement of the siege there were present one superintendent and four nursing Sisters, Army Nursing Service, 11 civil nursing Sisters employed by me, and 11 Sisters with the Natal Volunteer force. Five more nurses were subsequently obtained from the civil camp at Intombi.

Ample medical arrangements were therefore made for an investment for such a period as was then anticipated. The Army Service Corps also got in as large a supply of medical comforts as I believe was practicable, though a sufficiency of tinned milk was not available owing to the transport which brought the supply from England for the force, having gone to Cape Town instead of to Durban, as was intended when it left England. For the actions outside Ladysmith of October 21st, 24th, and 30th the following arrangements were made: on 21st (Elandslaagte) only a small force (about 900) went out in the morning and with it went a lightly equipped section of No. 24 British Field Hospital with some dandies. Later on in the day when other troops went out and the action commenced, more help was sent by train, all the dandies available being sent in trucks. The hospital train was also sent and made two journeys back with wounded during the night, so that although the action did not end until dark, almost all our wounded were brought in by early morning. The Boer wounded were brought in during the next day.

For the action of the 24th a light section from each of the two field hospitals (with all the dandies, ambulances, and tongas), accompanied the force, and half the hospital train went out and brought in the wounded that afternoon.

For the action of the 30th the following were the arrangements: no wheeled transport being allowed with the column (consisting of the Royal Irish Fusiliers, Gloucester Regiment, and No. 10 Mountain Battery), medical and surgical panniers, &c., were sent out on pack mules. Each of the other columns was accompanied by the greater part of the personnel of a field hospital with such equipment as was considered necessary for the action, and all the ambulances, tongas, and dandies available.

In the evening when it was known that the first-mentioned column had surrendered, a relief party of Medical Officers and orderlies, with medical and surgical panniers, medical comforts, cooking utensils, &c., on pack mules went out and rendered aid to the wounded during the night; at daylight ambulances went out and brought in all the wounded, except those taken by the Boers to Pretoria. With the exception of a very few wounded from the extreme right of our line (who were cared for by our Medical Officers in a farmhouse for the night) all the wounded of the other two columns were brought into Ladysmith on the day of the action.

Up to the time of commencement of the siege all arrangements had been very satisfactory, but soon these were to be upset. On November 3rd the enemy having mounted long range guns which could shell the town, it was seen that if the Boers persisted in shelling it as they did that day, it would not be possible to maintain the hospitals where they were without serious loss of life among the patients. As the civil population were also exposed to this shell fire, and were anxious that some steps should be taken to enable them to escape from having to submit to it, representations were made to the Commandant-General of the Boer army that he was shelling the wounded and civilians. As a result of the correspondence it was agreed that a portion of ground near Intombi Spruit, about four and a half miles from Ladysmith, should be set apart for a hospital and for a camp for civilians, that all the sick and wounded then in Ladysmith should be sent to that hospital, and that a train should run daily for the purpose of conveying sick and wounded and supplies to the camp. This decision was arrived at late on the evening of the 4th, and it was stipulated that the move should be completed by midnight of the 5th. Arrangements had therefore to be made to in one day establish a large camp hospital, send out and pitch its tents (sufficient of which could only be made available by sending those then occupied by the wounded), equip it with supplies of all sorts, and transfer to it all the wounded then in Ladysmith. This number was unexpectedly largely increased, on the evening of the 4th, by the Boers having sent in 94 of the wounded Officers and men who had been left at Dundee. With these wounded, the personnel of the one and a half field hospitals which had been with the Glencoe column arrived, except a small number left behind for the care of some severely wounded Officers and men unfit to move to Dundee. These hospitals, however, arrived with only one or two medical panniers each, a few tents, one ambulance, and six tongas; they had brought the whole of their equipment with them to the place of derailing, but this was then taken from them by the Boers.

For this treatment and accommodation of the sick and wounded* in the camp hospital at Intombi the following arrangements were made:—The whole of the personnel of the stationary hospital, including the civilian practitioners and all the nursing Sisters present, and the equipment of this hospital, were sent out; also the field hospital which had arrived from England, the personnel of the half field hospital from Glencoe, and a portion of the hospital and equipment of the Volunteer force. Lieut.-Colonel Mapleton, R.A.M.C., who with Major Westcott, R.A.M.C., had arrived a few days previously to be Principal Medical Officer and Secretary respectively of the infantry division of the force (which infantry division was not reformed after the death of Major-General Symons), were also sent out to superintend the whole camp hospital.

The establishment, accommodation, and equipment thus provided was enough to start with, but as more and more sick and wounded went out, extra tentage, equipment, and personnel were required. The former was provided by repairing marquees and other tents then in store, but which were more or less unfit for use when the camp was formed, and eventually by taking from the troops tents which became available as these troops were placed under shelters in the defence trenches. Equipment was provided from that in barrack stores, by utilising that in the hut camp, by making mattresses, &c., out of materials purchased in the town (they were all made by the personnel of the field hospitals from India), and by purchase of such various articles as could be obtained in the shops; but even by these means

* 251 were sent out on November 5th.

great difficulties had to be contended with to keep pace with the increasing requirements, as the sick list rapidly increased. The personnel as regards Medical Officers were sufficient for a considerable time, but that of the other members of a camp hospital was not so. It was at first supplemented by volunteer sick attendants obtained from the European residents in the camp for civilians, and by a gang of native labourers, also from that camp, for the various works connected with the sanitation, water supply, washing, &c., of the hospital. For some time it was possible with this personnel to carry on the hospital, but when the number of serious cases of enteric fever, dysentery, &c., became very great, the volunteer aid obtained from the civil camp was not sufficient to meet the requirements; consequently, resort was made to payment of these persons. This produced some extra assistance from that camp, but the number available was limited and not sufficient. Extra sick attendants were provided by denuding the bearer company of nearly all its personnel, and civilians were as far as possible obtained in Ladysmith, and sent out on the same terms as those obtained from the civil camp. Even by these means a sufficient number for the increasing requirements could not be made available, and consequently soldiers who had been in hospital, but had recovered, had to be kept in camp to attend on their comrades. Medical Officers were sent out, as far as practicable, by taking those with the bearer companies (except one) and also from the field hospitals, but owing to deaths and illness among the Medical Officers of the force, this means of adding to the number at Intombi was limited. The services of two doctors who were serving in the ranks of the Imperial Light Horse were also obtained. As regards death and illness among Medical Officers, I may here mention that of the 46 Officers Royal Army Medical Corps and two Officers Indian Medical Service present with the force at Ladysmith on October 30th, one died of wounds, three of enteric fever, and one of dysentery. In addition, 10 had severe attacks of enteric fever, and 12 others were incapacitated, in many instances for long periods, by attacks of other forms of fever or dysentery—facts which show what a strain was thrown on those who remained fit for duty.

In addition to the difficulties to be overcome in connection with the Intombi Hospital, others had to be contended with in Ladysmith. When the sick and wounded in hospital on November 5th were transferred to Intombi, it also became necessary to vacate the ground used by the field hospitals for their camps, as this place was much exposed to shell fire. At first the Town Hall and churches were used by two of these hospitals, and a third was established in tents in a locality convenient to a brigade of the force, and in as sheltered a position as possible. As, however, more long-range guns were mounted by the enemy, the buildings in the town, especially the Town Hall, became more and more subjected to shell fire. The latter was struck twice (on November 22nd and 30th) by shells, and consequently it was decided to vacate these buildings on December 1st, and establish the field hospitals in tents in a locality sheltered from the enemy's fire. Such ground was very limited, and became more so when wet weather set in. The sick rate at the same time increased, and it became necessary to treat more and more cases in the field hospitals, as it would have been impossible to provide for all at Intombi. The churches, supplemented by tents pitched out of view of the enemy (who shelled any tents pitched where they could be seen), had therefore again to be utilised, in addition to the sheltered localities above referred to. Having to scatter the sick thus over buildings and tents in various localities necessarily added to the labours of the field hospital establishment, as it is much easier to provide for the attendance of a number of sick when collected together than when scattered.

As the number in hospital eventually increased to 2,500, while a large number of others were receiving daily treatment in their regimental lines, it is evident that the strain thrown on the Medical Service of the Ladysmith force was very great indeed, but in spite of the privations and hardships of the siege, and towards the end, the great scarcity of nourishment suitable for cases of enteric fever and dysentery, the mortality among such cases was by no means as high as might have been expected. Every effort possible was made to prevent the outbreak or spread of enteric fever and dysentery, by attention as far as practicable to the general sanitary condition of the camps,

town, &c., but with the large number of animals collected together in a confined area and with insufficient labour, it was impossible to keep the whole area of the defences in such condition as would exist in peace time.

As regards the supply of water for drinking purposes, a part of the river above the town and as far as possible free from liability to contamination, was selected for this purpose. Here the Berkefeld filters were at first grouped together, and the water filtered through them was distributed to the various corps. Subsequently the filters were distributed to the various brigades, who arranged for the filtration being carried out in their own lines. Owing to the muddy condition of the river water, filtration through the Berkefeld filters was very difficult, as the candles quickly became choked. At first alum, to precipitate the mud, was used, but this was only to a slight extent effective; subsequently a satisfactory plan of straining the water through sheets was adopted.

A spring, which gave clear water, and which was said to have always been used by the townspeople, was also used for a time, but as it became evident that this "spring" was only contaminated surface water containing an excess of chlorides, its use was discontinued. Resort was then made to distillation, the engineer officer with the Naval Brigade ingeniously converting a railway engine into a distilling apparatus, which was used as long as fuel was available.

From almost the commencement of the siege an extra supply of coal was (on my recommendation) issued for the purpose of boiling all drinking water, and the importance of drinking only boiled water was enjoined on all concerned. It will be seen that the severe outbreak of enteric fever which occurred was not from want of precautions being taken. In my opinion the spread of the disease was largely through the agency of flies, which were so numerous that it was not possible to keep them off one's food when eating. The enormous swarms of flies were no doubt to a considerable extent due to the number of animals present with the force; it was impossible to cart all the litter to any distance from the camps, and it was often impossible for days, owing to heavy rains, to thoroughly destroy it by burning. As regards dysentery, in addition to the above precautions regarding the water supply, endeavours were made to prevent scurvy influencing the disease; all the vinegar in the town was, on my recommendation, purchased, and was issued when the supply of limejuice was exhausted. It apparently was of considerable benefit, but undoubtedly towards the end of the siege, in several cases of dysentery, a fatal issue was due to a scorbutic condition of the patient.

APPENDIX II.

MEDICAL REPORT ON THE CAMPAIGN IN NATAL, 1899-1900, BY SURGEON-GENERAL SIR T. J. GALLWEY, K.C.M.G., C.B.

Summary of Arrangements.

When the Boer Ultimatum was delivered, the forces in Natal were chiefly distributed between Dundee and Ladysmith, there being only a small body of troops south of the Tugela.

After the investment of Ladysmith, the remaining force was equivalent to about two and a half battalions, and the only hospital was that at Pietermaritzburg, which, in ordinary times, has room for 250 patients.

General Sir Redvers Buller, soon after his arrival at the Cape, determined to divert part of his force to Natal, and the headquarters of the 2nd Division, under Lieut.-General Sir F. Clery, arrived at Durban on November 15th, 1899.

The 2nd Division was followed by the 5th and 6th Brigades, and the force made up with artillery and mounted troops.

As the troops arrived they were pushed to the front, and the brigades gradually constituted complete with their field medical units.

At this stage, therefore, the field medical arrangements were almost complete, but there was a great lack of hospitals on the lines of communication.

In view of the proximity of the enemy, the Station Hospital, Maritzburg, had been moved from Fort Napier to the college, where there was room for only 70 beds in the buildings, but for a large number of marquees in the grounds. When, through the arrival of troops, a Boer descent on the capital was no longer to be feared, the hospital was moved back to the fort, and preliminary arrangements for its subsequent extension made.

When General Buller reached Natal, he directed that 800 spare beds should be prepared and available at an early date, and all were required for the wounded from Colenso.

There was in ordnance charge the equipment of a general hospital, and with this, supplemented by local purchase, a large number of beds could be made up in the barracks in the fort.

The difficulty was personnel, and this could only be obtained by detaching 25 N.C. Officers and men, Royal Army Medical Corps, from each beaer company. These men were replaced by men from the general depôt, waiting there to rejoin their corps in Ladysmith.

With the Royal Army Medical Corps thus obtained, and the employment of such civil surgeons and nurses as were available locally, over 1,000 beds were quickly got together.

At the end of November the force was pushed forward to Frere, where the concentration of the Natal Army was carried out, and No. 4 Stationary Hospital, which had meanwhile arrived, was established there, and increased to 300 beds.

As it was anticipated that the casualties in the impending attempt to force the passage of the Tugela would be great, and it was thought probable that the battle might be fought at a distance from the railway, the sanction of the General Officer Commanding was obtained for the enlistment of a corps of stretcher bearers from the European refugees who crowded the towns of Natal, and to supplement it by a corps of Indians, raised by the Public Works Department from among the indentured coolies employed on the plantations of the colony. By these means it was also hoped in some measure to relieve the trained personnel of the Royal Army Medical Corps from the exhausting labour involved in carrying wounded, and free them for nursing work in the field hospitals.

Early in November a base depôt of medical stores had been established in Durban, and from it was organised an advanced depôt that accompanied the field army throughout the campaign.

In October, with the assistance of the Natal Government railways, an ordinary passenger train was converted to ambulance purposes, in November a second and similar train was fitted out, while in March the "Princess Christian's" hospital train arrived in time to greatly facilitate the removal of the sick and wounded from Ladysmith.

The development of the campaign in Natal, precluded the evacuation of the sick and wounded to the Cape, and a transport was consequently fitted up at Durban as a hospital, this being the readiest means of relieving the pressure and meeting the lack of medical personnel. This ship was followed by others, till a fleet of six was got together and a fortnightly service to England inaugurated.

The early difficulties of the campaign were the provision of hospital accommodation on the line of communications, and it was only by the adoption of expedients such as that just mentioned that the pressure was met.

It cannot be too strenuously urged that the supply of hospitals on the line of communication is as important as the presence of the recognised medical units with the field army.* As such hospitals take some time to establish in working order, they should precede and not follow the army.†

In January the force was increased by the arrival of the 5th Division, and No. 4 General Hospital arrived and was established at Mooi River, a high and salubrious site within easy access of the front. Its accommodation was increased from 520 to 920 beds.

Natal
Volunteer
Ambulance
Corps.

Indian
ambulance
corps.

Medical
store
depôts.

Ambulance
trains.

Hospital
ships.

Early
difficulties.

Arrival of
5th Divi-
sion and
No. 4
General
Hospital.

* Yes. This is a fact that it is of the first importance to recollect.—R.B.

† Yes, certainly they should.—R.B.

Flank
march to
Springfield.

At this stage, as it was determined to move the force by way of Springfield, it became necessary to modify the existing medical arrangements. It was accordingly resolved to take with the force a hospital liberally supplied with all the essentials of a general hospital, and equipped with beds on a modified scale.

No. 4
Stationary
Hospital.

No. 4 Stationary Hospital was selected and provided with the extra gear necessary, its place at railhead being taken by No. 1 Stationary Hospital, the equipment of which we had found in Maritzburg on our arrival, but for which it was only now possible to improvise a staff. No. 4 Stationary Hospital was encamped at Spearmans, and as the casualties at Spion Kop and Vaal Krantz grew, it was temporarily enlarged by the tentage of two battalions.

Evacuation from Spearmans to Frere was carried out by returning ox wagons and ambulances, while the serious cases were carried on stretchers the whole way back by the two locally raised ambulance corps.

Battles near
Pieters.

During the last stage of the operations for the relief of Ladysmith the evacuation of the field hospitals was much simplified by proximity to the railway, but with the heavy and continuous fighting involved, the provision of a sufficiency of beds on the lines of communication became difficult.

The existing hospitals were enlarged and more ships provided, but before we entered Ladysmith there were 4,500 patients in General Buller's hospitals, a number that strained the accommodation to the utmost.

Relief of
Ladysmith.

On the relief of Ladysmith there were 2,000 sick and wounded in the garrison, and at least another 2,000 should have been in hospital, while it was anticipated that the numbers of sick among the relieving troops would be very largely augmented by the exposure they had endured, and the insanitary conditions in which they had lived for the preceding fortnight while occupying Boer positions.

The problem of the medical relief of the garrison was therefore complex, and beset with difficulties. Our line of communication hospitals were full, the removal of the sick from Ladysmith and the release of the over-worked staff urgent, and all the while the sick list in both the relieving and relieved forces was growing rapidly.

Medical
relief of
Ladysmith
garrison.

The removal of the sick from the Intombi Hospital was most urgent, but this could not even be begun until the hospitals further down the line were cleared by transferring cases to England in transports and hospital ships.

A convalescent depôt was also established at Mooi River for 50 Officers and 1,500 men to assist in this. Before railway communication was restored, 400 serious cases were removed to No. 4 Stationary Hospital, then at Chieveley, the patients being carried across the Tugela by hand, and as soon as traffic was reopened evacuation proceeded rapidly. Meanwhile the field hospitals of the Ladysmith garrison were concentrated, and a large hospital opened as a temporary measure in the Ladysmith barrack huts.

No. 1 Stationary Hospital was moved to Modder Spruit, to assist the field hospitals in providing for the relieving force and prevent the necessity of sending their sick into Ladysmith.

The army about this time was reorganised, and the Ladysmith Field Hospitals being required with their brigades, were replaced in the Tin Camp by a general hospital of 1,000 beds, which was speedily improvised. This hospital was merely intended as an expedient pending the completion of a large hut hospital which had been sanctioned at Howick.

In March No. 7 General Hospital arrived and was established at Estcourt in time to assist in the medical relief of Ladysmith. As in the case of No. 4 General Hospital, its accommodation was increased to 920 beds.

Despite all that had been done, the sick accumulated in the field hospitals and at Modder Spruit, and until substantial relief had been obtained down the line, little assistance could be afforded the field army. By the end of April, before the army was again on the move, the strain on the field hospitals was lessened, and the stress of the medical campaign at an end.

As the army moved northward the two stationary hospitals were pushed forward to Charlestown and Standerton, and No. 14 General Hospital, on its arrival from England, was established at Newcastle.

Disband-
ment of
N.V.A.C.

The local ambulance corps were disbanded in February and March. This was necessary in the case of the Natal Volunteer Ambulance Corps to allow

of such a reorganisation as would permit its Officers and the 25 N.C. Officers and men serving with each Royal Army Medical Corps bearer company, rejoining their battalions. A corps of Europeans, called the Imperial Bearer Corps was formed and 100 men attached to each regular bearer company.

Imperial
Bearer
Corps.

At the same time a corps called the Imperial Hospital Corps was raised for duty in line of communication hospitals. These men were required in order to release regimental orderlies, replace civil attendants, form a permanent staff for the hospital ships, and supplement the inadequate Royal Army Medical Corps personnel available.

Imperial
Hospital
Corps.

The principles that guided the medical strategy of the campaign in Natal were chiefly :— Principles.

- (1) To have large and efficient hospitals spread along the line of communications. Hospitals were not placed so near the front as to be too much in evidence, and they were spread along the lines in order to take the fullest advantage of local supplies, such as milk, &c., and not interfere with one another in this respect.
 - (2) To minimise the movement of hospitals on the line of communications when once established. This rule was absolute as regards general hospitals, and the stationary hospitals which developed into small general hospitals were moved as seldom as possible. The movement of a general hospital, once it is established, means the loss of its services for a period of some five or six weeks.
 - (3) To minimise the movements of patients as much as possible, the normal procedure being to move patients twice only, from field to line of communication hospitals, and from line of communications to depôts or when necessary to invalid them to ships.
 - (4) To assist the line of communication hospitals by the maintenance of a large convalescent depôt on a healthy and invigorating site, removed from the temptations of a garrison town. A special dietary was authorised for this depôt. Eventually all discharges from hospitals on lines of communication were sent to this depôt to be re-equipped before rejoining their units.*
 - (5) To provide such a number of hospital ships as enabled the transfer of invalids to England to be carried out systematically, and according to programme, on known dates.
- Invaliding in the early part of the campaign was carefully guarded in order to keep up the fighting strength of the army, but later this was impossible owing to overwhelming numbers, and patients were sent to England in transports to make room in hospitals.†
- (6) When the army left the railway and the evacuation of patients was likely to be difficult and even doubtful, an adequate hospital, well equipped and staffed with nurses, accompanied the army to meet the large casualty list expected and to provide for serious cases.
 - (7) The inability of the bearer companies to deal with large numbers of wounded rapidly was recognised and met by raising special corps of carriers.‡
 - (8) It was arranged that field hospitals should carry sufficient reserves of medical comforts to render them independent in this respect for many days, and Medical Officers in charge were provided with imprest accounts and empowered to make local purchases, such as of milk, eggs, &c., whenever possible.
 - (9) The large number of bearers, and the almost unlimited supply of stretchers available, simplified the medical dispositions in action by enabling the field hospitals to remain at places convenient for the transfer of sick and wounded towards the base. Their presence was also of immense assistance to the bearer companies,

* This answered very well, and I should recommend its adoption by regulations. It relieves the hospital staff, and on the whole the convalescents are better looked after and more readily brought back to the colours.—R.B.

† I had to do this, but I believe on the whole they did better during the journey home and out again than they would have in hospital in Natal.—R.B.

‡ Of this, see later.—R.B.

and I was seldom under any anxiety as to the clearing of the field of wounded men.

- (10) The transport for all medical units was provided at the beginning of the campaign, and remained with them throughout, unless when a hospital became stationary for a time when, on my initiative, it was lent to the director of transport as a temporary measure. I am not in favour of medical transport being unalienable.*
- (11) Unless tents and equipment cannot be brought up, buildings such as are generally available in towns and villages, should not be used for hospital purposes, as no staff is strong enough to bear the subdivision this entails, such houses are often insanitary, and sick and wounded do much better, and are better looked after in camp than is possible in scattered buildings. If buildings must be utilised, churches and public buildings are to be preferred to private houses.

General Remarks.

It will now be convenient to deal more in detail with the medical arrangements, but before doing so, I would premise that some of the suggestions made are put forward tentatively, as subjects of debate which deserve to be threshed out departmentally.

Our organisation has been accused of lack of elasticity, and as being fettered by red tape, but a system that bore the strain of the unexpected change of base involved in the sending of an army to Natal where no preparations had been made for them, and the local army medical resources were almost entirely absorbed in besieged Ladysmith, and where a battle of magnitude was fought within a month of the arrival of the pioneers of the army, is neither inelastic nor hide-bound. In proof of this it is only necessary to state that when the battle of Colenso was fought there was no general hospital in Natal, and that the wounded were collected from the field and comfortably housed in hospitals improvised for the occasion, with a rapidity, and, I think, success, unusual in war.

Field Army.

Regimental
arrange-
ments.

In some instances the place of the Royal Army Medical Corps Officer in charge of a unit was taken by a civil surgeon or an assistant surgeon Indian Subordinate Medical Department, but Royal Army Medical Corps Officers should be employed whenever possible.

Sanitation.

The duties of the Medical Officer in charge of a unit are sufficiently obvious, and do not call for special comment, except that the prevention of avoidable disease in an army depends on the manner in which the sanitary duties of the unit are carried out. In this work the co-operation of the Commanding Officer, and the assistance of the Quartermaster and Company Officers are essential to success.†

The only satisfactory sanitation on service is the regimental sanitation, and this principle was borne in mind in drawing up the simple suggestions embodied in Enclosure I. The Principal Medical Officer Division is the connecting link. In large camps and occupation of towns a special Sanitary Officer should be appointed.

Filters.

Berkefeld filters were to have been supplied to units in the proportion of one per company, but very few battalions had their full complement, and it is doubtful how far those supplied were satisfactory. Ordinary South African water clogs the candle very quickly, and when these filters cannot be frequently and thoroughly sterilised, their efficiency, in a bacterial sense, is not above suspicion.

Medical
and
surgical
equipment.

The medical equipment supplied to units was sufficient and satisfactory. The surgical haversack should be large and roomy, and it might be simplified. It should contain iodoform, morphia, dressings, and a flask of brandy.

* I agree. Medical transport should be, like all other, regimental transport.—R.B.

† The fact is we are in danger of forgetting that when we had A.Q.M.G.'s and D.A.Q.M.G.'s with an army, they did work which is essential but now sometimes overlooked.—R.B.

This proved most satisfactory, and cannot be improved upon. The elimination of the jaconet has been suggested, but if soldiers are taught only to use this in wet weather it might well be left as it is.

First field dressing.

The present proportion of stretchers and bearers is sufficient. The number of bearers per stretcher need not be increased, as regimental bearers should not carry patients long distances.

Regimental stretchers and bearers.

It was ruled that regimental stretcher bearers were to bear the brassard instead of the stretcher bearer armlet which the enemy did not understand. The "S.B." armlet does not, of course, neutralise the wearer, and his protection from capture is a matter of grace. The Geneva badge, on the other hand, affords absolute protection, and no one who is liable to use arms against the enemy should wear it, so that its adoption by regimental bearers implies that these men can only be employed throughout the campaign as non-combatants.

Brassards and stretcher bearer armlets.

Being unable to supply field hospitals or bearer companies to the mounted brigades in the early part of the campaign, it was arranged, in order to guard against hardship, to supply each regiment with an ambulance. This worked so well that it was continued after field hospitals were provided, and I am clearly of opinion that, considering the nature of cavalry work, it should always form a part of the regimental transport.

Ambulances for cavalry units.

The field service ration, as issued, was ample and satisfactory. The troops always received full rations and frequently fresh meat and bread. After a period of specially arduous service an endeavour was always made while the troops were resting to issue fresh bread and meat and vegetables, such as onions. The benefit to men who had been living for days on "Bully" beef and biscuit was noteworthy.

Rations.

Khaki drill was used during the hot season, and serge substituted with the approach of the cold weather, but in a climate where the hot is the wet season, a light, durable serge would be the most satisfactory form of clothing.

Clothing.

"Warm British coats" were issued to the irregular corps in lieu of great coats, and in many cases to regulars.

These coats are most comfortable to march in, and a coat of this description with an apron or kilt of waterproof that might be used as a ground sheet, is worthy of consideration as a possible substitute for the present great coat on service. Warm underclothing was supplied in abundance by friends at home, and at all times the army was well clothed.*

The bearer company, as at present constituted by regulation, is a waste of trained Royal Army Medical Corps personnel much required elsewhere. At the very beginning of the campaign it was found necessary to withdraw 25 N.C. Officers and men from each company to assist in staffing the large hospital being formed at Maritzburg. The men withdrawn were replaced by regimental orderlies, but it was felt that with their limited number of stretchers and bearers, the company would still be unable to cope with even a moderate number of wounded within a reasonable period of time.

Bearer companies' personnel.

All the experience of the present campaign has emphasised this anticipation, and in the future the personnel of the company must be largely increased by the inclusion of a larger number of bearers—men who have been taught to carry a stretcher, and need not know more than that, and the application of a first field dressing. A bearer company should consist of a nucleus of Royal Army Medical Corps N.C. Officers and men; the former to carry out their usual duties and the latter to act as number ones of stretcher detachments, wagon orderlies, &c.†

The number of bearers to a stretcher should not be less than six and the number of stretchers to a company about 20. This with the nucleus just mentioned would raise the establishment to about 130, 100 of whom would be mere carriers, perhaps locally enlisted as was possible in Natal, but preferably raised from the Militia or its Reserve, the Volunteer Medical Staff Corps, or such organisations as the St. John Ambulance Brigade. The Militia or Volunteers would probably be best, from their knowledge of

* I think this as a substitute for great coat will deserve consideration.—R.B.

† I entirely agree with this. We want the help of our R.A.M.C. for hospitals, and there is no difficulty if a small nucleus of trained men is given in improvising the personnel of bearer companies.—R.B.

elementary drill, and men could readily be obtained from regiments not called up for service.

In some campaigns Indian coolies might with advantage be employed.

The bearer companies should be Officered as at present.

Equipment.

The existing equipment is satisfactory, but the number of "antiseptic cases" should be larger, the contents increased, and the boxes of lighter make as they appear to be unnecessarily strong at present.

Ambulances.

There is a universal opinion, medical and military, that our ambulance wagons are not satisfactory, and a suitable vehicle for ambulance work in war has yet, I believe, to be found. The problem is beset with difficulties, and I regret that I have no suggestion to offer towards its solution except that the offer of a substantial prize for a design fulfilling certain specified conditions might be successful.

With cavalry brigades?

I have purposely omitted to refer to the organisation or necessity for bearer companies with cavalry brigades, as our experience in Natal was not such as enabled me to form any definite opinion on the subject.

Local ambulance corps.
Natal Volunteer Ambulance Corps.

In view of the inadequacy of our bearer companies to deal with the large number of wounded in an action such as was to be anticipated, a special corps was very hurriedly raised just before the passage of the Tugela was attempted. It was also thought that the action might be fought at a distance from the railway, and that special arrangements might be necessary to bring back the wounded to it.

To meet this emergency the corps was raised as carriers, and although it was not intended at first to employ them in front of the field hospitals, they were actually employed in clearing the field of the wounded.

It was at first intended to raise 1,200 men, but the establishment was almost at once increased to 1,800 although that number was never reached.

The corps was divided into four companies, each attached to a brigade, to each of which were attached two Officers from regiments, and a bare nucleus of regimental N.C. Officers to act as quartermaster-sergeants, cooks, &c.

There was also one leader in each section of 25, elected by the men from among their fellows, and these leaders were specially paid 10s. a day, the men receiving 5s. as in other Imperial irregular corps. The corps was recruited from the European refugees from the Transvaal.*

Indian Ambulance Corps.

The European carriers were supplemented by a corps of Indians called the "Indian Ambulance Corps" raised and organised by the Public Works Department of the colony from indentured coolies lent by the employers of such labour.

This corps numbered 600 to 800 men, and was under the control of two officials of the Public Works Department, who were assisted in their duties by native gangers. The pay of the men was between £3 and £4 a month, and was specially arranged for by the Public Works Department. This corps was intended to work from railhead to a point where they met the wounded being brought in by the European bearers.

The European corps was only disbanded after the relief of Ladysmith, during which period it took a conspicuous part in all the actions fought. At Colenso, with their assistance, the field was cleared of 800 wounded before dark. At Spion Kop, Colonel Allin, Principal Medical Officer of the force engaged, reported that without their assistance the wounded could not all have been brought in for days, as owing to the difficult and hilly nature of the ground, the use of ambulances in the second line was impossible.

In the series of actions near Pieter's Hill, besides carrying wounded to the dressing stations and hospitals, they carried them to the trains and freed the Royal Army Medical Corps for work for which they were much required elsewhere.

Throughout, they prevented the Royal Army Medical Corps personnel from being overworked, for if an orderly has to carry a stretcher it soon tires him out and unfits him for other more important duties.

The Indian corps was called up from time to time as occasion required, and was finally disbanded in February, 1900.

* This was a makeshift at a moment of great difficulty, and I think in result proved worth the money.—R.B.

The field hospital as at present constituted is a thoroughly mobile and efficient organisation. The personnel is sufficient for ordinary work, but there is no margin for casualties, and in Natal these could not be met, owing to the short-handed condition of the Royal Army Medical Corps.

Field hospitals.

The regulated issue was on the whole satisfactory, but one antiseptic case was found altogether insufficient for a field hospital and four were supplied to each.

Medical and surgical equipment.

A special box of splints in addition to the regulation fracture box, should be supplied to field hospitals.

The field ration of course formed the basis of the hospital dietary. Fresh meat, bread, and onions were supplied whenever possible, and where many wounded had to be dealt with, Medical Officers in charge were empowered to overdraw rations, so that at all times a plentiful supply of hot stew was available for wounded men as they arrived. The importance of such a provision for men who are much exhausted, and have been without food for many hours, cannot be exaggerated.* In cases where solid food is not contra-indicated, the mere supply of beef tea or stimulant is a mockery to men who require a good meal.

Dietary.

Each hospital, from the time the army left the railway in January, carried an extra reserve of medical comforts (1,000 lbs.), room for which in the wagons was obtained by substituting single for double fly tents.† This reserve practically rendered the hospitals independent of the supply columns (who carried 15 per cent. in addition), and the convenience of this where large numbers of wounded have to be dealt with suddenly, and it may be under circumstances that render the issue of comforts by the Army Service Corps difficult or impracticable, is obvious, and more than counterbalances the argument that such a course merely relieves the Army Service Corps of the duty. There was a sense of security, and of ability to meet emergency, afforded by this reserve that would have been absent under other circumstances.

Medical comforts.

Doubly fly tents are not essential in field hospitals in South Africa, and, as just stated they were dispensed with in January. How far a bell tent is a suitable and convenient form of shelter for a field hospital, is a question that our experience in Natal makes us regard as far from settled. This form of tent has obvious advantages, in the matter of weight and capacity, but the patients are much crowded, and access to and nursing of individuals is difficult. The Indian mountain battery single fly pal, two or more of which can be joined together so as to form a larger tent, affords comparatively easy access to and facilitates nursing, and is in my opinion, and that of many Medical Officers, to be preferred.‡

Tents.

The Indian field hospitals are supplied with such tents, but with double flies, which are of course necessary in very hot climates.

Wounded men frequently arrive at hospitals with next to nothing in the way of clothes, and a supply of clothing is essential. This supply should be in the form of pyjama suits of stout flannel, and should be supplemented by a proportion of socks, shirts, night caps, and shoes.§

Clothing.

The number of stretchers in a field hospital should be increased from eight to 20 to make beds for serious cases, and the balance of the patients provided with palliasses and pillow slips, such as are supplied to Indian hospitals. These can be stuffed with straw or dry grass, and are much appreciated by patients.||

Stretchers and palliasses.

The supply of these should not be merely sufficient for the number of patients for whom there is accommodation in the hospital; convoys take away a large number as men frequently do not bring their blankets to hospital, and it is often impossible to procure them, so that when a convoy leaves, a serious inroad is made on the hospital supply, and the deficiency cannot be made good for many days perhaps.*

Blankets and water-proof sheets.

* It cannot.—R.B.

† I think this was of great advantage.—R.B.

‡ I had a notion there was a committee a few years ago which recommended these pals. Certainly for hospitals they are better than the bell tents.—R.B.

§ This is essential.—R.B.

|| Very desirable. At present a field hospital is really no better than a dressing-station.—R.B.

¶ An important recommendation.—R.B.

Imprest
accounts.

Medical Officers in charge of hospitals, were authorised to open imprest accounts, so as to be able to buy for ready money such supplies as milk, eggs, chickens, &c. Natives and even European farmers were glad to sell their small quantities of such supplies for cash, but would not deal at all if they had to go through the usual routine of army payments.

Cows.

From time to time, as cows were captured, herds were handed over to various hospitals, only a couple of Kaffirs were required to herd and drive the cows, and the supply of fresh milk obtained was of great advantage to the seriously ill.

Arms.
Disposal of
money,
valuables,
and kits of
patients.

The disposal of the arms and kits of soldiers admitted to hospital has been a source of trouble and loss throughout the campaign. In civilised warfare it is unnecessary for a patient to retain his arms in hospital; it is undesirable in view of the Geneva Convention that they should be there or carried in neutral convoys or hospital trains, and it is suggested that a small ordnance dépôt should accompany the field force for the reception of such arms.*

Money and valuables by regulation should be passed from hospital to hospital with the patients, but this is always difficult to arrange, and often quite impracticable. As a result patients retain these on their persons, and robberies are not uncommon. If it could be arranged that money and valuables could be received by the field paymaster, and by him transmitted to the general dépôt at the base, where all corps are represented, and accounts are made up, much loss would be prevented and temptation avoided. In one case £200 in gold was found in the possession of an unconscious patient in hospital. The kits of soldiers admitted to hospital should be retained by battalions, and by them sent to the baggage master for transmission to the dépôt at the base.† At present they are sent to the field hospital, and are retained there sometimes days after the owner has gone down the line.

Field
hospitals.
Inter-
relation of
field
hospitals
and bearer
companies.

It may here be convenient to discuss the question of the inter-relation of field hospitals and bearer companies.

The general opinion of Medical Officers, among whom the subject has been much debated, is in favour of amalgamating the two units, as is done under the system in vogue in India.

The advantages of such a course are the facilities it affords for the equalisation of duties, and if our bearer companies are to continue to consist of trained Royal Army Medical Corps personnel, this argument is difficult to resist, for otherwise a personnel of nurses is only exceptionally employed. It is laid down in regulations that bearer companies are to be encamped near and assist field hospitals in various ways, but it is argued that the separation of commands renders this assistance difficult of practical application. If, however, the bearer company of the future is to consist for the most part of an untrained personnel this argument loses much of its force, and in any case the matter is one more for the exercise of the authority vested in the Senior Medical Officer of the brigade and Principal Medical Officer of the division than to call for such a change as that proposed. On one point I am quite clear that the Medical Officer in charge of a field hospital should *ipso facto* be Senior Medical Officer of the brigade,‡ and when this is ensured, and that Officer exercises his authority, there is not, and need not, be any difficulty in this regard.

Field
hospitals.

It was frequently found that a brigade had to move, and that owing to the number of sick the field hospital was temporarily immobile. In such circumstances the bearer company accompanied the force and acted as a temporary hospital. Their personnel and medical equipment was ample for this purpose, and the tentage of the company afforded shelter for the sick. This was of special advantage when troops were moving without tents and in a difficult country, for under such circumstances it was unnecessary to leave

* This is a question that ought to be thrashed out by a committee. I am in favour of attaching a small staff to each bearer company for this duty.—R.B.

† I say yes, to the field paymaster; but then there is not always a field paymaster. What then? One thing is certain, the battalion cannot and should not keep the kits. It is a difficult question, and I would recommend that the same committee that considers what to do with the arms should consider this also.—R.B.

‡ I agree.—R.B.

the bearer companies' tents behind as the gain in weight did not amount to a wagon load.

It would, of course, be possible, if the units were combined, for part of the hospital to move with the troops, but this involves the dislocation of a unit at a time when it can least afford it.

Even a bearer company such as proposed could still form an efficient hospital, for in addition to the N.C. Officers there would be sufficient men of the corps to act as orderlies.

The advantage in this respect is so practical that it should not be foregone, and the difficulties, to obviate which the change is proposed, can be avoided by making the Medical Officer in charge of the field hospital command the Royal Army Medical Corps in his brigade. One other drawback to the amalgamation remains to be mentioned, that is, that the change would involve two classes of field hospitals, a brigade hospital which would be field hospital and bearer company combined, and a divisional hospital which would remain a field hospital as at present constituted. The Principal Medical Officer of a division can now divert some of the bearer company staff not only to a brigade field hospital, but also to that with the divisional troops, if required, but it would not be so easy for him to divert part of a hospital for this purpose.*

It is impossible to have too many stretchers in the field, and the regulated supply might in the aggregate be trebled without being in any way excessive. This is especially important where large numbers of wounded men have to be dealt with, and at all times an excess is required to make good losses and breakages, to avoid the unnecessary moving of patients on arrival at their destination, and to save the time of bearers who have not to wait for their stretchers, but take away a spare one in its place.

Supply of
stretchers
in the field.

Many of the stretchers in use were of the new pattern provided with hoods and with two handles on each side, so that six bearers can be simultaneously employed.

This pattern, if a little heavier, is of advantage, and is recommended.

The number of stretchers supplied by the ordnance to the Natal Army was about 1,200, exclusive of those brought out by medical and other units.

If wounded are to be carried a long way (and no method of carriage is so little injurious) at least six bearers per stretcher are required, and in the case of the Natal Volunteer Ambulance Corps, where it was proposed to carry the cases for very long distances, 12 bearers were allowed to each stretcher.

Lines of Communication.

Before considering in detail the different subjects that come under this head, it will be convenient to sum up the work done and difficulties connected with the administration of the line of communications. General remarks.

The building up of hospitals was attended with extreme difficulty, owing to want of personnel and material, untrained staffs had to be recruited and large numbers of beds improvised.

The battle of Colenso was fought without a general hospital proper, and only one hospital of this class was provided to meet all the casualties incurred during the hard fighting on the Tugela before the relief of Ladysmith.

After Ladysmith was reached another general hospital arrived, and was, of course, of great assistance, but it was manifestly insufficient to cope with the enormous numbers of sick and wounded then in hospitals.

At the beginning of March there were, including Ladysmith, 6,500 patients in hospital, and between that time and the end of June the figures did not fall below 5,000. The official number of beds in the command was under 2,000, and it was therefore necessary to provide and staff nearly 5,000 in addition.

A good deal of the gear for these extra beds came from home, some was made or purchased locally, and all was obtained from the Ordnance Department.†

* Personally I agree with Colonel Gallwey's views as here expressed.—R.B.

† Except a few from Red Cross.—T.J.G.

The personnel was produced from home and from local resources, and, with the exception of civil surgeons and nurses, this extra staff was practically untrained in hospital duties. During the highest stress of war the provision of accommodation and the reception of patients went on concurrently, entailing enormous difficulties on the staff, and this arduous work did not cease till well on in June, when sickness began to diminish.

That there was no breakdown under these conditions, I can only attribute to the strenuous endeavour and incessant labour of an undermanned and overworked staff.*

The fact should not be concealed that the chances were all in favour of a collapse, as it was well understood that there was no hope of casualties in the Royal Army Medical Corps being filled up, owing to the undermanned state of the corps. As the casualties grew and the work increased, the prospects were gloomy in the extreme, as no form of civilian aid can easily take the place of trained personnel. As it was, the margin of trained staff became perilously low, and the large proportion of untrained assistance was a distinct element of weakness in all hospitals on the line of communications. I am not in favour of a predominance of the civilian element in these hospitals. Considering the varied sources from which the extra personnel was obtained, and the varying rates of pay and conditions they were serving under, the work was on the whole carried out in a remarkably harmonious manner.

The proportion of staff to beds in the Natal command in July was roughly as follows:—

Medical Officers	...	...	...	...	...	1 to 40.
Nurses	...	...	...	...	...	1 to 25.
Orderlies	...	...	...	...	...	1 to 3.

This was, of course, not maintained throughout, and in the early days, the available staff was not so adequate.

The eminent consulting surgeons employed were of great advantage to the army, and should always be employed in future wars.

These gentlemen should be given the honorary and temporary rank of surgeon-general, their functions should be clearly defined as professional consultants, and they should not be charged with administrative or executive duties.

I consider that consulting physicians and civilian sanitary experts are unnecessary, as the average Officer of the Royal Army Medical Corps has a larger experience of camp diseases and the practical methods for their prevention in an army on service than any specialist can have.†

The only private hospital in Natal was Mr. Moseley's "Princess Christian" hospital which was established near Durban, and was of great assistance to the Natal army.

Such hospitals are most usefully employed on the line of communications near the base, and should not as a rule be pushed to the front.‡

The following is the order of development of the hospitals on the line of communications in Natal:—

- (1) An improvised hospital was established in the Convent at Estcourt early in November. This hospital, originally of 30, was eventually increased to 130 beds.
- (2) The hospital at Maritzburg was moved from the College back to the Fort, and increased from 250 to 1,020 beds, towards the end of November, and later was still further increased.
- (3) In the beginning of December No. 4 Stationary Hospital was established at Frere, and moved to Chieveley, where it was stationed during the battle of Colenso.
- (4) In January, No. 4 General Hospital was pitched at Mooi River, and increased during February to 920 beds.

* This is true.—R.B.

† So do I. I believe the remedy for sickness, when it can humanly speaking be prevented, is to make regimental officers take more interest in sanitation.—R.B.

‡ As a rule they are too heavy to move.—R.B.

- (5) On January 10th, No. 4 Stationary Hospital was made into a mobile general hospital of 500 beds to move with the army fighting on the Tugela.
- (6) No. 1 Stationary Hospital was opened at railhead (Frere) and increased to 300 beds in January, to take the place of No. 4 Stationary.
- (7) After the relief of Ladysmith a general hospital of 1,000 beds was improvised in the barrack huts there.
- (8) No. 7 General Hospital arrived at the end of March, was sent to Estcourt, increased to 920 beds, and on April 8th and 9th received 450 patients from the field army.
- (9) No. 4 Stationary Hospital, again at Chieveley, received 400 of the worst cases from Intombi before the Colenso Railway Bridge was repaired.
- (10) At the end of May General Buller sanctioned the erection of a large hospital of 1,000 beds, half in huts, half in tents, at Howick, to take the place of the Ladysmith Hospital. This hospital was in perfect working order in July and the Ladysmith Hospital disestablished, only a small stationary hospital remaining there.
- (11) In June the Natal Volunteers established a hospital at Dundee to provide for their own force which garrisoned that town at the time.
- (12) No. 14 General Hospital arrived in July, and was stationed at Newcastle.
- (13) Nos. 1 and 4 Stationary Hospitals practically became general hospitals about this time and were stationed respectively at Charlestown and Standerton.

The advantages of stationary hospitals, which as at present constituted differ little from field hospitals except in being supplied with 100 stretchers and hospital clothing, has been questioned, and some Officers are of opinion that if field hospitals are supplied with stretchers, &c., they are unnecessary as separate organisations. But in reality they are not separate organisations, and a stationary hospital has only to leave its stretchers, &c., behind and be equipped with transport to become a field hospital.* This it was not necessary to do at any time in Natal, but on the other hand the divisional field hospitals were supplied with stretchers and converted thereby into stationary hospitals. Stationary hospitals.

All hospitals not equipped with beds should be known as "field" hospitals, as the word "stationary"† is apt to imply a degree of comfort incompatible with their service organisation. The standard of hospital comfort has been raised in this campaign, and public opinion will demand its maintenance in future wars, a demand that can only be met by the improvement of stationary hospitals. In Natal these hospitals by a natural and inevitable process of development grew into something that was hardly distinguishable from a general hospital, except that the equipment was not so complete nor the staff so large.

On the other hand the hospitals were comparatively mobile, and were moved from time to time by road or rail. This raises the question of having a hospital of say 200 beds staffed and equipped on the lines of a general hospital.‡ Such a hospital would be capable of expansion upon occasion and would not be too cumbersome to move when opportunity offered or necessity demanded. One such hospital should be allowed to each infantry division or equivalent number of troops.

General hospitals should be provided in the proportion of two to an infantry division which numbers roughly 10,000 men. This is necessary to provide for 10 per cent. of sick, and in addition beds are required for cavalry, irregulars, &c., which almost invariably are added to a force of this size. The General hospitals.

* The fact is, a field hospital should not be included in any returns of the hospital beds in the command; it is, and should be merely a receiving station.—R.B.

† For the above reason I would retain stationary hospitals, making their scale of comfort higher, but so organising them as to retain mobility if required.—R.B.

‡ Yes, this is what I want the stationary hospital to be.—R.B.

stationary hospital of 200 beds such as already suggested would provide for these.

The enlargement of general hospitals is not a course that can be recommended, as 520 beds is a unit already sufficiently large for administrative purposes.* Every addition enormously increases the difficulties of supply and supervision, and the only logical outcome is the provision of general hospitals on the scale suggested.

In Natal this would have meant about 10 general hospitals and, as it was, over 6,000 beds had to be provided by one means or another.

The general hospitals supplied or improvised were spread along the line of communications in order not to interfere with one another as regards local supplies. They were established on elevated healthy sites, with good and sufficient water supply, at a distance from towns or villages, as near the fighting force as the military situation and supplies would permit, and in close proximity to the railway. Once established they were never moved.

The official general hospitals were planned as follows: Administrative huts in the centre in the following order:—

Adminis-
trative
buildings.

- (1) Office, &c.
- (2) Operating theatre, X-ray room, and chloroform room.
- (3) Dispensary, medical store, and soiled linen store.
- (4) Linen and utensil stores.
- (4) Steward's store.
- (6) Pack store.
- (7) Kitchen and coal store.

Each of the seven buildings mentioned measured 60 by 22 by 10 feet (to eaves), and all were fitted with electric light.

The medical and surgical divisions were on either side in huts or tents, pitched in rows lettered and numbered, and with special arrangements for the isolation and aggregation of cases of enteric fever, dysentery, and other diseases. The outhouses consisted of wash houses, with bath cubicles, latrines, enclosures for the disinfection of enteric excreta, incinerator for all infective dejecta, and mortuary.

Separate outhouses were provided for the hospital staff.

Water
supply.

The water, when not obtained from the established water system of towns, was pumped up from rivers into elevated tanks and passed through automatic Pasteur-Chamberland filters before being distributed throughout the hospital in pipes.

Cooking
and
feeding.

The greatest difficulty connected with large hospitals is the cooking and feeding arrangements.

Every facility was afforded by the elaborate furnishing of kitchens with large ranges, Soyer's stoves, heating apparatus, &c.

Indian cooks were used to supplement the staff.

The distribution of food to the wards was a serious difficulty, and in future light metal wagons on wheels with a jacket chamber for hot water should be provided.

Removal of
refuse.
Drainage.

The dry-earth system was used and all filth removed in sanitary carts and buried or burnt.

In some instances water from lavatories and cook-houses was removed by cart, in others by built drains, discharging into soakage pits or on to the open veldt at a distance.

Washing.

Owing to breakdowns in washing contracts 200 native washermen were obtained from India. These men were distributed among the hospitals according to requirements, and were easily transferred from one to another to meet any extraordinary pressure.†

Personnel.

The scale of personnel allowed in war establishments is nearly sufficient for 520 beds, but does not afford a margin for casualties, and in epidemics and other abnormal conditions the staff would require to be supplemented.

* Yes, this is true; we had to enlarge them in Natal, but if possible I am sure that a general hospital restricted to 520 beds is the right thing to aim at.—R.B.

† This is a point that is overlooked. In cases where contractors are not available, special arrangements for washing are absolutely necessary.—R.B.

The following appointments should, however, be provided for:—

	N.C. Officers.	Privates.
Carpenter	—	1
Shoemaker	—	1
Tailor (hospital)	—	1
Post Office	1	1
For charge of arms	1	1 (Army Ordnance Department.)
For charge of disinfectant, sanitary carts, and incinerator	1	1
For sanitary work	1	—
For operating and X-ray rooms and surgery	—	1
Clerks for Divisional Officers	—	2
For charge of transport carts	—	1
For Officers' mess	1	1

In addition to the present clerical staff, an extra clerk is required for the Registrar's Office to keep up a special register of patients by corps, to assist in replying to the innumerable inquiries regarding the disposal of men who have passed through the hospital, for Post Office references, and to compile Army Form A 36, in accordance with paragraph 1727, King's Regulations.

The relative efficiency of the various classes of personnel may be stated in the following order:—

- (1) Royal Army Medical Corps.
- (2) { St. John Ambulance Brigade.
Militia Medical Staff Corps.
Volunteer Medical Staff Corps.
- (3) Imperial Hospital Corps.
- (4) Regimental orderlies.

The men who came from home were of good character, submissive to discipline, and after a certain amount of training became efficient orderlies. In the case of the St. John Ambulance Brigade the period of engagement (six months) was too short, as they were only available for four months in South Africa, and had just become really useful when they had to return home. These men should have been engaged for a year or until the end of the war, and although most useful in a war extending over so long a period as the present, they could never take the place of trained Royal Army Medical Corps in a short, sharp campaign.

The Imperial Hospital Corps was authorised in order to set free regimental orderlies employed, and to arrest the constant change amongst such orderlies, which was a cause of great inconvenience and dislocation of working machinery in hospitals.

In future this strain should be met by the provision of sufficient hospitals duly staffed at the outset.

Even if the Royal Army Medical Corps available at home at the beginning of a war is not sufficient, recruiting should be pushed in the hope that the recruits would be available before its close, they being sent out early and their preliminary instruction completed on the way. Any arrangement is to be preferred to perpetual change of staff.*

There was no difficulty in the matter of supplies except as regards fresh milk and eggs. The former could never be obtained in the quantities desired, the colony did not produce it, so that a proportion of tinned milk had to be used. Later large quantities of cold storage milk were obtained from Australia.

Eggs had to be imported into Natal by the Director of Supplies, the local supply being altogether inadequate to our requirements.

I am strongly in favour of the employment of female nurses in all military hospitals where they can with propriety be employed. This, as a rule will include all general and stationary hospitals and exclude field hospitals. Nursing.

* Note this.—R.B.

Nurses in time of peace should be sparingly used and then chiefly for duties of superintendence and teaching, as the necessity for continuous training of the Royal Army Medical Corps should always be borne in mind, for on these men the nursing at the front must always fall, and in our average campaigns much of that done on the lines of communication as well.

Hospitals under canvas require an exceptionally large staff of nurses and nursing orderlies as only six to eight patients can be treated in each tent. So many orderlies are required for duty at night that the ordinary service custom of detailing a medical guard for night work, from which special orderlies are posted in reliefs, had to be departed from and a special staff of orderlies told off for night duty for a week at a time. This arrangement was found to work well.

Nursing Sisters were similarly detailed for day and night duty in turns. Each Sister had the superintendence and charge of, on an average, 25 patients.

Officers' wards.

Officers in hospital received the regulation hospital diets supplemented in the usual way by extras. Special cooks accompanied each general hospital from England to cook for sick Officers, and in other hospitals good Indian cooks were provided.

Officers' servants.

Officers' servants accompanied their masters to hospital, and their assistance was found most useful.

Reception of convoys.

Sick and wounded arriving by rail were received at the special hospital sidings, which had sheltered platforms, and were provided with seats for the convenience of patients.

Wheeled-stretcher carriages, called the "McCormack-Brook Stretcher Carriage" (from the names of the inventors, Major McCormack and Lieutenant and Quartermaster Brook, R.A.M.C.) were used for the conveyance of patients from trains to hospital. These carriages, which take the regulation stretcher, are strong and stable.

They proved invaluable, and largely replaced ambulance wagons on the line of communications; 130 provided by the Ordnance Department were in use in Natal.*

Medical and surgical equipment.

The medical and surgical equipment of general hospitals should not be in the form of the regulation panniers, as this leads to reduplication of certain articles, and the provision of others in a form not well suited to such hospitals.

Ordnance equipment.

The present ordnance equipment is, generally speaking, satisfactory, but I would recommend that the following changes and modifications be carried out:—

Tents.—The hospital marquee is not suitable and should be abolished. It is hot in summer, and cold in winter; ropes and material shrink with rain, then dry and stretch; it is very liable to be blown down in strong winds, and is even in ordinary weather subject to severe wear and tear, so that it rapidly becomes unserviceable.†

It should be replaced in general hospitals either by the ordinary European Privates Indian Pattern tent, or by a similar tent specially designed to hold 25 patients. I would favour the latter, as it would greatly facilitate nursing and do away with the necessity for administrative huts except for kitchens. Special tents should be provided for outhouses, &c. The fact of the whole hospital being under canvas would make it more mobile if required to move.

Beds.—The "Lawson Tait" bed cot should be reduced in size to 6 feet 6 inches by 2 feet 6 inches, and the method in which the spring mattress is attached improved.

Mattresses should be considerably reduced in thickness when a spring cot is used.

Feather pillows should be issued in addition to hair ones.‡

Tables.—Bedside tables should be reduced in height to 2 feet, should have only one shelf, and they might be made to fold up.

Portable tables should be only 2 feet 6 inches in width.

Lamps.§—Lamps should be considerably improved as good lighting is imperative in hospital. Had it not been that the Natal Government Railways

* Everybody who saw them spoke well of them.—R.B.

† It is not a satisfactory tent.—R.B.

‡ Important.—R.B.

§ Most important.—R.B.

supplied all hospitals with electric light, we should have been in a bad way owing to the unsatisfactory nature of the lamps supplied.

Water Vessels.—Covered receptacles for holding drinking water for ward use should be provided.

Enamelled Iron versus Zinc.—All zinc utensils should be replaced by iron enamel, as the former are objectionable and difficult to keep clean.*

Rubbish Receptacles.†—Provision for the reception and removal of rubbish and filth should form part of the gear of a general hospital.

All aid societies should work through the regular military channels. The articles which may with advantage be received from them or from private individuals are pipes, tobacco, walking sticks, games, literature, pictures, cards, fruit, flowers, and furniture such as screens, easy chairs, cushions, curtains, and tablecloths. Also such articles as nightingales, pyjamas, socks, and underclothing not provided by regulation.‡ Articles of diet, extras, or equipment which can be obtained through the regular supply departments should not, as a rule, be received. They should never be permitted to supply liquor in any form. Aid societies.

To insure the proper administration of supplies provided by aid societies, it is suggested that the various societies represented at the seat of war should conjointly nominate Commissioners to be on the staff of the Principal Medical Officers and act with and through them.

Such appointments would afford the Commissioners nominated assured status in the force to which they are credited, and through them, as representing the public, should be issued orders as to the reception and distribution of gifts and rules as to visitors to military hospitals. I think the general public would more readily and willingly assent to necessary restrictions if issued through a representative nominated by themselves. From a service point of view such an appointment would prevent overlapping and undesirable competition among societies.

As already explained it was at the outset of the campaign possible to carefully guard invaliding, and only cases not likely to be fit for duty for a period of three months were sent to England. Invaliding.

After the relief of Ladysmith, when the pressure on hospitals was great, and enteric fever present in the force in epidemic form, large numbers were transferred home simply to make room in hospitals.

In all hospitals special lists were kept up to date, distinguishing between invalids for hospital ships and those for transports, so that patients were ready to move in required numbers on receipt of telegraphic instructions.

The procedure recommended in the case of invaliding to England is noted under "Returns." In the case of irregular locally-raised forces, a short statement of case and proceedings of a medical board recorded on a modification of Army Form A 45 would probably suffice.

Where such soldiers are only entitled to a gratuity, the General Officer Commanding lines of communication should be empowered to dispose of the case, only cases recommended for pension being referred home to the Chelsea Commissioners.

In October and November, 1899, two ambulance trains were fitted up in the Natal Government Railway workshops. They were ordinary passenger trains converted to this purpose, and as there are no corridor trains on this line they had only the usual carriage corridors. They were consequently makeshift arrangements, but as the journeys were short as a rule, less inconvenience than might have been anticipated resulted from this cause. Ambulance trains.

The trains carried about 70 lying down cases and a proportionately larger number (roughly double) if sitting up. They were composed of:—

- (1) One first-class coach, half for the Medical Officer in charge and half for eight sick Officers.
- (2) Two composite first-class coaches converted so as to hold 15 beds each.

* I must say I cordially endorse this. I know the enamel chips, but even then it is far preferable to the zinc, which is a relic of barbarism.—R.B.

† Important.—R.B.

‡ These recommendations are both wise and necessary, and have my cordial support.—R.B.

- (3) Three mixed first and second class coaches with moveable seats, to accommodate sitting-up or lying-down cases as required. One compartment in this was fitted up as a surgery and another as a sleeping place for four orderlies.
- (4) An ordinary truck built to contain kitchen pantry and sleeping accommodation for the cook and his assistant.
- (5) A large guard's van with store rooms at either end and space in the centre for baggage and men's kits.

Lavatories, electric light, and bells were provided in each coach. The disadvantage of these trains over and above the lack of a through corridor was that, owing to the narrowness of the doors, patients had to be transferred to a special narrow stretcher before they could be lifted into the train. The supply of rations and medical comforts was arranged along the line by wire to Railway Staff Officers, who arranged with the Army Service Corps for supplies to be in waiting. The dietary provided was excellent, and Medical Officers in charge were directed to issue comforts and extras on a liberal scale.

The following staff is suggested for a train such as the above. One Medical Officer in charge (a major or senior captain), one lieutenant or civil surgeon, one staff sergeant as chief wardmaster, one sergeant or corporal as compounder and clerk, six ward orderlies, one cook, and one assistant cook.

Nurses could not be employed owing to the construction of these trains, and where, as in Natal, the journeys are comparatively short they are not essential.

The only sanitary way of dealing with infective excreta in trains is by the provision of special buckets fitted under the closets. These should be changed, and the contents dealt with at arranged stages along the line.

A store for foul linen should also be provided, and soiled articles exchanged at stations where it could be disinfected and washed.

The "Princess Christian" train arrived from home in March, 1900. It was an excellently arranged and perfectly fitted up corridor hospital train, well suited for the longest journeys. Apart from minor internal rearrangements the only suggestions regarding it I have to make are the provision of venetians to the windows and sufficient baggage room for the kits of patients. Two nurses were employed in this train.

All ambulance trains should be painted white with conspicuous red crosses on each coach, and distinctive lights such as an illuminated window with a red cross should be arranged for use at night. Whenever possible special engines marked with the red cross should be used to prevent their capture, for at present there is nothing to prevent the enemy holding up the train and taking away the engine. The three Natal ambulance trains were continuously employed, and during the year carried about 26,000 patients, while another 4,000 sitting-up cases were carried in special or ordinary trains.

Hospital
ships.

When the field force arrived in Natal, the hospital accommodation at Durban consisted of the hospital ship "Spartan," a vessel fitted up at home and intended for the removal of sick and wounded from one colonial port to another.

The development of the campaign in Natal showed that relief of this sort would be altogether insufficient, and the deficiencies in hospital accommodation and personnel already alluded to, led to the fitting up of the transport "Lismore Castle" as an auxiliary hospital. At this period a large hospital was being hastily improvised at Maritzburg, and neither Officers, N.C. Officers, nor men of the Royal Army Medical Corps could be spared. It therefore became necessary to staff this vessel with civilians, and it may be here pointed out that a great advantage in using ships as hospitals is that the catering, &c., is provided for by the ship, and that the purely Medical Staff is all the army is called upon to arrange for.

At first the "Lismore Castle" was regarded as a ward of the Maritzburg Hospital, but, later, when other ships were fitted out and all became independent medical units, an Officer, Royal Army Medical Corps, was placed in charge, assisted by a nucleus of N.C. Officers of the corps, the nursing orderlies being provided from the ranks of the Imperial Hospital Corps.

The port of Durban fortunately afforded great facilities for the conversion

of transports for hospital purposes, and the resources were so utilised by the naval transport authorities there that the transformation was not only rapidly but perfectly carried out.

The success of the first vessel led to the "Nubia," a splendid transport, being similarly converted, and at a later period the "Orcana" and "Avoca" were prepared.

After the relief of Ladysmith the pressure on the hospitals was so great, and the necessity for evacuation so urgent, that General Buller sanctioned the addition of the ships "Dunera" and "Simla." With this splendid fleet of six vessels a fortnightly service to England was initiated and is still maintained.

The whole fleet are admirably fitted out, the wards are spacious and airy, and the appointments generally of the highest class, so that it became an easy matter to send home serious cases either sick or wounded.

The capacity of the various vessels varied, but averaged 30 Officers and 240 men, and the average staff consisted of one Officer, Royal Army Medical Corps, four civil surgeons, one Superintending Sister, Army Nursing Service, five civil nurses, three N.C. Officers and men Royal Army Medical Corps, one or two civil dispensers, and about 34 men Imperial Hospital Corps. In Enclosure 2 the particulars of each vessel are shown.

In addition to the ships locally fitted up and arranged for, the hospital ships "Princess of Wales" and "Maine" were at different times in Durban, and were of assistance not only in bringing invalids to England, but in the reception of patients from the Natal Army.

The yachts of Sir Samuel Scott and of Mr. Jesse Coope were specially fitted out and placed at my disposal by their owners, who kindly received and entertained sick and convalescent patients from the hospital ships in harbour to which they acted as tenders.

Transports were not much used in the early part of the campaign, but later, when the pressure on hospitals became excessive, it was necessary to send patients home who were not in a real sense invalids, but who were likely for some time to continue blocking the hospitals. Sick transports.

To meet this transports were specially fitted up, at first almost as completely as in the case of hospital ships, but later, as this was found to greatly restrict the accommodation, with less elaboration.

The average number carried in each transport was 11 Officers and 290 men, and the average staff supplied amounted to two civil surgeons, two nurses and 10 attendants. The staff for such vessels was engaged at Durban for the voyage only, and varied with the requirements of the different vessels employed.

This dépôt was established in Durban early in November and secured excellent accommodation in a goods shed adjoining the central railway station. Here it was in direct railway communication with the wharves and all up-country stations, so neither time was lost nor expense for transport incurred. Medical store depôts. Base dépôt.

The railway afforded special facilities, and supplies urgently demanded were despatched by first passenger train. The supplies brought out from home had to be largely supplemented by requisition on London and by local purchase. Every effort was made to anticipate requirements in time to permit of supplies being obtained from home, and local purchases were only made to meet urgent demands.

Medical officers were not, except in cases of urgency, permitted to purchase drugs locally, the Officer in charge of the dépôt being the only authorised purchasing agent. Splints, particularly of the Macintyre pattern, were made in the railway workshops and by private firms, while the "Durban Women's Patriotic League" undertook the manufacture of calico and flannel bandages, pads for splints, &c., from material supplied by the dépôt.

An ample supply of medical and surgical material has always been in hand, and there has never been any delay in meeting requisitions.

This dépôt, as representing the medical and surgical supply of the Natal Army, was directly under my orders. The personnel consisted of the Officer in charge, one quartermaster, one staff sergeant, one private, and five civilians locally employed.

Advanced
depôt.

An advanced depôt was established under a quartermaster with one sergeant and two men, at the beginning of the campaign, and was accommodated in two goods vans specially fitted up for the purpose. These vans were kept at railhead, and when the army left the railway the stores were transferred to ox wagons and accompanied the force.

This depôt was also used for the distribution of gifts of clothing, &c., received for the use of patients in the field hospitals.

General Subjects.

Medical
adminis-
tration.

The Medical Administrative Staff of the Natal Army was that originally appointed to the 2nd Division, and it so continued until May, 1900, when the forces engaged in the relief of Ladysmith and the relieved garrison were amalgamated and reorganised in four infantry divisions and three cavalry brigades, when a recasting of the medical arrangements became necessary.

Reorgani-
sation after
Ladysmith.

There were besieged in Ladysmith the three and a half Indian field hospitals, which are designed to combine field hospitals and bearer company and one British field hospital.

A complete field hospital, English or Indian, was allotted to each infantry brigade, and half an Indian field hospital to each cavalry brigade and to the divisional troops of the 4th Division. The only brigade incomplete was the 8th, which had an English field hospital and no bearer company, but as the 5th and 6th Brigades left for the Cape about this time, sufficient men of the Imperial Bearer Corps were available, with the addition of the regulation ambulances and a nucleus of Royal Army Medical Corps, to form a bearer company. The field army units were thus completed, and there remained half an Indian field hospital at disposal.

Division of
duties.

Principal Medical Officers were appointed to each division. Lieut-Colonel Allin from the 5th Division was made Principal Medical Officer of the field army, and Colonel Clery, from No. 4 General Hospital, Principal Medical Officer line of communications.

This division of duties was only effected after the organisation of the hospitals on the line of communications had been completed, and was made with the entire approval of the General Commanding, in order that I might (while remaining on the headquarter staff) inspect and supervise wherever necessary, and be the connecting link between field army and line of communications.*

I was careful (and I think the point is of importance) that when inspecting my visits were purely informal, so as never to interfere with the working of hospitals. My custom was to give no previous notice of my coming, and on arrival to visit the kitchens, stores, &c., to see the administrative work going on in its usual way. Later a proportion of the wards were seen, but not so as to interfere with their routine.

Position of
a P.M.O. of
a force.

The position of a Principal Medical Officer of a force is correctly shown in "War Establishments."

Of P.M.O.
field army.

The duties assigned to the Principal Medical Officer of the field army were general supervision of all bearer companies and field hospitals and their evacuation, as required from time to time, in communication with the Principal Medical Officer line of communications through my office.

He † was especially charged with the actual arrangements in the field in the event of an action, and he remained with headquarters to advise the General Officer Commanding on medical and sanitary matters connected with the field army.

P.M.O. line
of commu-
nications.

The Principal Medical Officer line of communications had his headquarters with the General Officer Commanding line of communications. He was responsible for the administration of all general and stationary hospitals, for invaliding to England, for the arrangements for hospital ships and

* The medical regulations are not I think clear enough on this point. The P.M.O. is an Officer of the headquarter staff, but not always *with* the headquarter staff. It is essential that he should supervise the whole, both field army and line of communications, with each of which he should have a S.M.O. as his representative.—R.B.

† "He" here means the P.M.O., or, as I prefer to call him, S.M.O., of the field army. This, in my opinion, is right arrangement.—R.B.

transports, for the working of the hospital trains, for the engagement of civil surgeons and nurses, and for any recruiting necessary for the Imperial Irregular Medical Corps, &c.

The identification of soldiers killed or wounded is, in one sense, not a medical question, but it is one that gives the Medical Service an incalculable amount of trouble in the field. The present identification ticket sewn to the skirt of a soldier's coat is most unsatisfactory, inasmuch as wounded and unconscious men are frequently brought to hospital without their coats or without the ticket. The numbers on the men's clothing would then, it might be thought, afford the necessary clue, but on service garments are frequently not marked, or insufficiently marked, and in the hospitals in Natal men have died whose identity has never been established.

It is suggested that a remedy for this might be found if each Officer and soldier wore on service a metal disc bearing a number or his name and corps. This disc should be attached to a wire or chain and worn round the neck. If this were done, means of identification (except in the exceptional instance of a man losing his head) would always be available. These discs should be collected when men are buried on the field, and in their absence it should be the duty of the chaplain or person conducting the burial to note any clue and try by every other means in his power to establish the identity of the body before interment.*

I have specially excluded from this report any reference to health statistics, as it is useless to indulge in generalities or impressions that are not backed up by detailed information.

I am glad to say that I have had very little to do with statistics throughout the campaign, as returns were only forwarded through me to the Principal Medical Officer of the army.

I consider that on service a Principal Medical Officer of an army should have nothing to do with the checking or compilation of statistics. There should be a special statistical section at the base of operations occupied solely with this duty, and thus relieve the office at headquarters of this work, and supply any information required.†

1. *Daily State*.—Enclosure 3 is a copy of a state I rendered to the General in chief command, General Officer Commanding, Lines of Communication, and Principal Medical Officer, Lines of Communication, daily. This is a very simple numerical return showing admissions, deaths and remainings, Officers and men separately, and something of this sort should take the place of the present daily state which is too complicated and when rendered is so belated as to be worthless.

The return referred to shows also the distribution of hospitals and the troops every day, as the information from each hospital is so simple that it can be rendered by telegrams. It is also important as showing at a glance, not only the numbers in hospital day by day, but where evacuation is required and where beds are available.

2. *Admission and Discharge Books*.—The admission and discharge books of hospitals are the basis of all statistics and every effort should be made to keep these records complete and accurate. The general return at the end of the campaign should be made up from these books when returned to the War Office.

3. *Weekly Returns*.—The weekly return of sick and wounded should be simplified to the utmost, and be a bare record of the week's work showing by diseases, cases admitted, transferred to or from hospitals, discharges, and deaths. The number of sick under treatment from each unit should be indicated but all reference to strengths omitted, as this information is difficult to procure and not always correct when obtained. Strengths should be obtained from the War Office at the end of the campaign.

4. *Convoy Returns*.—The New Convoy Return recently introduced is too complicated for use in the field. In Natal convoys had frequently to be made up while fighting was still going on and wounded men pouring into hospital. In such circumstances it is as much as the small clerical staff can do to make a record of admissions, and note the names of those transferred in

* A suggestion worth consideration.—R.B.

† Important.—R.B.

the admission and discharge book. Simple nominal rolls are also, owing to changes in the convoys, useless, as for example when a convoy arrives at a station and finds that all cannot go together in one train or that all cannot be accommodated in one hospital.

The only method that suggests itself is that a tally (perhaps a little larger, and with room for greater detail than the present wound tally) should be attached to each patient's identification disc if such is adopted.* Such a record would not be likely to go astray and would be a readily available source of information to everyone down the line. The medical transfer certificate would not serve this purpose. What is required is an eyelet-holed waterproof tally, protected by a little envelope into which the tally would slip.

5. *Invaliding Documents.*—Similarly in the case of invalids sent home the only document required should be a medical transfer certificate for each man (which in case of men transferred from the front should be accompanied by the tally), prepared at the time the man is approved as an invalid so as to be ready at all times in case of a sudden order to move. Rolls of men embarked should be sent from port of embarkation or first port of call to base of operations.

Men returning in sick transports as distinguished from hospital ships, should not be regarded as patients for the purpose of medical returns, except such as are admitted to hospital on board. Such cases should be entered in an admission and discharge book, and the book sent to the War Office on arrival.

It is impossible to get civil surgeons who are frequently in charge of such ships to make out returns and this should be recognised.

Casualty
office.

Some means of diminishing the clerical work in all hospitals in the field is urgently required, and it is suggested that in future a "casualty office" should be formed at the base or headquarters of the line of communications. The staff of this office might be purely civilian and a War Office clerk might be placed in charge. To this office all necessary information should be rendered and all inquiries addressed. The following quasi-medical subjects might be dealt with in such an office:—

1. Information to units as to the whereabouts of men. At present Army Form A 36 has by Queen's Regulations to be rendered weekly, in duplicate, by corps, by all hospitals. One copy goes to the general dépôt, and the other to the station commandant for despatch to the different corps concerned. With 1,000 men in hospital belonging to perhaps 100 different units the labour involved is enormous and some modification of the procedure is absolutely essential.†

What is proposed is that instead of Army Form A 36 each hospital should render to "casualty" a single nominal roll of patients distinguishing admissions, discharges to duty, convalescent dépôt, &c., transfers to and from hospital, including invalids who have left, deaths, and remainings. The names of the diseases from which patients are suffering should be given, and cases seriously ill marked on the list. It should be the business of this office to dissect these lists and furnish commanding officers with a single roll giving the fullest possible information about all men of his unit in whatever hospital they may be, and a second copy should be sent to the general dépôt. The information might be given on a form like Army Form A 36.

2. The information given above would enable "casualty" to answer all inquiries about patients and others, and relieve the staff, general and medical, and hospitals from large numbers of inquiries. At present almost every inquiry has to be circulated to all hospitals as no one has all the information necessary for a reply, and much trouble and great delay is occasioned thereby.

3. After an action lists of killed and wounded should be sent to "casualty." The procedure laid down in the medical regulations was not followed in the

* This suggestion merits consideration.—R.B.

† Something of the sort recommended in this and the following paragraphs is urgently wanted. At present a vast amount of labour is futilely wasted in trying to obtain from a corps information that it ought not to be required to have. A central office, such as is suggested here, seems to me to meet many of the known difficulties, and merits consideration.—R.B.

Natal Army, where lists were rendered by brigades, &c., to the Assistant Adjutant-General of the Force. These lists might still be made out and rendered by brigades, but it should be the duty of everyone who knows of a casualty to report it by the most direct means. This especially applies to deaths, which when they occur after an action and out of hospital are sometimes not reported at all and are very difficult to trace.

4. Lists of embarkations of all invalids should be sent to this office from port of embarkation or first port of call, and by them sent to War Office.

5. This office might also compile and send home weekly lists of Officers and men in hospital, distinguishing admissions, discharges, transfers, deaths, diseases, and name of hospital.

6. To "casualty" the names of patients dangerously ill might be reported by telegram. Such an office would relieve the staff of hospitals of much troublesome correspondence, would save a great deal of telegraphing, and would greatly simplify procedure, especially when made known through the Press at home that all information about killed, wounded, or sick could be obtained by application to this office.

Such success as attended the organisation and administration of the hospitals in Natal was dependent on the unvarying support and invaluable information given me personally on all occasions by the General Officer in chief command, upon the manner in which he was seconded by the general and departmental staffs of the line of communications and by the unstinted efforts of all ranks of the Medical Services of the Natal Army.

Conclusion.

St. George's Barracks,
January 1st, 1901.

T. J. GALLWEY, Colonel,
P.M.O., Natal Army.

ENCLOSURE 1.

Sanitary Recommendations by the Principal Medical Officer.

"Disease Kills more than Bullets."

1. Officers commanding units should, with Medical Officers in charge, impress on all Officers, N.C. Officers, and men under their command the urgent necessity of paying strict attention to sanitation in order to prevent disease, and thus keep up the fighting strength.

2. After the selection of camps, immediate steps should be taken to fix sites for latrines, urinals, kitchen and washing places, and refuse pits in order to prevent contamination of the ground, which is a fruitful source of disease.

3. The water supply should be protected by appointing places for drinking, watering animals, bathing, &c. When of doubtful character, water should (if possible) be boiled.

4. Conservancy police should be established in each unit to see that the sanitary orders are carried out.

5. Besides such a general scheme of sanitation, individual officers can do much to preserve the health of their men by attending to the following points:—

- (a) Inspection of feet, socks, and boots, and early attention to abrasions.
- (b) Changing clothes when wet, and the use of the ground sheet and flannel belt or puttee in lieu.
Helmets should be worn during the day in the hot weather, except on wet or dull days.
- (c) Prevention of early resort to the water-bottle on the march, and excessive drinking at any one time of too much water.
- (d) Cleanly and varied cooking is an important adjunct in the preservation of health. Milk should be boiled.

ENCLOSURE 2.

Name of Ship.	Date of Completion.	Staff.							Accommodation.	
		Officers, R.A.M.C.	Civil Surgeons.	Nurses, A.N.S.	Nurses, Civil.	N.C.O.'s and Men, R.A.M.C.	Dispensers, Civil.	Imperial Hospital Corps.	Officers.	N.C.O.'s and Men.
" Lisamore Castle "	4.12.99	1	4	—	5	—	1	29	20	142
" Nubia "	6.1.00	1	4	1	6	3	1	40	40	275
" Avoca "	31.1.00	1	5	1	5	4	2	40	33	260
" Orcana "	6.3.00	1	4	1	5	2	1	29	21	182
" Simla "	9.4.00	1	5	1	5	6	2	33	40	275
" Dunera "	2.5.00	1	4	1	4	3	2	35	27	284

In addition to the above, the hospital ships " Princess of Wales " and " Maine " each made one voyage from Durban to England with invalids.

ENCLOSURE 3.

Daily State of Sick in Natal Army, 21st October 1900.

Description of Hospital.	Station.	Remained.		Died.		Remaining.	
		Officers.	Men.	Officers.	Men.	Officers.	Men.
2nd Brigade Field Hospital	Half Platrand and half Paarde Kop.	2	45	—	—	2	50
4th Brigade	Heidelberg	—	61	—	1	—	60
2nd Divisional	Volksrust	5	45	—	2	2	67
7th Brigade	Spitz Kop	—	43	—	—	1	56
8th Brigade	Lydenburg	2	96	1	—	1	101
4th Divisional	"	—	40	—	—	1	53
10th Brigade	Ingogo	—	27	—	—	—	25
11th Brigade	Half Wakkerstroom and half Utrecht	2	85	—	1	2	92
5th Divisional	Dundee	—	24	—	—	—	24
No. 1 Stationary Hospital	Charlestown	10	204	—	—	6	132
No. 4	Standerton	5	165	—	—	5	165
No. 14 General Hospital	Newcastle	15	332	—	2	11	268
No. 7	Estcourt	10	492	—	3	10	489
No. 4	Mooi River	18	881	—	—	18	881
General Hospital	Howick	20	724	—	1	15	796
	Maritzburg	12	300	—	2	12	320
Stationary Hospital	Lady Smith	—	25	—	—	—	20
26th British Field Hospital	Van Reenens	—	4	—	—	—	6
Princess Christian's Hospital	Pinetown Bridge	25	76	—	—	25	76
H.S. " Lisamore Castle "	At sea	—	—	—	—	—	—
H.S. " Nubia "	Durban	5	115	—	—	5	115
H.S. " Orcana "	"	—	20	—	—	—	20
H.S. " Simla "	At sea	—	—	—	—	—	—
H.S. " Dunera "	"	—	—	—	—	—	—
H.S. " Avoca "	"	—	—	—	—	—	—
In transit	Ambulance trains	—	—	—	—	4	72
Totals		131	3,504	1	12	120	3,888

P.M.O. Army.

To Chief of Staff.

General Officer Commanding Lines of Communication.

Principal Medical Officer, Lines of Communication.

APPENDIX III.

MEDICAL EQUIPMENT.

Medical equipment of an infantry battalion—

- 2 field medical panniers (Nos. 1 and 2).
- 1 medical haversack.
- 2 surgical haversacks.
- 6 water-bottles.

Cavalry regiments—

- 1 pair surgical saddle bags (Nos. 1 and 2).
- 1 medical haversack.
- 1 surgical haversack.
- 2 water-bottles.

Artillery units the same as cavalry.

Engineers, Army Service Corps, &c., will get medical assistance from the nearest regiment.

Contents of field medical pannier No. 1 :—

Acid, boric	...	...	...	...	...	ozs.	2
Acid, Carbol. (crystals) (1 bottle)	...	...	...	...	...	"	4
Ammon. Carb., 3-gr. tablets	...	...	...	...	...	doz.	16
Brandy (3 bottles)	...	...	...	...	...	ozs.	24
Chloroform in 2-oz. tubes	...	...	...	...	...	lbs.	1
Hydrarg. Perchlor. Soloids	...	...	...	...	...	doz.	24
Ipecac. Pulv. sine Emet.	...	...	...	...	...	"	12
Mist. pro Diarrhoea	...	...	...	...	...	ozs.	8
Ol. Menth. Pip.	...	...	...	...	...	"	2
Ol. Ricini...	...	...	...	...	...	lbs.	1½
Ol. Terebinth	...	...	...	...	...	ozs.	4
Paraffin Molle (1 tin)	...	...	...	...	...	lb.	1
Pill and tablet tin	...	...	...	...	...	No.	1
Pot. Bicarb., 10-gr. tablets	...	...	...	...	...	doz.	8½
Pot. Brom., 5-gr. tablets	...	...	...	...	...	"	8
Pulv. Ipecac. Co., 5-gr. tablets...	...	...	...	...	...	"	21
Quin. Ac. Sulph., 2-gr. tablets...	...	...	...	...	...	"	92
" " 5-gr. tablets...	...	...	...	...	...	"	33
Sinapis Charta	...	...	...	...	...	boxes.	2
Sod. Bicarb., 10-gr. tablets	...	...	...	...	...	doz.	9
Sod. Salicylas, 5-gr. tablets	...	...	...	...	...	"	19
Sp. Ammon. Aromat.	...	...	...	...	...	ozs.	8
Tr. Chloroformi et Morph. Co.	...	...	...	...	...	"	6
Tr. Opii	...	...	...	...	...	"	8
Bottle, capped, chloroform, empty	...	...	...	...	...	No.	1
Gallipots, nested...	...	...	...	...	...	"	3
Labels	...	...	...	...	...	"	25
Corkscrew, folding	...	...	...	...	...	"	1
Cups (medicine and mortar)	...	...	...	...	...	"	2
Cups, with pestles, vulcanite	...	...	...	...	...	"	2
Tongue depressor	...	...	...	...	...	"	1
Gimlet	...	...	...	...	...	"	1
Instruments, surgeons', metal handle (surgical saddle bag pattern)	...	...	...	...	...	"	1
Measures, minim	...	...	...	...	...	"	3
Packthread (ball)	...	...	...	...	...	"	1
Stopper loosener...	...	...	...	...	...	"	2
Book, note-, and pencil	...	...	...	...	...	"	1

Contents of field medical pannier No. 1 (*continued*)—

Candles	No.	12
Envelopes (linen lined)	"	25
Needles, packing... ..	"	4
Paper, test-, books	"	2
Paper, writing	quire	$\frac{1}{2}$
Pellets, ink	tin	1
Pencils, camel-hair	No.	3
" blacklead	"	4
" copying ink	"	2
Pens (3 dozen)	box	1
Penholders	No.	2
Pins, safety	boxes	2
" common	paper	$\frac{1}{2}$
Tubes, test	No.	3
Bottles, ink	"	1
Field hypodermic box and case, containing	"	1
Bottle, Morph. Sol., empty	"	1
Syringe	"	1
Needles (platina, 2; steel, 1)	"	3
Morph. tablets, gr. $\frac{1}{6}$, tubes	"	3
Glass mortar, and measure, dr. 2	"	1
Wires, cleaning needles, tubes	"	1
Case, Hypoderm. and Ophthal... ..	"	1
(Contents as in present case.)		
Scissors	pair	1
Screwdriver	No.	1
Spoons, tea... ..	"	2
Sterilizer, containing	"	1
Lamps	"	2
Spirit, methylated	ozs.	18
Irrigators (2)	set	1
Lanterns, candle... ..	No.	2
Pinch cocks	"	2
Splints, Potts' ($\frac{1}{2}$ set)	"	6
Wool, double cyanide	lbs.	$1\frac{1}{2}$
Measure glasses (2-oz.) in boxwood case	No.	2
Bottle, extra, for Fd. Hypo. case	"	1
Stethoscope, binaural	"	1
Thermometers, clinical, in plated bayonet-catch cases	"	4
Tin (for wax matches, 2-oz)	"	1
Tubing, screw joints and metal nozzles for irrigators	"	2
Padlock, with 2 keys	"	1

Contents of field medical pannier No. 2 :—

Bovril, invalid (4-oz. tins)	lb.	$\frac{1}{2}$
Meat, extract of (4-oz. tins)	"	$\frac{1}{2}$
Bandages, loose woven, plain	No.	100
Prescription books (A.B. 39)	"	2
Calico, thin	yds.	4
Catgut, in carbolised tubes	tubes	1
Cloth, waterproof, black	yds.	4
Gauze, double cyanide (6 yds.)... ..	"	72
Jaconet, waterproof	"	3
Plaster, adhesive, each 10 yds. 1-inch tape, Mead's	tins	3
Plaster, adhesive, indiarubber (7-inch)	"	1
Tape, pieces of	No.	6
Tubing, drainage (Nos. 1 and 2), in aseptic solution	"	2
Wool, double cyanide (4-oz.)	lbs.	2

Contents of field medical pannier No. 2 (*continued*)—

Basins, dressing, 1 set, kidney shape, iron enamelled ...	No.	3
Bearers' dressing case, containing	"	1
Clasp knife ...	"	1
Forceps ...	"	1
Pins, common ...	"	40
" safety ...	"	24
Scissors ...	pair	1
Spatula ...	No.	1
Thread, sewing, tablet ...	"	1
Vulcanite case for sewing needles ...	"	1
Needles, sewing ...	"	6
Instruments, tooth, pouch, small (1), containing—		
Forceps, tooth ...	"	3
Splints, long, jointed, thigh, wood ...	"	1
Warmers, food (spirit lamp, Mark I) ...	"	1
Padlocks with two keys ...	"	1
Tourniquet, B.O. anchor ...	"	1

Contents of medical haversack :—

Chloroform (2 bottles) ...	ozs.	4
Mist. pro Diarrhœa ...	"	1½
Sp. Ammon. Arom. ...	"	3
Tr. Opii ...	"	3
Pill and tablet tin ...	No.	1
Catheters, olivary, Nos. 3, 6, 8, in tin case ...	"	1
Vulcanite case (1), containing—		
Needles, surgeons', plated ...	"	6
" hare-lip, plated ...	"	2
Bandages, loose woven ...	"	2
" gauze, double cyanide ...	yds.	3
Wool, double cyanide ...	ozs.	4
Pins, safety ...	No.	6
Field Hypoderm. box and case, containing	"	1
Syringe ...	"	1
Morphia solution bottle (5ss) ...	"	1
Needles (platina, 2; steel, 1) ...	"	3
Morphia tablets, ½ gr. ...	tubes	3
Wire for cleaning needles, tube of ...	No.	1
Glass mortar and measure (3ii) ...	"	1
Medicine cup and mortar (with pestle) ...	"	1
Glass, graduated (2-oz.), in boxwood case ...	"	1
Silk, twisted, fine and medium, tubes ...	"	2
Tin, wax matches (1-oz.) ...	"	1
Tourniquets, screw, small ...	"	1
" B.O. anchor ...	"	1

Contents of surgical haversack :—

Paraffin molle, tin ...	lbs.	¼
Bandages, loose woven, plain ...	No.	10
" triangular ...	"	6
Basin, kidney shape, vulcanite ...	"	1
Bearers' dressing case (1), containing—		
Clasp knife ...	"	1
Forceps ...	pair	1
Pins, common ...	No.	40
" safety ...	"	24
Scissors ...	pair	1
Spatula ...	No.	1
Thread, sewing, tablet ...	"	1
Vulcanite needle case ...	"	1
Needles, sewing ...	"	6

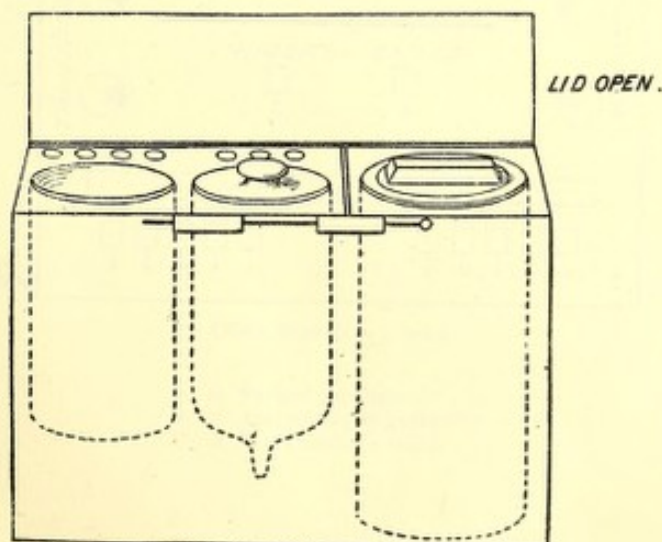
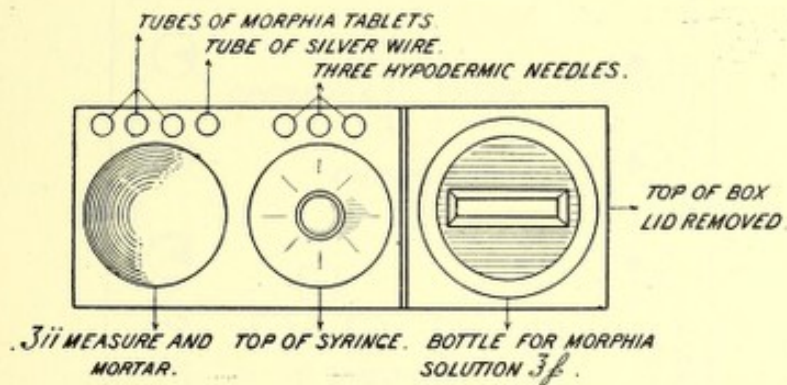
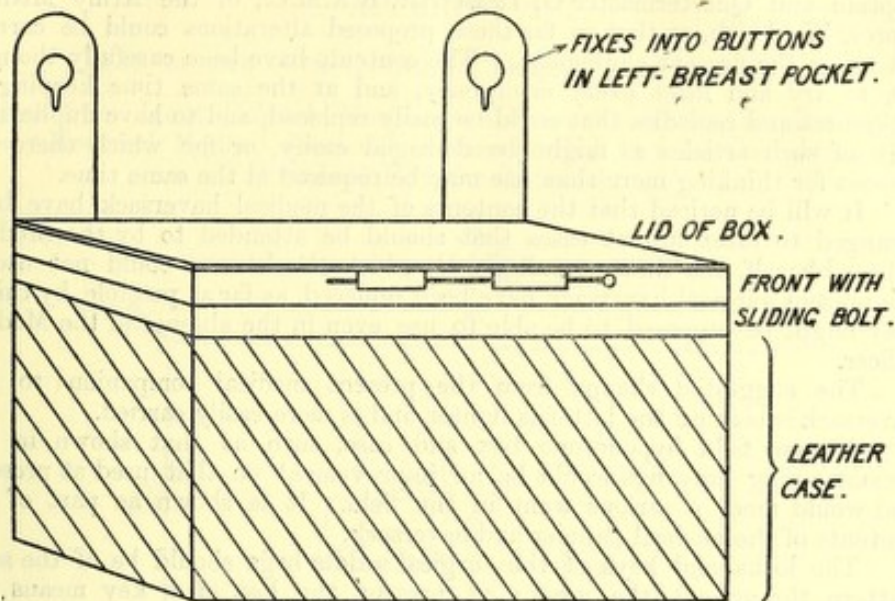
Contents of surgical haversack (*continued*)—

Gauze, double cyanide	yds.	18
Wool, " " " " " " " "	ozs.	8
Plaster, rubber, tins	No.	2
Splints, wire, arm	pairs	2
Tourniquets, screw, small	No.	2
Tin, wax matches (1-oz.)	"	1
Specification tallies, book	"	1

Contents of a pair of surgical saddle bags:—

Acid Carbol. (liquid)	ozs.	2½
Chloroform (in three bottles)	"	9
Hydrarg. Perchlor. (soloids)	No.	70
Sp. Ammon. Aromat.	ozs.	2
Brandy	"	8
Antipyrine, 5-gr. tablets	No.	30
Pulv. Ipecac. Co., 5-gr. tablets... ..	"	60
Pot. Brom., 5-gr. tablets	"	70
Pot. Permang., 2-gr. tablets	"	100
Quin. Ac. Sulph., 5-gr. tablets	"	280
" " 2-gr. " " " " " "	"	348
In leather case { Catgut in Carbol. solution, tubes... ..	"	2
" " { Silk ligatures in aseptic solution, tubes	"	2
Minim measure in case	"	1
Pins, safety	box	1
Plaster, rubber, tins	No.	3
Glass measure (2-oz.) in boxwood case... ..	"	1
Splints, wire, arm	pairs	4
Wool, double cyanide	lbs.	1½
Surgeons' instrument case	No.	1
Paraffin molle, tin	lb.	¼
Vulcanite case, containing—		
Surgeons' needles	No.	6
Hare-lip pins	"	2
Bandages, loose woven, plain	"	24
" triangular	"	6
Bearers' case, containing—		
Clasp knife	"	1
Forceps	pair	1
Pins, common	No.	40
" safety... ..	"	24
Scissors	pair	1
Spatula	No.	1
Thread, sewing, tablet	"	1
Needles, sewing (in vulcanite case)	"	6
Field hypodermic box and case, containing—		
Syringe	"	1
Bottle for morphia solution (3ss)	"	1
Needles (platina, 2; steel, 1)	"	3
Morphia tablets, ½-gr. tubes	"	3
Wire for cleaning needles	tube	1
Glass measure and mortar (3ii)	No.	1
Christia	yd.	1
Gauze, double cyanide	yds.	24
Spoons, tea	No.	2
Liebig's, tin	"	1
Tin for wax matches (1 oz.)	"	1
Tin for candles (4)	"	1
Candle lamp	"	1

Illustration of Suggested Field Hypodermic Box and Case.



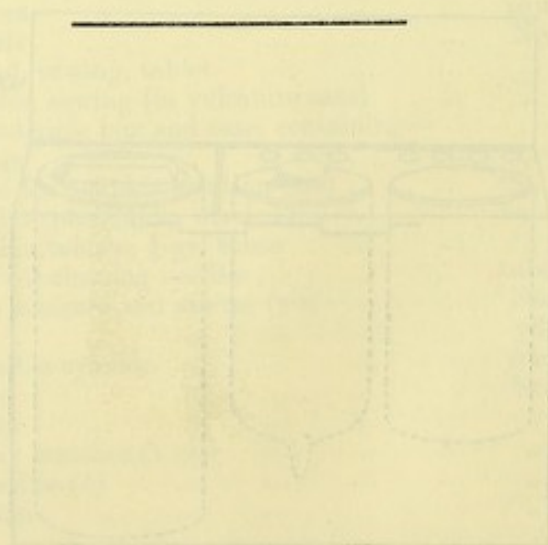
The present field medical panniers (Nos. 1 and 2), the surgical haversack and suggested medical haversack (instead of the medical companion), and the surgical saddle bags have been carefully fitted with the above contents by Captain and Quartermaster G. T. Merritt, R.A.M.C., of the Army Medical Stores, Woolwich, so that so far these proposed alterations could be carried out using the present equipment. The contents have been carefully thought out to try and meet every emergency, and at the same time keeping to appliances and remedies that could be easily replaced, and to have duplication only of such articles as might be damaged easily, or for which there are reasons for thinking more than one may be required at the same time.

It will be noticed that the contents of the medical haversack have been arranged to meet urgent cases that should be attended to by the Medical Officer himself, and that several articles which the bearers could not use in the present surgical haversack have been replaced, as far as possible, by things they might be supposed to be able to use even in the absence of the Medical Officer.

The suggested change from the present medical companion to the haversack is because the latter is lighter and is more easily carried.

A new field hypodermic box and case, such as that shown in the accompanying drawings would be an improvement on that used at present, and would meet a serious want in the field. It is shown as part of the contents of the medical pannier and haversack.

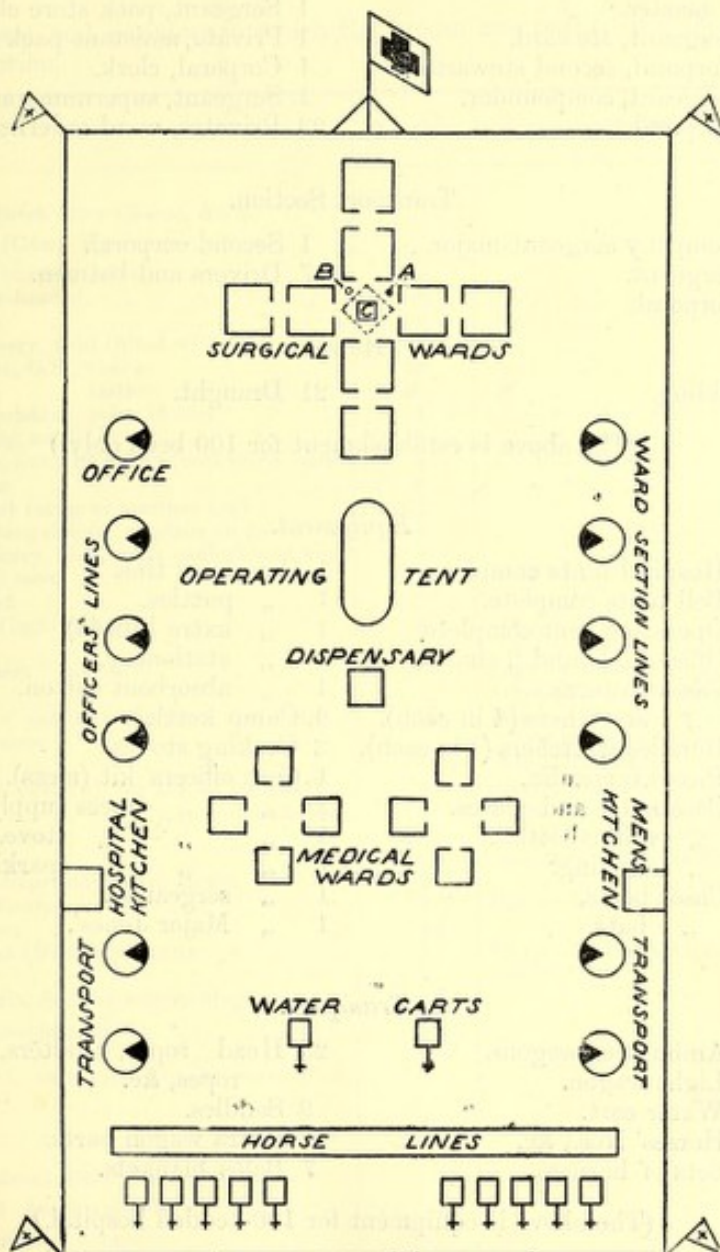
The locks and keys of the surgical saddle bags should be of the same pattern throughout the army; at present the loss of a key means the unavoidable cutting of the leather strap, as there are no two keys alike, even of the two bags of the same set.



APPENDIX IV.

PLAN OF THE 10TH CANADIAN FIELD HOSPITAL IN CAMP.

Taken from Lieut.-Colonel Worthington's account of the hospital sent to the "Montreal Medical Journal." Recommended to take the place of the Divisional F.H. for British Army.



(Scale, 20 yards = 1 inch.)

- A. = Forbes' steriliser.
- B. = Acetylene gas generator.
- C. = Wardmaster's table.

Establishment.

Field Hospital Staff.

- | | |
|------------------------------|----------------|
| 1 Lieutenant-colonel. | 1 Captain. |
| 1 Major (second in command). | 2 Lieutenants. |

Ward Section.

- | | |
|-----------------------------------|--|
| (a) 1 W.O., chief wardmaster. | 1 Sergeant, cook. |
| 1 Sergeant, assistant wardmaster. | 1 Corporal, second cook. |
| 1 Sergeant, steward. | 1 Sergeant, pack store clerk. |
| 1 Corporal, second steward. | 1 Private, assistant pack store clerk. |
| 1 Sergeant, compounder. | 1 Corporal, clerk. |
| 1 Corporal, „ „ | 1 Sergeant, supernumerary. |
| | 23 Privates, ward orderlies. |

Transport Section.

- | | |
|-------------------------------|------------------------|
| (b) 1 Company sergeant-major. | 1 Second corporal. |
| 1 Sergeant. | 17 Drivers and batmen. |
| 1 Corporal. | |

Horses.

- | | |
|-----------|-------------|
| 8 Riding. | 21 Draught. |
|-----------|-------------|

(The above is establishment for 100 beds only.)

Equipment.

- | | |
|-----------------------------------|------------------------------|
| 16 Hospital tents complete. | 1 Case mess tins. |
| 11 Bell tents complete. | 1 „ putties. |
| 1 Operating tent complete. | 1 „ extra kits (4). |
| 1 Office table and 2 chairs. | 1 „ stationery. |
| 2 Cases lanterns. | 1 „ absorbent cotton. |
| 2 „ stretchers (4 in each). | 9 Camp kettles. |
| 2 Bundles stretchers (4 in each). | 2 Cooking stoves. |
| 8 Pieces tarpaulin. | 1 Case officers' kit (mess). |
| 1 Case mugs and plates. | 1 „ „ mess supply. |
| 1 „ water-bottles. | 1 „ „ „ stove. |
| 1 „ clothing. | 1 „ „ „ sparklets. |
| 2 Cases boots. | 1 „ sergeants'. |
| 2 „ hats. | 1 „ Major Jones'. |

Transport.

- | | |
|----------------------|--|
| 9 Ambulance wagons. | 29 Head ropes, halters, picketing ropes, &c. |
| 1 Light wagon. | 9 Saddles. |
| 1 Water-cart. | 7 Extra wagon parts. |
| 30 Horses' Nos., &c. | 7 Bales blankets. |
| 11 Sets of harness. | |

(The above is equipment for 100-bedded hospital.)

APPENDIX V.

MOBILIZATION STORE TABLE FOR "FIELD AMBULANCE."

(Capable of accommodating 160 sick, in substitution of the printed Army Form G 1098/41, Mobilization Store Table, Field Army.)

All these stores are to be divided equally into four parts so that each of the four sections has the same amount of stores, and is therefore self-contained.

The cases and panniers in which the stores are packed will be the same for each section.

Articles.	Number.	Remarks.
<i>Woolwich Store Charge, No. 2.</i>		
(Camp Equipment.)		
Axes, felling, curved, helve	4	
" hammer-headed	4	
Boxes, candle	4	
" stationery, field (filled with forms)	4	
Buckets, water, G.S., canvas	48	
" " leather	40	
Flags, distinguishing, poles 16 feet	4	
Hooks, reaping, small	4	
Kettles, camp, oval, 12 quarts (nest of 8) nests	4	
Lamps, candle	8	
Lanterns, hand (same as marines use)	32	
" distinguishing, to place on pole	4	
Panniers, grocery, G.S., with padlock and key, fitted for 40 men.	4	
Sheets, ground	200	
Stools, camp (light pattern)	8	
Tables, camp	4	
Tents ("Hubert" pattern)	16	Each tent holds 10 patients comfortably on stretchers.
" (Indian pattern), for use for latrine purposes.	8	Two small light pattern tents for patients using night-stools; only for fever cases.
" (Indian pattern); for use for mortuary ...	4	Small; used only for this purpose.
" " " disinfecting purposes.	4	Where linen used for E.F. patients could be put in tubs with sol. of mercury for disinfecting.
Bell tents, 1 dispensary, 1 for store	2	Per section.
" Officers... ..	1	
" men	4	
Operating tent (British pattern)	1	To go with the headquarter section only.
(Tools, &c., for entrenching.)		
Axes, pick, complete, 6½ lbs.	4	
" " 2½ lbs.	4	
Shovels, light, cast steel (to be carried on wagon side).	4	
Spades, N.P.	4	
<i>Woolwich Store Charge, No. 3.</i>		
(Field Ambulance Equipment.)		
Basins, enamelled, 14-inch	56	
" " 7½-inch	28	
" " soup, 6-inch	160	
Matches, packets	4	
Filters, "Berkefeld," complete	4	This is included in U.S. sterilising chest.
Cups, spitting, paper	200	
Cans, oil, 5½ pints... ..	4	
Feeders, enamelled	56	
Flags, distinguishing, hospital	4	
" " pendant	24	
" union, 6 feet by 3 feet	4	
" poles, 5 feet... ..	24	

Articles.	Number.	Remarks.
<i>Woolwich Store Charge, No. 3—continued.</i>		
Kettles, enamelled	4	
Flannel, white yds.	12	
Ladles, cooks', F.H.	8	
Case lamp, acetylene, outfit, complete	4	
Lines, clothes, hospital, 40 yards	4	
Panniers, medical comfort	4	
" mess chest	4	
" G.S., No. 1	4	
" G.S., No. 2	4	
" lavatory or washing	4	
" hospital, equipment A... ..	4	
" " " B... ..	4	
" " " C... ..	4	
" " clothing 1	4	
" " " 2	4	
Pannikins, pint, enamelled	160	
Pans, bed, enamelled	80	
" frying, 9-inch enamelled	8	
Plates, dinner, enamelled... ..	160	
Pots, chamber, enamelled	32	
" tea, enamelled	8	
Saucepans, F.H. (nest of 8) nests	4	
Stools, close, F.H.P. (nest of 12) "Hubert" pattern nests	4	
Stoves, portable	4	
Stretchers, light pattern for all purposes as used in S.A. War by Canadian Hospital, weight 16 lbs.	80	
Tables, operating, folding	4	
Tow, carbolized lbs.	400	
Drums, oil, 6 gallons	4	
<i>Woolwich Store Charge, No. 4.</i>		
(Carts and Wagons.)		
Ambulances	—	
Carts, forage	4	See remarks re Canadian pattern.
" water tank		
Wagons, G.S.	—	
<i>Woolwich Store Charge No. 5.</i>		
(Harness and Saddlery.)		
To be arranged by transport officials.		
<i>Woolwich Store Charge, Nos. 7, 8, 10, and 18.</i>		
(Tools, Artificers', and Labourers'.)		
Cases, tools, carpenters', complete ... cases	4	
Housewife, complete, large	4	
Jacks, lifting (jack de luxe, made by a Bir- mingham firm), to be carried on wagon.	4	
<i>Woolwich Store Charge, No. 11.</i>		
(Oil, Paint, &c.)		
Dubbing, carried on wagon box lbs.	16	This is required for hospital use, and any required for harness, saddlery, wagons, &c., to be added to this amount by transport officials.
Oil for lamps, in drum galls.	24	
Soap, soft lbs.	40	
" ivory tablets	20	
" yellow lbs.	200	
<i>Woolwich Store Charge, No. 25.</i>		
(Barrack and Hospital Stores, Part I.)		
Brushes, scrubbing, hand	8	
" nail, washing	32	
Clippers, hair pairs	8	
Forks, dinner	160	
" flesh... ..	4	

Articles.	Number.	Remarks.
<i>Woolwich Store Charge, No. 25—continued.</i>		
Funnels, tin, $\frac{1}{2}$ -pint	8	
Knives, dinner	160	
Paper, latrine lbs.	16	
Scissors, lamp pairs	4	
Sponges, bath	48	
Spoons, table	160	
Urinals, enamelled	56	
Warmers, stomach, india-rubber	8	
Trays, dressing	28	
<i>Woolwich Store Charge, No. 26.</i>		
(Barrack and Hospital Stores, Part II.)		
Balances, spring, 80 lbs.	4	
Implement, butchers', cases complete ... cases	4	
Sterilizers, "Forbes," complete	4	
<i>Woolwich Store Charge, No. 27.</i>		
(Textile Stores, Bedding, &c.)		
Blankets, G.S.	160	
" hospital, khaki coloured, to distinguish from ordinary blankets.	320	Possibly half the number khaki coloured; to be used for E.F. cases, dysentery, &c., and kept for this purpose, and finally to be destroyed.
Cases, mattress	160	
" bolster	160	
Netting, mosquito yards	200	
Suits, sleeping, khaki coloured flannel ... suits	80	Possibly half or more khaki colour; to be used as long as serviceable and then destroyed (for E.F. cases).
Shirts, hospital	80	
Socks, G.S. pairs	80	
Slippers, hospital	80	
Suits, bleached, light cotton clothing ... suits	48	For use of orderlies attending E.F. patients.
Towels, hand, hospital	80	
" bath	40	

Description of articles.	Number allowed on old equipment scale.	Number now proposed to be allowed.	Remarks.
Lamps, hand, F.H.	8	—	
" operating	2	—	
Lamp, acetylene, case complete cases	—	4	
Ladles, cook's, F.H.	4	8	
Mattress, operating table	2	—	
Mills, coffee, F.H.	2	—	
Machine, mincing, small	2	—	
Oil in drum gallons	3	24	
Pans, bed, enamelled	8	80	
" frying, 9-inch, enamelled	4	8	
Plates, dinner, enamelled	100	160	
Pots, chamber, "	8	32	
" tea, enamelled	4	8	
Pannikins, pint, enamelled	60	160	
Panniers, canteen	16	32	To be called by different names than before. 8 panniers to a section.
" grocery	2	4	
" cooking, mess chest	—	4	
" medical comfort	4	4	
Shovels, light, cast steel	6	4	
" universal	8	—	
Spades, N.P.	8	4	
Stools, camp	4	8	
" close, F.H. (nest of 6) nests	2	4	To be 12 nested " Hubert" pattern.
Scoops, flour, $\frac{1}{2}$ pint	4	—	
Scissors, hair-cutting pairs	4	—	
" lamp	2	4	
Shapes, pudding	12	—	
Skewers sets	6	—	
Straps, bed	10	—	
Saw, cross-cut, in leather case	1	—	
Stretchers	8	80	To be of the pattern as used in Canadian Hospital.
Sheets, ground	100	200	
Saucepans, F.H. (nests of 8) nests	2	4	
Stoves, portable	2	4	
Soap, ivory, tablets	—	20	
Sponges, bath	4	48	
Spoons, table	100	160	
Steriliser, " Forbes," complete	—	4	
Shirts, hospital	—	80	
Socks, G.S. pairs	—	80	
Suits, sleeping, khaki coloured suits	—	80	
" bleached, cotton duck	—	48	
Slippers, hospital pairs	—	80	
Tents, complete	40	16	To be of " Hubert" pattern.
" operating	1	—	
" Indian pattern	—	16	
Tables, camp	2	4	
" operating, folding	2	4	
Tow, carbolised lbs.	40	400	
Towels, hand, hospital	48	80	
" bath	—	40	
Urinals, zinc	4	—	
" enamelled	—	56	
Warmers, stomach, india-rubber	4	8	

APPENDIX VII.

EQUIPMENT—ONE SECTION OF A FIELD AMBULANCE.

This list includes the whole of the equipment, medical and surgical, and ordnance for *one section* of a "Field Ambulance," to accommodate 40 patients.

This equipment, it is proposed, should be carried by each section in its own separate transport vehicles.

Medical and Surgical Equipment—

		No.	Weight lbs.
* {	United States regimental medical chest ...	1	135
	" " " surgical " ...	1	95
	" " " steriliser " ...	1	100
	† " " " supplementary dressing chest ...	1	100
	" " " reserve surgical dressings ...	1	100
	" " " supplementary medical chest ...	1	135
	Field medical companion (British pattern) ...	2	24
	Surgical haversacks (British pattern) ...	4	24
	Water bottles ...	4	8
	Fracture box... ...	1	50

Field Ambulance Chest (Mess Chest)—

	No.	Weight lbs. oz.
Balances, spring (80 lbs.) ...	1	3 5
Forks, flesh ...	1	0 6
‡ Implements, butcher's, case, complete ...	1	58 0
Kettles, enamelled ...	1	1 6
Lamps, candle ...	1	1 0
Ladles, cook's, F.H....	2	1 0
Pans, frying, enamelled, 9-inch ...	2	2 0
Saucepans, F.H., nest of 8 ...	nests 1	20 0
Stoves, portable ...	No. 1	90 0

Approximate weight ... 177 lbs.

Kettles, camp, oval, 12 quarts, nest of 8 (nest 1) will be carried as a separate package.

Field Ambulance Pannier No. 1 (Equipment)—

Cups, spitting, paper ...	No.	50
Pans, bed, enamelled ...	"	20
Pots, chamber ...	"	8
Tow, carbolised ...	lbs.	50
Paper, latrine ...	"	4
Urinals, enamelled ...	No.	8
Trays, dressing ...	"	7
Lanterns, hand (mariner's) ...	"	8

* For contents of these, see "United States Medical Manual," 1902. These weights are approximate.

† The contents of this chest to be the same as that adopted by Lieut.-Colonel Worthington, late Officer Commanding 10th Canadian Field Hospital. The articles included in this chest will be found enumerated in Appendix XIII.

‡ Implements, butcher's {	Case, wood ...	No.	1
	Sheet, ground (unserviceable) ...	"	1
	Chopper, meat ...	"	1
	Hooks, butcher's, dressing ...	"	6
	Knives, butcher's { cutting	"	1
	flaying, large...	"	1
	Steel, butcher's ...	"	1
	Steelyard, 56 lbs. ...	"	1

(Weight, 58 lbs.)

Field Ambulance Pannier No. 2 (Equipment)—

Basins, soup, 6-inch	...	...	...	...	No.	40
Funnels, tin, $\frac{1}{2}$ pint	...	...	...	...	"	2
Forks, dinner	...	...	...	...	"	40
Feeders, enamelled	...	...	...	...	"	14
Knives, dinner	...	...	...	...	"	40
Pannikins, pint, enamelled	...	...	...	...	"	40
Pots, enamelled, tea	...	...	...	...	"	2
Plates, dinner, enamelled	...	...	...	...	"	40
Spoons, table	...	...	...	...	"	40

Field Ambulance Pannier No. 3 (Equipment)—

Clippers, hair	...	...	...	...	pairs	2
Housewife, large	...	...	...	...	No.	1
Lamp, candle	...	...	...	...	"	1
" distinguishing	...	...	...	...	"	1
Scissors, lamp	...	...	...	...	pair	1
*Flag, distinguishing, hospital, with pole, 16 feet	...	...	...	...	No.	1
Flags, pendant	...	...	...	...	"	6
Flag, union, 6' x 3'	...	...	...	...	"	1
Flag poles, 5 feet	...	...	...	...	"	6
†Tools, carpenter's, small set (weight 12 lbs.)	...	...	...	...	set	1
Matches	...	...	...	...	packet	1

Field Ambulance Pannier No. 4 (G.S.)—

Axe, felling, curved, helve	...	...	...	...	No.	1
" hammer-headed	...	...	...	...	"	1
Box, candle	...	...	...	...	"	1
Axe, pick, complete, 6 $\frac{1}{2}$ lbs.	...	...	...	...	"	1
" " " 2 $\frac{3}{4}$ "	...	...	...	...	"	1
Can, oil, 5 $\frac{1}{2}$ pints	...	...	...	...	"	1
Hook, reaping	...	...	...	...	"	1
Spade, N.P.	...	...	...	...	"	1
Line, clothes, hospital, 40 yards	...	...	...	...	"	1
Stools, camp	...	...	...	...	"	2
Table	...	...	...	...	"	1

Field Ambulance Pannier No. 5 (Lavatory)—

Brushes, scrubbing, hand	...	...	...	...	No.	2
" nail, washing	...	...	...	...	"	8
Sponges, bath	...	...	...	...	"	12
Towels, hand, hospital	...	...	...	...	"	20
" bath	...	...	...	...	"	10
Soap, ivory	...	...	...	...	tablets	20
Basins, enamelled, 14-inch	...	...	...	...	No.	14
" " 7 $\frac{1}{2}$ -inch	...	...	...	...	"	7
Buckets, canvas, G.S.	...	...	...	...	"	12

* The masthead light is considered better than the crossbar lights. These never worked satisfactorily, and the lights invariably blew out.

† Contents of carpenter's case.

Chisel, socket, 1-inch	...	...	...	...	No.	1
Driver, screw, G.S., 6-inch	...	...	...	...	"	1
Gimlets, common	...	...	...	...	"	3
Hammer, riveting	...	...	...	...	"	1
Nails and screws, assorted	...	...	...	...	lbs.	7
Pincers, carpenter's	...	...	...	...	pair	1
Saw, hand, 24-inch	...	...	...	...	No.	1
" set, hand	...	...	...	...	"	1
" " pit	...	...	...	...	"	1
Files, saw, 3-square (set 1)	...	...	...	...	set	1

Field Ambulance Pannier No. 6 (Medical Comforts)—

Arrowroot	...	...	...	...	...	lbs.	6
Bovril (4-oz. tins)	...	...	...	...	...	"	10
Meat extract (4-oz. tins)	...	...	...	...	...	"	8
Chocolate, sugared (in foil-covered cakes)	...	...	...	...	...	"	4½
Brandy	...	...	...	...	...	bottles	6
Milk, condensed (St. Charles brand of milk, as used by Canadian Hospital in South African War)	...	...	...	...	...	tins	20
Valentine's meat juice	...	...	...	...	...	bottles	6
Gelatine	...	...	...	...	...	lbs.	3
Sago	...	...	...	...	...	lb.	1
Whisky	...	...	...	...	...	bottles	6
Rolled oats (or equivalent)	...	...	...	...	...	lbs.	10
Mustard	...	...	...	...	...	ozs.	8
Pepper	...	...	...	...	...	"	8
Salt	...	...	...	...	...	lb.	1
Sugar	...	...	...	...	...	lbs.	6
Tea	...	...	...	...	...	"	3
Candles	...	...	...	...	...	"	2
Matches	...	...	...	...	...	boxes	2
Soap, ivory	...	...	...	...	...	tablet	1
Spirits of wine	...	...	...	...	...	pints	3
Warmers, food (spirit lamp)	...	...	...	...	...	No.	2
Tin, spirits of wine (3-pint)	...	...	...	...	...	"	1
Canisters, tin, screw-cupped containers	...	...	...	...	...	"	7
Caster, pepper	...	...	...	...	...	"	1
Corkscrews, folding	...	...	...	...	...	"	2
Forks, dinner	...	...	...	...	...	"	2
Knives, dinner	...	...	...	...	...	"	2
" opening tin	...	...	...	...	...	"	4
Measures, F.H. (nest of 4)	...	...	...	...	...	nest	1
Pot, mustard	...	...	...	...	...	"	1
Dredgers, salt	...	...	...	...	...	"	2

The alterations in this Pannier as formerly used are:—

<i>Added.</i>							
Arrowroot	...	...	...	...	...	lbs.	4½
Bovril	...	...	...	...	...	"	7
Meat extract	...	...	...	...	...	"	2
Chocolate, sugared	...	...	...	...	...	"	4½
Brandy	...	...	...	...	...	bottles	5
Milk, condensed	...	...	...	...	...	tins	4
Tea	...	...	...	...	...	lb.	1
Whisky	...	...	...	...	...	bottles	4
Soap, ivory	...	...	...	...	...	tablet	1
Spirits of wine	...	...	...	...	...	pints	1½
Tin, spirits of wine (1½ pints)	...	...	...	...	...	No.	1
Warmer, food (spirit lamp)	...	...	...	...	...	"	1
Valentine's meat juice	...	...	...	...	...	bottles	6
Gelatine	...	...	...	...	...	lbs.	3
Rolled oats (or equivalent)	...	...	...	...	...	"	10
Screw-topped container for canisters	...	...	...	...	...	...	...
<i>Omitted.</i>							
Port wine (not required)	...	...	...	...	...	bottle	1
Soap, bar...	...	...	...	...	...	bar	½

Field Ambulance Pannier No. 7 (Clothing)—I. :—

Cases, mattress	...	...	...	...	No.	40
" bolster slip	...	...	...	...	"	40
Suits, sleeping, khaki-coloured	...	...	...	...	suits	20
Shirts, hospital	...	...	...	...	No.	20
Socks, G.S.	...	...	...	...	pairs	20

Field Ambulance Pannier No. 8 (Clothing)—II. :—

Flannel, white	yards	3
Suits, bleached, cotton, duck, clothing	suits	12
Slippers, hospital	pairs	20
Netting, mosquito	yards	50

List of Articles which are not Carried in Panniers, but as separate packages.

(For each Section.)

Weight, lbs. (about)	Articles.	Number.	Remarks.
70	Boxes, stationery, filled	1	
50	Buckets, leather (to be strapped on wagons)	10	
58	Kettles, camp (nest of 4) 12 quarts nests	2	
35	Panniers, grocery, for 40 men	1	
150	Sheets, ground	50	In one bundle.
724	Tents, "Hubert" pattern	4	
360	" Indian pattern (for latrine, mortuary, and disinfecting purposes).	4	Small light pattern; two for infectious patients using night stools, one for mortuary, and one for disinfecting soiled linen in.
360	Tents, circular, single linen, for office tent	4	
5	Shovels, light, cast steel (to be carried on wagon sides).	1	
30	Case, lamp, acetylene, outfit complete ...	1	Pattern supplied to regimental hospital, U.S. Army.
58	Stools, close, "Hubert" pattern	8	
320	Stretchers, Canadian pattern	20	
100	Tow, carbolised lbs.	100	In case.
23	Table, operating, folding	1	
60	Drum, oil, 6 gallons, filled	1	
6	Jack, lifting (to be carried in wagon box)	1	
4	Dubbing (to be carried in wagon box) lbs.	4	
10	Soap, soft " " " lbs.	10	
50	" yellow, in case " " lbs.	50	
190	Blankets, G.S.	40	In one bundle.
380	" hospital, khaki coloured	80	In two bundles.

N.B.—The tent pegs should be of iron, and iron mallets carried.

APPENDIX VIII.

PROPOSED LOAD FOR R.A.M.C. EQUIPMENT WAGON

(First Line of Transport).

One Section of a Field Ambulance for 160 Patients.

						Approximate weight. lbs.
*United States Army regimental medical chest	...	No.	1			90
* " " " surgical chest	...	"	1			90
* " " " steriliser chest	...	"	1			90
Field medical companion (British pattern)	...	"	2			24
Surgical haversacks	...	"	4			24
Water bottles	...	"	4			8
Fracture box	...	"	1			72
Field ambulance pannier No. 6	...	"	1			125
" " No. 1	...	"	1			100
" " No. 2	...	"	1			80
" " No. 3	...	"	1			80
" " No. 4	...	"	1			80
" " No. 5	...	"	1			80
Field ambulance chest, No. 1	...	"	1			177
Tents, two Hubert pattern and two Indian pattern	...	"	4			542
Bucket, G.S., leather (strapped on wagon)	...	"	1			5
Kettles, camp (nest of four)	...	nest	1			29
Stools, close, Hubert pattern	...	No.	6			29
Stretchers, Canadian pattern	...	"	12			192
Table, operating, folding	...	"	1			23
Blankets, G.S.	...	"	20			95
" hospital	...	"	40			190
Total lbs.						2,263
Wagon equipped, lbs.						2,169

Total lbs. ... 4,432 = 39 cwt. 64 lbs.

Ambulances, two for first line of transport, carrying four stretchers each. These stretchers are to be same as those used by the Canadian Hospital in the late South African War.

Water cart, one for first line of transport.

APPENDIX IX.

PROPOSED LOAD FOR GENERAL SERVICE WAGON
(Second Line of Transport).

One Section of a Field Ambulance for 160 Patients.

				Approximate weight, lbs.
*United States supplementary dressing chest	...	No.	1	120
* " " reserve surgical dressings	...	"	1	100
* " " supplementary medical chest	...	"	1	120
Field ambulance pannier, No. 7	...	"	1	120
" " " No. 8	...	"	1	100
Tents (two Hubert and two Indian pattern)	...	"	4	542
" C.S., linen, for office tent	...	"	1	90
Buckets, G.S., leather (strapped on wagon)	...	"	1	5
Blankets, G.S.	...	"	20	95
" hospital	...	"	40	190
Box, stationery, filled	...	"	1	70
*Case, lamp, acetylene	...	"	1	30
Drum, oil, 6 gallons, filled	...	"	1	60
Dubbing	...	lbs.	4	4
Jack, lifting	...	No.	1	6
Kettles, camp (nest of four)	...	nest	1	29
Sheets, ground	...	No.	25	75
Shovel, light, cast steel (carried on wagon side)	...	"	1	5
Stools, close, Hubert pattern	...	"	6	29
Soap, soft (carried in wagon box)	...	lbs.	10	10
" yellow, in case	...	"	50	50
Tow, carbolised, in case	...	"	100	100
Total lbs.				1,945
Wagon equipped, lbs.				2,169

Total lbs. ... 4,114 = 36 cwt. 76 lbs.

Load of one Baggage Cart (second line of transport)—

				Weight. lbs.
Bucket, G.S., leather (strapped on cart)	...	No.	1	5
Blankets, two each for 40 men	...	"	80	380
Sheets, one each for 40 men	...	"	40	120
Men's kits at 10 lbs. each	...	"	40	400
Officer's kits	...	"	2	75

Total lbs. ... 980 = 8 cwt. 84 lbs.

Load of one Supply Cart (second line of transport)—

					Weight. lbs.
Panniers, grocery, for 40 men	...	...	No.	1	35
Reserve ration, one day for men	...	...	"	40	120
" " one day for horses...	...	...	"	25	300
Total lbs.	...	...	455 =	4 cwt. 7 lbs.	

* For contents see "United States Medical Manual, 1902."

APPENDIX X.

COMPARISON OF WEIGHTS.

Comparison of weights of equipment between the bearer company and field hospital *together* (old scale) and the proposed "Field ambulance" to accommodate 160 patients divisible into four sections.

The equipment for each section is precisely the same.

The weight of equipment for the *whole* of a field ambulance (both medical and ordnance) is approximately 23,084 lbs. Weight per section 5,771 lbs.

The weight of equipment carried under the old scale for field hospitals and bearer companies was approximately 13,083 lbs., but it must be remembered that this weight does not include either tents, blankets, or waterproof sheets, nor kits for officers and men, nor reserve rations for men and horses of both units, if these *be* included the weight would be about 16,381 lbs.

Again the field hospital provided accommodation for only 100 patients, the field ambulance provides for 160, *i.e.*, 60 per cent. more. If 60 per cent. of the weight under the old scale is added it brings the total up to about 20,930 lbs.

The total weight for a field ambulance *includes* tents for sick, hospital clothing, a large number of stretchers, equipment and stores for 160 patients as compared with 100; it includes as well two blankets and one waterproof sheet for each of the personnel, 10 lbs. of kit and a reserve ration of 3 lbs. per man, 35 lbs. of kit for each officer, and a 3 lbs. ration, also a reserve ration of 12 lbs. for each of the transport animals.

Transport for Each Section.

It is proposed that the transport for each section should consist of—

Ambulance wagons ...	...	...	2	} To constitute the 1st line of transport.
Water-cart ...	...	...	1	
G.S. wagon ...	...	...	1	
Vehicles	...	...	4	
G.S. wagon ...	...	...	1	} To constitute the 2nd line of transport.
Baggage cart ...	...	...	1	
Supply cart (forage)...	...	...	1	
Vehicles	...	...	3	

APPENDIX XI.

THE HUBERT TENT.

Parts.—

(1) Tent proper.				
(1A) Outer fly ...	...	...	...	1
(2) Ridgepole, jointed.				
(3) Uprights, jointed	...	...	...	2
(4) Double guy-ropes	...	...	...	2
(5) Tent bag ...	...	...	...	1
(6) Pegs ...	...	...	...	60
(7) Mallets ...	...	...	...	2
(8) Pegs, large guy ...	...	...	...	4
Total weight (lbs.)	...	...	...	150
Value ...	...	...	...	£16
Number of men required for pitching	...	...	...	4

Description.—This tent is a modification of the "Munson" tent which is used in the United States Army. It is oblong, has low walls, an angular roof with ridge, and beneath this roof the tent proper, separated from the roof by an interval, capable of variation, but usually 1 foot.

The tent proper is nearly square in shape, the length being 16 feet, the breadth 15 feet. The height of the side walls is $3\frac{1}{2}$ feet, and the entire height to the inner roof 11 feet. The cubic accommodation works out at 1,740 cubic feet.

DIAGRAM showing the Roof of Tent Proper (Method of Suspension and Ventilation)

FIVE ROPES, EACH ONE FOOT LONG, WITH HOOKS
FOR ATTACHING TO RIDGE-POLE.

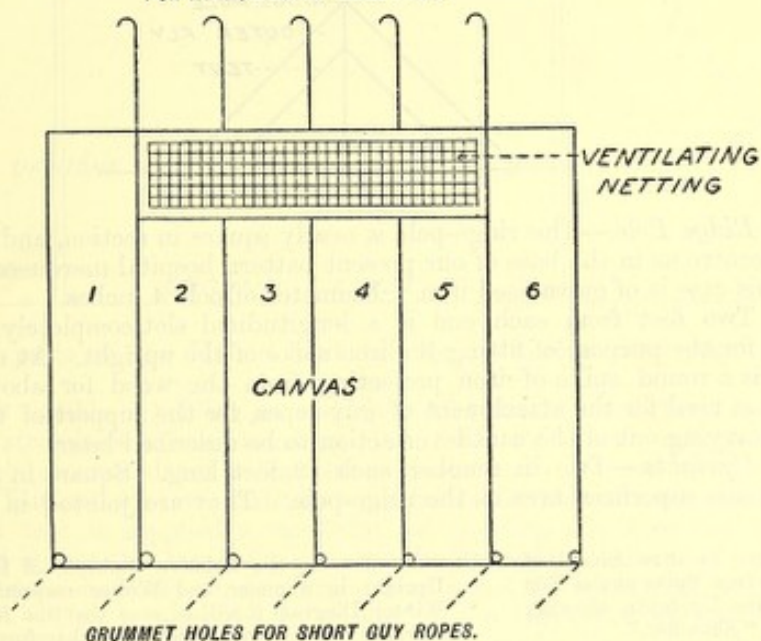
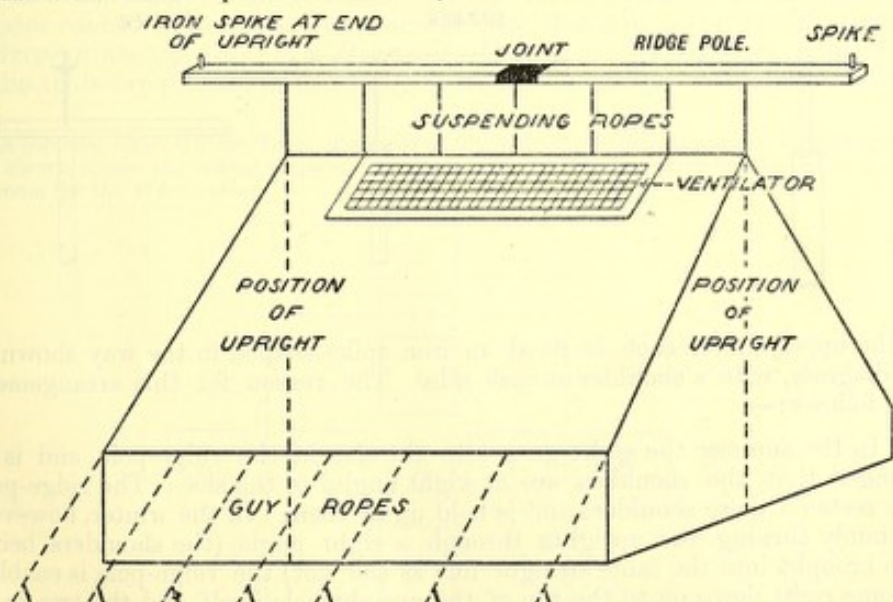


DIAGRAM to show Tent Proper without Outer Fly, and Method of Suspension from Ridge-pole.



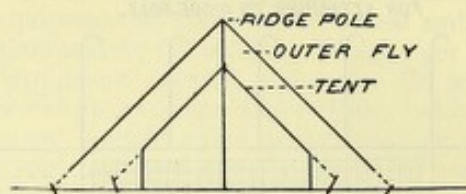
This tent proper is made of duck, which is heavier than that of the outer fly. It is made up of six lengths. The centre four of these are shorter at their upper end, thus leaving a space which is filled in with netting for the purposes of ventilation.

The inner tent hangs from the under surface of the ridge-pole, being attached to it by ropes 1 foot in length.

Outer Fly.—The outer fly, or roof, is made of lighter duck than the tent proper. It is supported by the ridge pole, over which it passes. It is longer and broader than the inner roof, thus overlapping it all round and forming a sort of verandah.

Both roofs are fastened to tent pegs by guy-ropes, the two being thus kept well separated. The end walls of the tent are split at the centre from top to bottom and lace over, overlapping to the extent of 1 foot, by which arrangement the entry of wind and rain is avoided.

Cross-section of Tent Diagram to show the Method by which the Outer Fly is kept from touching the Tent Proper.



Ridge Pole.—The ridge-pole is nearly square in section, and is jointed at the centre as in the base of our present pattern hospital marquees. The joint in this case is of galvanised iron. Diameter of pole 4 inches.

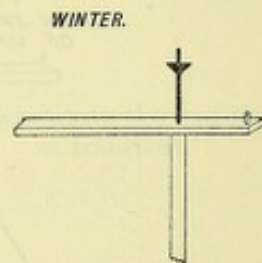
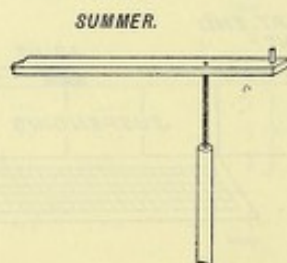
Two feet from each end is a longitudinal slot completely through the pole for the purpose of fitting the iron spike of the upright. At each extreme end is a round spike of iron projecting from the wood for about 3 inches. This is used for the attachment of guy-ropes, for the support of the tent, and the carrying out of the cantilever action to be described later.

Uprights.—Two in number, each 12 feet long. Square in shape and of the same superficial area as the ridge-pole. They are jointed in the centre.

DIAGRAM to show Shape of the Iron Spike at the Top of the Uprights, showing the "Shoulder."



DIAGRAM showing the Relative Positions of Ridge Pole and Upright in Summer and Winter respectively. In the Winter Diagram it will be seen that the Ridge Pole and Upright are in close apposition, therefore bringing the Outer Fly and Tent Proper into apposition also.



At the upper end of each is fixed an iron spike shaped in the way shown in the diagram, with a shoulder at each side. The reason for this arrangement is as follows:—

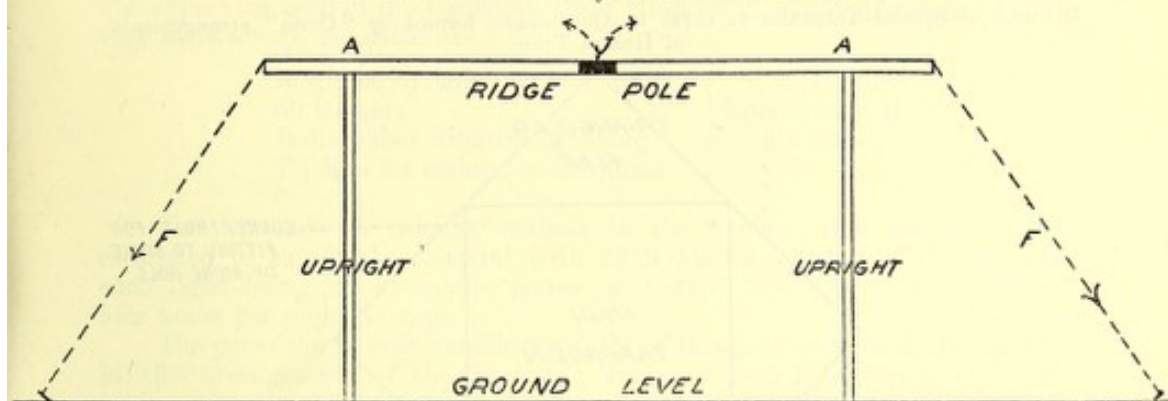
In the summer the spike goes into the slot in the ridge-pole, and is so arranged that the shoulders are at right angles to the slot. The ridge-pole thus rests on these shoulders and is held up by them. In the winter, however, by simply turning the uprights through a right angle (the shoulders being thus brought into the same straight line as the slot) the ridge-pole is enabled to come right down on to the top of the upright pole itself, and the two roofs of the tent are brought into contact.

Double Guy-ropes.—These are for attaching to the iron spikes on the extreme ends of the ridge-pole. It will have been noticed that there is no centre pole to this tent, and one might therefore argue that there would be a great likelihood of the tent collapsing in the centre. This is prevented by what is known as "cantilever" action, which is thus produced:—

The action of the guy-ropes downwards in the direction of the arrows, F, by leverage at a fulcrum, A, formed up the upright and the ridge-pole, forces the point, J (the joint in the ridge-pole) upwards. In this manner the point of junction of the two pieces of pole is kept intact.

DIAGRAM to Illustrate Cantilever Action.

Power—Pull of Guy Ropes in Direction F. Fulcrum—at A.
Therefore the leverage tends to make the Centre of the Ridge Pole (J) fly upwards in the Direction indicated by the arrow-dotted lines.



The other parts of the Hubert tent call for no special description or comment.

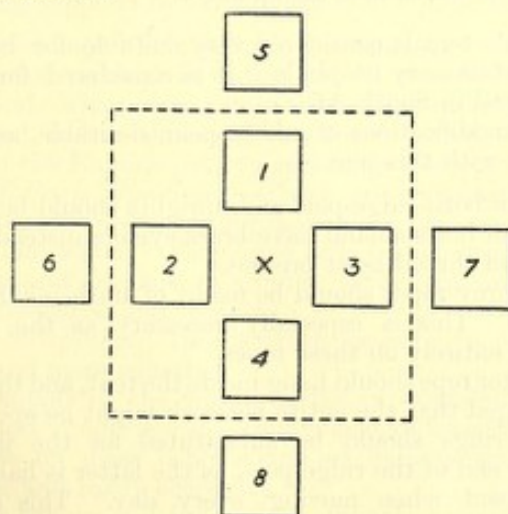
The tent is capable of holding on stretchers 10 patients comfortably, and 12 with the stretchers nearly touching. In cases of great emergency 20 patients can be accommodated on blankets on the ground. If fitted with beds of the Lawson Tait pattern seven patients could be comfortably accommodated.

With each tent is supplied a tarpaulin for covering the floor, and an important point is that this tarpaulin rests on the "sod cloth" all round, and so renders the tent completely wind and rain proof round the bottom of the fly.

Ventilation.—This is arranged by means of the meshwork of netting before mentioned in the description of the inner roof. This network is covered by a canvas flap which can be raised or lowered at will by a rope, which however hangs in the verandah outside. As at present arranged this ventilator cannot be raised on both sides at once, half only going up at a time.

Arrangement of Tents in a Hospital.—It is generally arranged in camps that the tents are pitched in the form of crosses as shown in diagram, each

DIAGRAM showing eight Hubert Tents, arranged in the form of a cross. Four can be arranged as shown inside the dotted square. X shows the Quadrangle which can be made into a room for the Wardmaster.

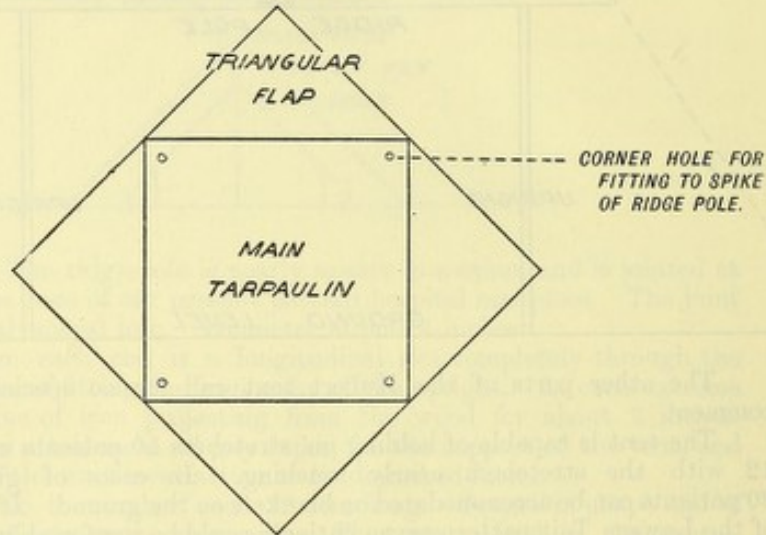


cross being composed of four or eight tents. Thus an open quadrangle is formed at the centres of the crosses. These can be covered with a specially adapted tarpaulin, and a room thus made in the centre of each section from

which each group of four or eight tents can be controlled by one wardmaster. Fewer orderlies are required under this system also. In this central room can also be placed the lighting apparatus, medical comforts, medicines, &c.

Special Tarpaulin.—The special tarpaulin carried for covering in the quadrangle formed at the centre of the above described crosses is square, and of such a size that it would exactly cover the floor of the quadrangle if placed on it. At each corner is a hole, and when pitching these tents each of these holes is placed over the projecting spike at the proximal end of the ridge

DIAGRAM of Special Tarpaulin to cover in Quadrangle, formed by "Cross" arrangements of Hubert Tents.



poles of the tents forming the quadrangle. Thus the roof is formed. The sides of the quadrangle are completed by triangular flaps, the bases of which join the sides of the square tarpaulin, and the apices of which are fixed by guy ropes and pegs to the ground. At the same time these do not fit closely to the adjacent tents, and thus sufficient room is left for the passage of attendants without exposing the patients to needless draughts.

The advantages of this tent as compared to others are:—

- (a) Its weight, taking into consideration its holding capacity.
- (b) The economy in the number of "special" orderlies required.
- (c) The greater air-space.
- (d) The fact that it is cooler in summer or hot climates and warmer in winter or cold climates.
- (e) The ease with which it is manipulated.

In actual use this tent is considered very suitable for both mobile work in the field and for stationary hospitals. It is considered far superior to any pattern otherwise used in South Africa.

The following modifications would appear desirable as the outcome of of actual experience with this tent:—

- (1) The joints in both ridge-pole and uprights should be strengthened.
- (2) The grummet holes should have brass eyelets instead of being worked with linen thread as at present.
- (3) The double guy-ropes should be made of unshrinkable cotton instead of hemp. This is especially necessary, as the cantilever action depends entirely on these ropes.
- (4) The ventilator rope should hang inside the tent, and the canvas covering so arranged that the entire network might be opened if desired.
- (5) That iron rings should be substituted for the iron spike at the extreme end of the ridge pole, as the latter is liable to be knocked off or bent when moving every day. This alteration would necessitate a modification of the special tarpaulin.
- (6) That the long-shouldered iron at the end of the uprights should be strengthened. These occasionally get bent.
- (7) That the ground end of the uprights should be shod with iron.

APPENDIX XII.

THE LIGHTING OF THE HOSPITAL.

The light recommended is produced by the burning of acetylene gas. The apparatus used in the Canadian Field Hospital in South Africa and found very satisfactory, consisted of—

A special cylinder, weight 30 lbs.	} This is carried in a case.
60 burners	
Indiarubber connecting tubing	
T-joints for making connections	

Sixty pounds of calcium carbide is also carried, this amount being estimated to supply the hospital with 60 lights for a period of six months each light being of 30 candle power, and kept burning for a period of four hours per night average.

The *generator* is kept outside the tents in the quadrangle before described in the arrangement of the hospital. It is connected by means of $\frac{1}{2}$ -inch tubing with the different tents, the tube being carried along the ridge pole. Connection with the special burners employed is made by means of the T-shaped connections and shorter pieces of rubber tubing.

The light is a very bright one, and can be made more so if desired by means of reflectors. On the other hand, it can be toned down if desired by means of shades.

APPENDIX XIII.

SUPPLEMENTARY DRESSING CHEST.

(Weight, 100 lbs.)

This chest was adopted on the recommendation of Lieut.-Colonel Worthington, the Officer in charge of the Canadian Field Hospital, and contains in a compact form a great variety of very useful surgical appliances which are constantly required under active service conditions.

A detailed list will be found attached. The appliances brought most prominently before the notice of the Board, and which they consider much superior to anything supplied in the English field equipment, are :—

- (a) *Yucca Splinting*.—This splinting is made of built-up wood fibre, which, when soaked in water, can be moulded to any part of the body, and, when dry, retains its shape excellently. It is very light, and, in the opinion of the Board, would be a great improvement on the English pattern splintings if adopted.
- (b) *Plaster of Paris Bandages*.—These are contained in sealed tins of two sizes, and are ready for immediate use, simply requiring to be dipped into water. They have been found especially useful in cases of compound fracture (a window being cut out of the bandage), simple fractures, and sprains.
- (c) *Adhesive Strapping*.—This is much superior to our own, being both firmer and more adhesive.
- (d) A large supply of the ligatures before described is carried in this chest, and in addition it contains a small housewife holding dry silk ligatures on glass bobbins and of various sizes, which are both portable and easily accessible.
- (e) Irrigating tubing and indiarubber funnels are carried in this chest. These articles are exceedingly useful in the field.
- (f) Triangular tins of plasters such as belladonna, mustard, cantharides, &c. These are in constant demand in field practice.

Instruments.—A large assortment of surgical instruments are contained in this chest. These are, with few exceptions, carried in small rolls made of canvas and lined with fleecy wool, with fleecy wool flaps, and fit into elastic compartments in these rolls, the whole being fastened round with an ordinary strap and buckle.

The following articles were specially noted by the Board as useful, and which they would advise being adopted into our field service equipment :—

- (a) An exceedingly neat and complete "eye" case. The whole case is only the size of a small cigarette case. This is very portable and useful.
- (b) A rectal speculum, an exceedingly useful instrument in a field hospital.
- (c) A strong needle-holder.
- (d) Strong scissors curved on the flat.
- (e) Transfusion cannula with rounded points.
- (f) A dental mouth gag.
- (g) Several key rings, each carrying six Spencer Wells forceps. The English capital cases do not contain nearly enough of these useful instruments for a severe operation.
- (h) Pencil case thermometers with safety-pin and chain attached. (In general use in the profession in Canada.)
- (i) An aluminium case containing a selection of needles.
- (j) A fairly complete set of dental instruments and temporary stopping implements.
- (k) A Pacquelin cautery.

Contents of No. 1 Supplementary Dressings and Instruments.

Contents of left front compartment—

- | | |
|---------------------------------|---------------------------------|
| 1 instrument roll containing— | |
| 2 tongue depressors. | 2 pairs needle holding forceps. |
| 12 pairs Tait's artery forceps. | 12 „ scissors. |
| 1 instrument roll, containing— | |
| 3 Pomeroy ear syringes. | 3 cases knives. |
| 1 clinical thermometer. | 2 papers pins. |
| 1 Denhardt's mouth gag. | 1 laryngeal set. |
| 3 razors. | 2 boxes safety pins. |
| 3 silver tracheotomy tubes. | 1 Morgan ligature case. |
| 1 pair vulsellum forceps. | 4 spatulae. |
| 1 saline transfusion apparatus. | 3 spools linen thread. |
| 6 silver catheters. | |

Contents of left back compartment—

- | | |
|--------------------------------|--------------------------|
| 1 instrument roll, containing— | |
| 1 dozen tooth forceps. | 1 1-yard isinglass. |
| 1 Potain's aspirator. | 3 cakes germicidal soap. |
| 1 spool adhesive plaster. | 2 corkscrews. |
| 2 1-yard oil silk. | 2 1-dozen finger cots. |
| 2 1-yard G.P. tissue. | 1 iodoform duster. |
| 1 case knife. | 1 aristol duster. |

Contents of bottom—

- | | |
|--------------------------------------|--|
| 1 instrument roll containing— | |
| 1 eye instrument case. | 3 plaster of Paris bandaging (2-inch). |
| 1 set Murphy's buttons. | 3 plaster of Paris bandaging (3-inch). |
| 1 antitoxin syringe. | 1 lb. absorbent cotton. |
| 3 filled needle cases. | 1 rubber apron. |
| 1 Pratt's rectal speculum. | 3 razor strops. |
| 1 pair Parkin's retractors. | 1 Clover's inhaler. |
| 2 bristle probang. | 2 air cushions. |
| 17 drainage tubing. | 1 dozen triangular bandages. |
| 1 5-yard jar iodoform gauze. | 6 instrument dishes. |
| 1 5-yard jar plain sterilised gauze. | 6 flannel bandages. |
| 1 5-yard supp. gauze. | 2 Bergmann's operating gowns. |
| 1 5-yard carbolic gauze. | 1 I.R. bed-pan |
| 15 Fielding dressing sets. | |
| 9 Yucca splints. | |

Contents of right front compartment—

- | | |
|---|--|
| 1 5-yard adhesive plaster. | 1 box Fowler's ligature tubes. |
| 1 1-yard belladonna plaster. | 1 box emergency tube of silk-worm gut. |
| 1 1-yard belladonna and capsicum plaster. | 2 boxes ethyl chloride. |
| 1 1-yard cantharides plaster. | 3 spools of adhesive plaster (1-in.) |
| 2 bottles catgut. | 1 spool of adhesive plaster (2-in.) |
| 2 boxes safety-pins. | 1 methylated spirit lamp. |
| 1 coil silkworm gut. | |

Right back compartment contents—

- | | |
|------------------------------|--|
| 12 soft rubber catheters. | 3 combination F.S. and H.W. bottle. |
| 4 Esmarch's tourniquets. | 1 set rubber tubing for transfusion apparatus. |
| 2 litres head coils. | 3 1-dozen finger cots. |
| 3 enema syringes. | 2 sets rubber tubing for Potain's aspirator. |
| 6 I.R. rectal tubes. | |
| 2 rubber bandages (2½-inch). | |
| 2 I.R. ear bags. | |

Contents of No. 2 Case Supplementary Dressings, &c.

Left back compartment—

- | | |
|--------------------------------|-----------------------------|
| 1 Potain's aspirator. | 1 iodoform duster. |
| 1 thermo-cautery. | 1 aristol duster. |
| 2 phonendoscopes. | 2 1-yard boxes oil silk. |
| 3 coils silkworm gut. | 1 1-yard G.P. tissue. |
| 1 dozen absorbent cotton mops. | 1 1-yard isinglass plaster. |

Left front compartment—

- | | |
|--|-------------------------------------|
| 1 5-yard roll adhesive plaster. | 3 cakes germicidal soap. |
| 1 1-yard roll belladonna plaster. | 2 spools adhesive plaster (2-inch). |
| 1 1-yard roll bell. and caps. plaster. | 2 " " " (1-inch). |
| 1 1-yard cantharides plaster. | 2 boxes ligature emergency tubes. |
| 1 box safety-pins. | 9 dozen camel hair pencils. |
| 1 tube ethyl chloride. | |

Contents of bottom—

- | | |
|--------------------------------------|---------------------------------------|
| 1 eye instrument set. | 3 plaster of Paris bandages (2-inch). |
| 1 set Murphy's buttons. | 3 plaster of Paris bandages (1-inch). |
| 1 antitoxin syringe. | 1 lb. absorbent cotton. |
| 3 filled needle cases. | 1 rubber apron. |
| 1 Pratt's rectal speculum. | 3 razor strops. |
| 1 pair Parker's retractors. | 1 Clover's inhaler. |
| 2 bristle probangs. | 2 air cushions |
| 1 5-yard jar iodoform gauze. | 3 instrument dishes. |
| 1 5-yard jar plain sterilised gauze. | 1 dozen triangular bandages. |
| 1 5-yard jar supp. gauze. | 6 flannel " " |
| 1 5-yard jar carbolised gauze. | 2 Bergmann's operating gowns. |
| 15 field dressing sets. | 1 I.R. bed-pan. |
| 9 Yucca splints. | |

Right front compartment—

- | | |
|---------------------------------|-------------------------|
| 2 tongue depressors. | 2 pairs needle holders. |
| 16 pairs Tait's artery forceps. | 12 " scissors. |

Instrument roll containing—

- | | |
|---------------------------------|-------------------------------|
| 2 Pomeroy ear syringes. | 3 nail brushes. |
| 1 dozen clinical thermometers. | 1 corkscrew. |
| 1 Denhardt's mouth gag. | 3 spools linen thread. |
| 3 razors. | 1 laryngeal set. |
| 3 silver tracheotomy tubes. | 2 boxes safety-pins. |
| 1 pair vullsellum forceps. | 1 Morgan's ligature set silk. |
| 1 saline transfusion apparatus. | 3 1 dozen finger cots. |
| 6 silver catheters. | 3 paper pins. |
| 3 Anglin ribbed catheters. | 4 spatulae. |
| 3 case knives. | |

APPENDIX XIV.

GENERAL REMARKS ON THE PROPOSED FIELD AMBULANCE FOR THE
RECEPTION OF 160 WOUNDED, DIVISIBLE INTO FOUR SECTIONS—ONE
FIELD AMBULANCE TO BE ATTACHED TO EACH BRIGADE OF INFANTRY.

It will be observed that in the proposed field ambulance the personnel is considerably increased in some particulars when compared with the recognised establishment of the present bearer company and field hospital. This is considered to be essential. It is never a good policy to take the field with a weak unit. Allowance must always be made for certain wastage in personnel—Officers and men—and this, as a rule, commences early in a campaign, and seems greatest both absolutely and relatively at this period.

The reserves (if they may be so called) in the front line of medical aid consist in an ample personnel of all ranks to start with.

Reason for
increase of
personnel
generally.

The real reserves at the base and on the lines of communication should not be required until the campaign has made some progress. Reserves must, of course, be organised and provided for from the first, but should not be wanted at the very outset of war.

Number of
bearers
increased.

In the proposed "combined unit" the number of bearers has been materially increased, in fact, doubled; four sections instead of two; that is, 64 bearers instead of 32; the present number being considered wholly insufficient for the most ordinary necessities of field work.

Increase in
officers to
supervise
work of the
bearers in
the field.

Two Officers instead of one are provided for the increased number of bearers, that is, one Officer to two stretcher sections (the old scale), two additional N.C. Officers (corporals) are also added. Thus, total strength of the four sections for stretcher work would be—

Officers	...	...	...	...	...	...	...	2
Sergeants	...	...	...	...	...	...	...	2
Corporals	...	...	...	...	...	...	...	2
Privates	...	...	...	...	...	...	...	64
Total	...	...	...	...	...	...	...	70

This increase materially strengthens the aid in the fighting line, where before it was weak, and should greatly facilitate the removal of wounded from the field either during or after an engagement.

Wagon
orderlies.

Instead of five corporals and five privates as "wagon orderlies," each in charge of an ambulance, in the proposed arrangement, there is one private to each ambulance—two sergeants in sub-charge of four ambulances each—the whole being under the command of an Officer.

There is also added one mounted messenger or orderly to carry messages between the place where the ambulance wagons rendezvous and the "dressing station."

Strength of
the wagon
party.

The strength of what here is called the "wagon party," with eight ambulance wagons, is as follows:—

Officer	...	...	...	...	...	...	...	1
N.C. Officer	...	...	...	...	...	...	...	2
Wagon orderlies	...	...	...	...	...	...	...	8
Mounted ditto	...	...	...	...	...	...	...	1
Total	...	...	...	...	...	...	...	12

The distance between the ambulance station (*i.e.*, where the ambulance wagons rendezvous) and the "dressing station" may be considerable, and it is therefore considered desirable that an Officer should be in charge of the wounded, some of whom may be gravely injured and cannot be left entirely to the care of N.C. Officers and privates *en route*. This is the practice in the United States Army, and may be usefully adopted in our own. The mounted

orderly is extremely necessary to cover ground quickly in conveying messages from the Officer in charge of the ambulances to the staff of the dressing station behind. It is proposed also that the ambulance wagons (each of which has a driver and one orderly) should carry a reserve of dressings and hospital stores; if there is any delay in the transport of the wounded owing to the road being blocked, or the advent of darkness, if an action has been fought late in the day, these dressings and stores will be found extremely useful for the sick convoy.

In this unit the personnel of the "dressing station" has been especially considered. The position to which all the wounded of the brigade converge should be the "dressing station," and it will often be found practicable for the "tent division" to get fairly close to the fighting line and receive the wounded direct from the field; the dressing station and tent division will then be merged into one. Under any circumstances at whatever place it may be determined upon to first deal, from an operative point of view, with wounded, it is necessary there to assemble a sufficient personnel for general duty, a few of the most highly trained orderlies, and the most skilled of the surgical staff.

The staff of the dressing station as it now stands is as follows:—

Officers	...	...	...	...	...	...	2
Sergeant-Major	...	...	...	...	...	...	1
Sergeants (one as compounder)	...	...	...	...	...	...	2
Corporal	...	...	...	...	...	...	1
Privates (one as cook)	...	...	...	...	...	...	4
							<hr/>
Total	...	...	...	...	...	...	10

The dressing station.

The tent division of a field ambulance should form the main dressing station where possible.

It is suggested that this personnel should be increased so as to include a staff of Officers and men for the "operating tent," and in addition a "slightly wounded section," and a proportionate number of N.C. Officers and men for general duty.

Increased personnel at the brigade dressing station.

For duty in the operating tent the following personnel is suggested:—

Officers	...	...	...	...	...	...	2
Staff-sergeant	...	...	...	...	...	...	1
Corporal	...	...	...	...	...	...	1
Orderlies (three of these to be first class orderlies and one a fatigue man)	...	...	...	...	...	...	4
							<hr/>
Total	...	...	...	...	...	...	8

Personnel of operating tent.

For duty with "slightly wounded section," for which a few "receiving tents" must be provided—

Officers	...	...	...	...	...	...	1
Staff-sergeant	...	...	...	...	...	...	1
Orderlies	...	...	...	...	...	...	5
							<hr/>
							7

Slightly wounded section.

For general duty—

Warrant Officer	...	...	...	...	...	...	1
Staff-sergeants	...	...	...	...	...	...	2
Cooks	...	...	...	...	...	...	2
Quartermaster-sergeant	...	...	...	...	...	...	1
Waterman	...	...	...	...	...	...	1
Privates	...	...	...	...	...	...	2
							<hr/>
							9

General duty.

Total number required for carrying on the systematic work of a brigade dressing station would be about 24. This personnel is suggested if an advanced dressing station is established, but when possible the tent division

should be pushed forward for this purpose, but the general arrangement as here indicated might still be followed as far as the distribution of work is concerned.

The sergeant-major should exercise a general supervision over all personnel and general arrangements for reception of wounded.

One staff-sergeant acting as compounder, the quartermaster-sergeant issuing all necessary stores, the cooks preparing food—some for the wounded and others for the bearers—the work of the latter being of the most exacting and fatiguing nature.

Specially
trained
orderlies for
operating
tent.

The N.C. Officers and men selected for work in the operating tent should all have had a training in the operating theatre of one of our military hospitals and thoroughly understand the requirements of an operation, and be skilful in the proper preparation and sterilisation of instruments, ligatures, drainage tubes, dressings, swabs, and sponges, &c.

Tent
division.

The personnel of the tent division is shown in the tables. The total of 44 includes four Officers and a quartermaster, but in camp the bearer division will do all the rough work—pitching tents, digging latrines, and generally assisting in all the various offices.

Under any circumstances it is necessary to guard as far as possible against shortage and diminution in the ranks of our orderlies from death and sickness, and one trained orderly should be provided for every three or four patients at the commencement. The suggested amalgamation meets this difficulty to some extent in field ambulance units, as in camp the "tent division" orderlies would be augmented by men from the bearer division, who, although not so highly trained, can relieve the sick attendants of a good deal of laborious work which, with a small personnel, they would have to undertake in addition to their nursing duties.

Mixture of
auxiliary
medical aid
with the
R.A.M.C.
units.

As to the rank and file of the field ambulance, it is thought that a large number of them should be drawn from the Auxiliary Medical Services—certainly a large number of the bearers, wagon orderlies, and possibly a few good N.C. Officers. The personnel of our highly-trained Royal Army Medical Corps orderlies should not be exhausted in the mere routine of bearer work. They should be reserved as far as possible for nursing duties both in the field units and elsewhere.

Number of
ambulances
for a
combined
field unit.

The number proposed here is eight—two for each section. This is a reduction on the old establishment of 10, but the proposed pattern ambulance will hold four lying-down cases instead of two. The suggestion, too, has been made of allowing one ambulance to be attached on the line of march for each infantry regiment, which might be handed over to the ambulance company before an action. It should be a light-pattern wagon, and could either form part of the regimental transport or be considered as lent only from the field ambulances. The latter would probably be the better plan.

Proportion
of ambu-
lances to
effective
force in
U.S. Army.

In the American Army an ambulance is allowed to every 400 men of the effective force. If the requirements of ambulance transport for British troops be similarly estimated, eight ambulances for the field unit and one per regiment would be about the proper proportion.

The system of allowing one ambulance per regiment on the line of march is adopted in the French and German Armies and in that of the United States.

APPENDIX XV.

TABLE I.—SUGGESTIONS BY LIEUT.-COLONEL R. W. FORD FOR A FIELD AMBULANCE OF 160 BEDS, DIVIDED INTO TENT AND BEARER DIVISIONS.

Distribution.	Lieut.-Colonels.	Majors.	Captains or Lieutenants.	Quartermaster.	Warrant Officers.	Staff Sergeants or Sergeants.	Corporals or Lance-Corporals.	Privates.	Buglers.	Drivers.	Total all ranks.	Horses.			Vehicles.				Remarks.	
												Riding.	Draught.	Total.	Ambulance wagons.	G.S. wagons.	Forage carts.	Water carts.		Total.
R.A.M.C. establishment...	1	2	6	1	1	13	13	128	1	—	166	—	—	—	—	—	—	—		
I. TENT DIVISION.																				
Commanding Officer of field ambulance	1	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	It is suggested that the acting Chief Wardmaster, Steward, and Compounder should be mounted or carried in a light cart, also the cooks.	
General duty	—	1	1	1	—	—	—	—	—	—	3	3	—	—	—	—	—			
Acting Chief Wardmaster and Sergeant-Major	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—			
Assistant Wardmaster	—	—	—	—	—	—	1	1	—	—	2	—	—	—	—	—	—			
Steward	—	—	—	—	—	1	1	—	—	—	2	—	—	—	—	—	—			
Compounder	—	—	—	—	—	2	—	—	—	—	2	—	—	—	—	—	—			
Cooks	—	—	—	—	—	1	1	2	—	—	4	—	—	—	—	—	—			
Pack store	—	—	—	—	—	—	1	1	—	—	2	—	—	—	—	—	—			
Clerk	—	—	—	—	—	—	—	1	—	—	2	—	—	—	—	—	—			
Ward orderlies	—	—	—	—	—	—	1	20	—	—	22	—	—	—	—	—	—			
Washermen	—	—	—	—	—	—	—	2	—	—	2	—	—	—	—	—	—	Ward orderlies to be selected from the most intelligent and best trained men.		
Waterman	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—			
Superannuated and servants	—	—	—	—	—	—	—	8	—	—	9	—	—	—	—	—	—			
Total Tent Division	1	1	1	1	—	5	7	36	—	—	52	4	—	4	—	—	—			
Transport.																				
Sergeant-Major	—	—	—	—	1	—	—	—	—	—	1	1	—	1	—	—	—	—		
N.C. Officers	—	—	—	—	—	1	1	—	—	—	2	2	—	2	—	—	—	—		
Drivers	—	—	—	—	—	—	—	—	—	10	10	—	28	28	—	—	—	—		
Vehicles	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	4	2	10	
Total Transport	—	—	—	—	1	1	1	—	—	10	13	3	28	31	—	4	4	2	10	
Total all services Tent Division	1	1	1	1	1	6	8	36	—	10	65	7	28	35	—	4	4	2	10	

It is suggested that the acting Chief Wardmaster, Steward, and Compounder should be mounted or carried in a light cart, also the cooks.

Ward orderlies to be selected from the most intelligent and best trained men.

TABLE I—continued.

Distribution.	Lieut.-Colonels.	Majors.	Captains or Lieutenants.	Quartermaster.	Warrant Officers.	Staff Sergeants and Sergeants.	Corporals or Lance-Corporals.	Privates.	Buglers.	Drivers.	Total all ranks.	Horses.			Vehicles.				Remarks.	
												Riding.	Draught.	Total.	Ambulance wagons.	G.S. wagons.	Forage carts.	Water carts.		Total.
II. BEARER DIVISION.																			{ For division into four sections see Tables II, III.	
Dressing Station—																				
Officer in Charge of dressing station	—	1	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—		
Operating tent...	—	—	—	—	—	1	1	4*	—	—	8	2	—	—	—	—	—	—		
Receiving tents	—	—	—	—	—	1	—	5†	—	—	6	9	—	—	—	—	—	—		
General duty	—	—	—	—	1	—	—	1	—	—	2	1	—	—	—	—	—	—		
Compounders and dressers	—	—	—	—	—	1	1	—	—	—	2	—	—	—	—	—	—	—		
Cooks	—	—	—	—	—	—	1	1	—	—	2	—	—	—	—	—	—	—		
Ambulance Station—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
Quartermaster-Sergeant	—	—	—	—	—	1†	—	—	—	—	1	1	—	—	—	—	—	—		
Waterman	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—		
Four stretcher sections	—	—	2	—	—	—	2	64	—	—	70	2	—	—	—	—	—	—		
Wagon party	—	—	1	—	—	2†	—	8	—	—	11	1	—	—	—	—	—	—		
Supernumerary and servants...	—	—	—	—	—	—	1†	8	1	—	10	—	—	—	—	—	—	—		
Total Bearer Division	—	1	5	—	1	8	6	92	1	—	114	8	—	8	—	—	—	—		
Transport.																				
N.C. Officers	—	—	—	—	—	1	1	—	—	—	2	2	—	2	—	—	—	—		
Drivers	—	—	—	—	—	—	—	—	—	18	18	—	—	—	—	—	—	—		
Vehicles	—	—	—	—	—	—	—	—	—	—	—	—	60	60	8	4	4	2 18		
Total Transport	—	—	—	—	—	1	1	—	—	18	20	2	60	62	8	4	4	2 18		
Total all services Bearer Division...	—	1	5	—	1	9	7	92	1	18	134	10	60	70	8	4	4	2 18		
Grand total all services Tent and Bearer Divisions	1	2	6	1	2	15	15	128	1	28	199	17	88	105	8	8	8	4 28		

* Three of these to be first class orderlies and one fatigue man.

† Two of these to be specially detailed to attend mortally-wounded men.

‡ A mounted orderly to carry messages between the ambulance and dressing stations; the N.C. Officer for wagon party might be mounted and Quartermaster-Sergeant.

TABLE II.—PERSONNEL OF HEADQUARTER SECTION OF FIELD AMBULANCE.

Distribution.	Lieut.-Colonels.	Majors.	Captains or Lieutenants.	Quartermaster.	Warrant Officers.	Staff Sergeants and Sergeants.	Corporals.	Drivers.	Privates.	Total all ranks.	Horses.			Vehicles.				Remarks.
											Riding.	Drayage.	Total.	Ambulance wagons.	Forage carts.	G.S. wagons.	Water carts.	
Commanding Officer ...	1	—	—	—	—	—	—	—	—	1	1	—	1	—	—	—	—	
General duty ...	—	—	—	—	—	—	—	—	—	3	3	—	3	—	—	—	—	
Chief Wardmaster ...	—	—	—	—	1	—	—	—	—	1	1	—	1	—	—	—	—	
Assistant Wardmaster ...	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	
Compounder ...	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	
Steward and pack store	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	
Clerk ...	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	
Cooks ...	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	
Ward orderlies ...	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	
Stretcher section ...	—	—	—	—	—	—	—	—	—	17	—	—	—	—	—	—	—	
Wagon orderlies ...	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	
Supernumeraries ...	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	
Total R.A.M.C. ...	1	—	2	1	1	4	4	—	32	45	5	—	5	—	—	—	—	
<i>Transport.</i>																		
Sergeant-Major Conductor ...	—	—	—	—	1	—	—	—	—	1	1	—	1	—	—	—	—	
N.C. Officer Sub-Conductor ...	—	—	—	—	—	—	1	—	—	1	1	—	1	—	—	—	—	
Drivers ...	—	—	—	—	—	—	—	7	—	7	—	22	22	2	2	2	1	
Vehicles ...	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	2	1	
Total Transport ...	—	—	—	—	1	—	1	7	—	9	2	22	24	2	2	2	1	
Total all services ...	1	—	2	1	2	4	5	7	32	54	7	22	29	2	2	2	1	

TABLE III.—PERSONNEL OF SECTION OF FIELD AMBULANCE OTHER THAN HEADQUARTER SECTION.

Distribution.	Majors.	Captains or Lieutenants.	Staff Sergeants or Sergeants.	Corporals.	Drivers.	Privates.	Total all ranks.	Horses.			Vehicles.				Remarks.
								Riding.	Draught.	Total.	Ambulance wagons.	Forage carts.	Water carts.	G.S. wagons.	
Officer in Charge of section	1	—	—	—	—	—	1	1	—	1	—	—	—	—	See Detail of Duties.
General duty	—	1	—	—	—	—	1	1	—	1	—	—	—	—	
Acting Sergeant-Major and Chief Wardmaster	—	—	1	—	—	—	1	—	—	—	—	—	—	—	
Assistant Wardmaster	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Compounder	—	—	1	—	—	—	1	—	—	—	—	—	—	—	
Steward and pack store	—	—	—	1	—	1	2	—	—	—	—	—	—	—	
Cooks	—	—	—	—	—	6	3	—	—	—	—	—	—	—	
Ward orderlies	—	—	—	—	—	1	6	—	—	—	—	—	—	—	
Clerk	—	—	—	—	—	16	1	—	—	—	—	—	—	—	
Stretchers section	—	—	1	—	—	2	3	—	—	—	—	—	—	—	
Wagon orderlies	—	—	—	1	—	4	4	—	—	—	—	—	—	—	
Supernumeraries	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Total R.A.M.C.	1	1	3	3	—	32	40	2	—	2	—	—	—	—	
Transport.															
N.C. Officer Sub-Conductor	—	—	—	1	—	—	1	—	—	—	—	—	—	—	
Drivers	—	—	—	—	7	—	7	—	—	—	—	—	—	—	
Horses	—	—	—	—	—	—	—	1	22	23	2	2	1	2	
Vehicles	—	—	—	—	—	—	—	—	—	—	2	2	—	—	
Total Transport	—	—	—	1	7	—	8	1	22	23	2	2	1	2	
Total all services	1	1	3	4	7	32	48	3	22	25	2	2	1	2	

Detail of Duties of N.C. Officers and Men of Section of Field Ambulance when in Camp and on Line of March.

Each section will camp and act independently of the other, and will carry out all routine duties in the same manner as a company of a regiment.

Ranks.			Detail of Duties.
Staff Sergeants and Sergeants.	Corporals and Lance-Corporals.	Privates.	
1	—	—	The senior N.C. Officer will act as Sergeant-Major and Chief Wardmaster, working directly under the Officer in charge of section.
1	—	—	To act as compounder.
1	—	—	Will have charge of the stretcher section when on line of march, and in camp will perform the duties of Assistant Wardmaster, and if required will also act as compounder.
—	1	1	The N.C. Officer will perform the duties of steward and pack store keeper, assisted by one private.
—	1	2	The N.C. Officer will act as master cook for the section, and two privates as assistants. These will be increased when in camp by two privates from the stretcher section, for rough work and fatigues in connection with the field kitchen.
—	1	—	To act as wagon N.C. Officer on line of march, and when in camp will have charge of camp sanitary work and general camp fatigues.
—	—	6	First class orderlies to have charge of ward tents, and when in camp to be increased by an additional six men of the stretcher section.
—	—	1	Clerk to the Officer in charge of section, and keep section "A. and D. Book" when engaged as a separate unit, under the supervision of the senior N.C. Officer.
—	—	1	Waterman, accompanying water cart on march and keeping it filled; also when in camp will have charge of all drinking water and filters.
—	—	2	Wagon orderlies when on line of march, and when in camp will be employed on general camp fatigues under the sanitary N.C. Officer.
—	—	16	Stretcher bearers while on line of march, marching in front of ambulance wagon with the N.C. Officer in charge. In camp these men will be detailed as under:—
			Ward orderlies 6
			To assist cooks 2
			„ compounder 1
			„ steward 1
			Messenger 1
			Washerman 1
			Latrines and general camp fatigues ... 4
—	—	3	Supernumeraries. Two of these will be Officers' servants, and the other a spare man to replace any casualty that may occur.
3	3	32	Total.

APPENDIX XVI.
PERSONNEL OF "MOUNTED AMBULANCE" PROPOSED BY LIEUT.-COLONEL R. W. FORD, D.S.O.

	Lieut.-Colonels.	Major.	Captains or Lieutenants.	Warrant Officers.	Staff Sergeants or Sergeants.	Corporals.	Privates.	Drivers.	Total all ranks.	Riding horses.	Draught horses.	Total horses.	Heavy ambulance wagons, 4-wheel.	Light ambulance wagons, 2-wheel longn type.	Equipment carts.	G.S. wagons.	Water carts.	Total vehicles.
Headquarter Section—																		
R.A.M.C. details ...	1	—	1	1	2	3	21	—	29	11	—	11	—	—	—	—	—	—
A.S.C. details ...	—	—	—	—	1	1	—	8	10	2	20	22	1	2	2	1	1	8
Left Half Section—																		
R.A.M.C. details ...	—	1	1	—	2	2	20	—	26	9	—	9	—	—	—	—	—	—
A.S.C. details ...	—	—	—	—	—	1	—	8	9	1	20	21	1	3	2	1	1	8
Grand total—R.A.M.C. details ...	1	1	2	1	4	5	41	—	53	20	—	20	—	—	—	—	—	—
A.S.C. details ...	—	—	—	—	1	2	—	16	19	3	40	43	2	6	4	2	2	16
Total of whole details ...	1	1	2	1	5	7	41	16	74	23	40	63	2	6	4	2	2	16

PERSONNEL OF HEADQUARTER SECTION OF MOUNTED AMBULANCE, PROPOSED BY LIEUT.-COLONEL R. W. FORD, D.S.O.

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Distribution.	Lieut.-Colonel.	Captain or Lieutenant.	Warrant Officer.	Staff Sergeants or Sergeants.	Corporals.	Privates.	Drivers.	Total all ranks.	Riding horses.	Draught horses.	Total horses.	Light ambulance wagons.	Heavy ambulance wagon.	Equipment carts.	G.S. wagon.	Water cart.	Total vehicles.	Remarks.	
Officer Commanding...	1																		
General duty...																			
Sergeant-Major...																			
Assistant Wardmaster...																			
Steward and pack store...																			
Compounder...																			
Cooks ...																			
Tent orderlies...																			
Waterman...																			
Mounted orderly...																			
Stretcher bearers...																			
Servants ...																			
Supernumeraries...																			
Total ...	1	1	1	2	3	21	—	29	11	—	11	—	—	—	—	—	—	—	
Transport ...	—	—	—	1	1†	—	8‡	10	2	20	22	3	1	2	1	1	8	—	† These four orderlies will carry a surgical haversack and water bottle.
Grand total ...	1	1	1	3	4	21	8	39	13	20	33	3	1	2	1	1	8	—	‡ The transport corporal to be a wheeler and one of the drivers to be a farrier.

2 X 2

* And work with stretchers bearers.

† These four orderlies will carry a surgical haversack and water bottle.

‡ The transport corporal to be a wheeler and one of the drivers to be a farrier.

The compounder and three orderlies will ride in the heavy ambulance wagon. One orderly will ride in each of the light ambulance wagons. The steward and pack store corporal and one orderly will ride on the equipment carts, as will also the two cooks.

The waterman will ride on water cart.

The G.S. wagon will accommodate the two servants, one supernumerary, and two tent orderlies and one corporal.

The remainder of the personnel will ride on cobs or ponies.

PERSONNEL OF LEFT HALF SECTION OF MOUNTED AMBULANCE, PROPOSED BY LIEUT.-COLONEL R. W. FORD, D.S.O.

Distribution.	Major.	Captain and Lieut-tenant.	Staff Sergeants or Sergeants.	Corporals.	Privates.	Drivers.	Total all ranks.	Riding horses.	Drayage horses.	Total horses.	Light ambulance wagons.	Heavy ambulance wagons.	Equipment carts.	G.S. wagon.	Water cart.	Total vehicles.	Remarks.
Officer in charge ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
General duty ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Acting Sergeant-Major ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Assistant Quartermaster ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Steward and pack store ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Compounder ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Cooks ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Tent orderlies ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Waterman ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Mounted orderly ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Stretcher bearer ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Servants ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Supernumeraries ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Total ...	1	1	2	2	20	—	26	9	—	9	—	—	—	—	—	—	
Transport ...	—	—	—	1†	—	8†	9	1	20	21	3	1	2	1	1	8	† These four orderlies will carry a surgical haversack and water bottle.
Grand total ...	1	1	2	3	20	8	35	10	20	30	3	1	2	1	1	8	† The corporal, if possible, to be a wheeler and one of the drivers a farrier.

The compounder and three orderlies will ride on heavy ambulance wagon. One orderly will ride in each of the light ambulances.

The steward and one orderly will ride in the equipment carts, as will also the two cooks.

Watermen will ride on water cart.

The G.S. wagon will accommodate two servants, one supernumerary, and two tent orderlies.

The remainder will ride on horses.

* And work with stretcher bearers.

Notes on the proposed Equipment for Mounted Field Ambulance by Sections.

Medical and Surgical Outfit.—Each ambulance or tonga carries a supply of surgical material and other requisites for the sick. The following articles taken, from the "Medical Manual" of the United States Army, are recommended to be carried in lieu of heavier equipment, viz. :—

- 1 field operating case, small (para. 306).
- 1 mess chest, small (outfitted for 25 patients, (para. 323).
- 1 field range, small (para. 324).
- 1 United States Army medical and surgical chest for detached services (para. 305).
- 1 food chest (para. 292).

Each Medical Officer's mounted orderly to carry the "orderlies' pouch (see para. 273 United States "Medical Manual").

The above would be carried in two-wheeled carts and any *reserve* material, &c., in the G.S. wagon, second line of transport.

General Equipment.

Tents, blankets, rations, &c., on the same lines as proposed for the section of a field ambulance.

The tents recommended are the Indian pattern, 80 lbs., and the square bell tent lately used by the Imperial Yeomanry Field Hospital.

APPENDIX XVII.

DETAIL OF IMPERIAL YEOMANRY AMBULANCE.

DIAGRAMS 2, 3, 4, 5, and 6, to illustrate the Latest Type of Ambulance for Imperial Yeomanry. The Committee are indebted to Captain G. Pearson (retired pay), Royal Hospital, Chelsea, for sketching these diagrams.

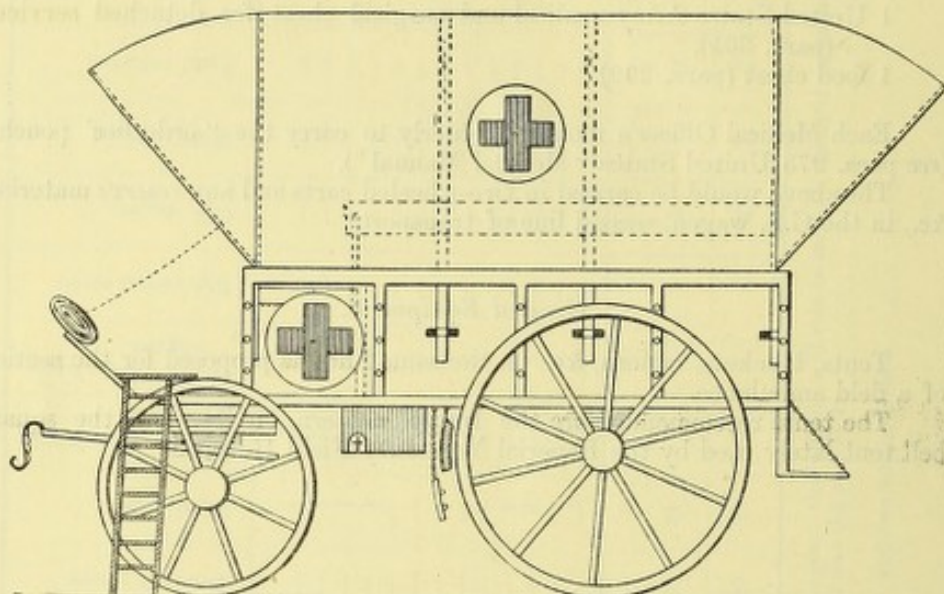


FIG. 2.

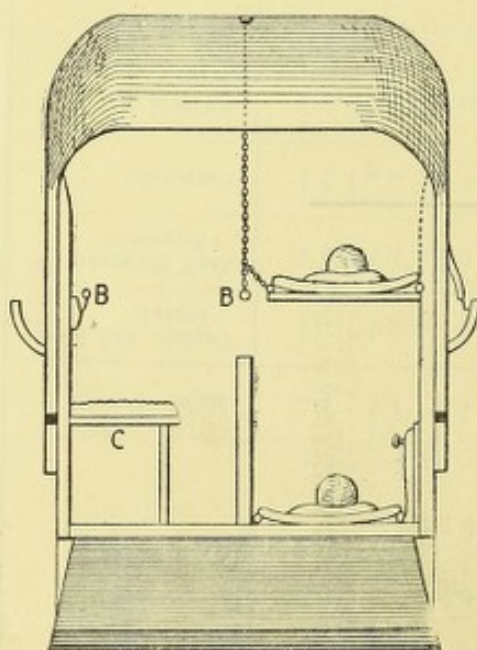


FIG. 3.

B. Stretcher Carriers.
C. Seats, folding.

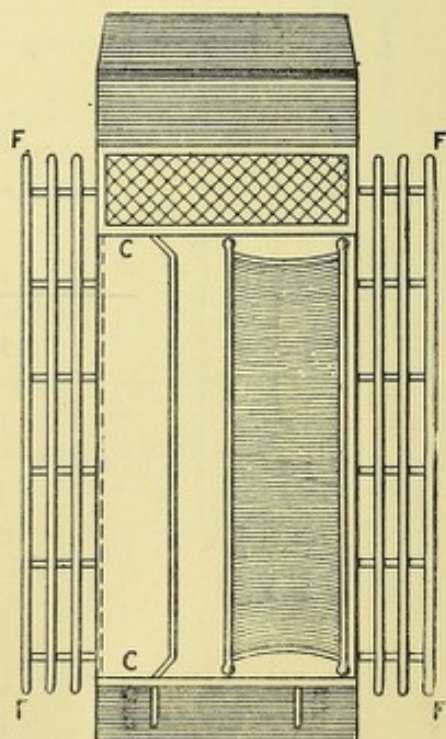


FIG. 4.

F.F. The lathes extend full length of sides of body of ambulance used for carrying a spare pole or swingletrees, and for light kits.
C.C. Seat raised—space for six men. Stretchers, when not in use, placed beneath the seats.

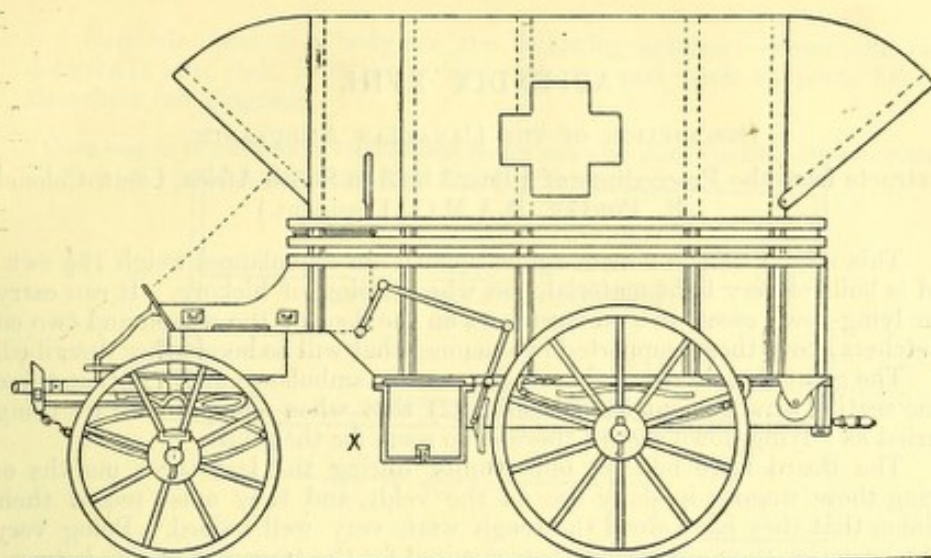


FIG. 5.—The Latest Pattern Ambulance Wagon, with Improvements.

X. The tank is now placed in the rear of the wagon, vide "Report on Ambulances." It is easily unshipped for refilling.

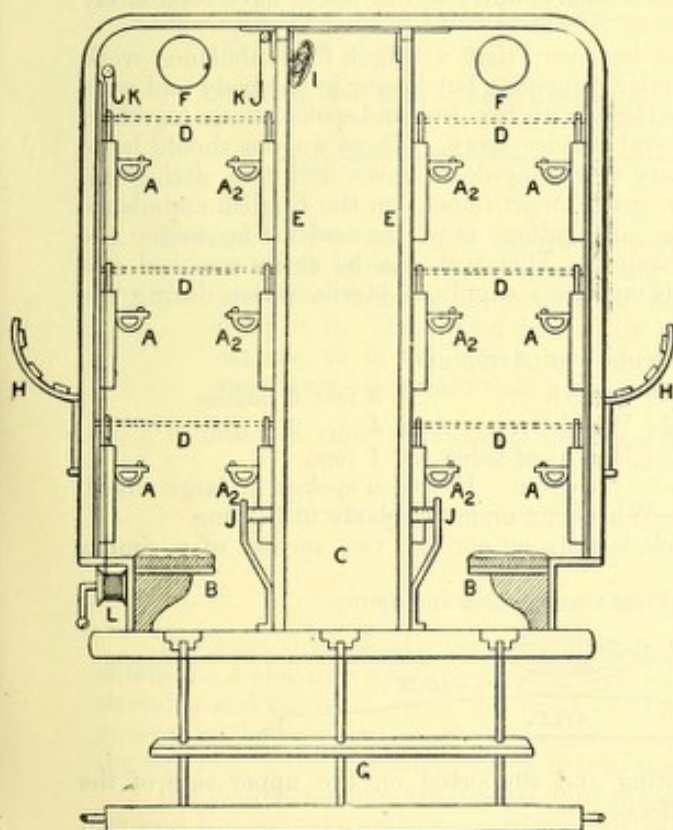


FIG. 6.

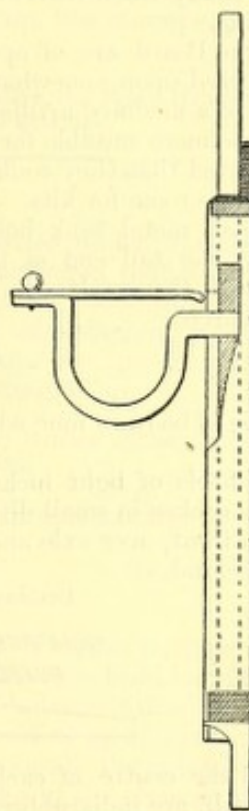


FIG. 7.—Section of Stretcher Attachment.

Diagrams marked 2, 3, 4, 5, and 6, extracted from Report by Major Stonham, C.M.G., Imperial Yeomanry Field Hospital.

Note to Fig. 6.

- A. Patent spring attachments for carrying stretchers.
- A2. Stretcher attachments which fold up to roof when not in use.
- B. Seats running the whole length of body for sitting patients when the two lower tiers of stretchers are not in use. These seats fold down against the body when they are not in use.
- C. Passage-way up the centre of wagon for attendants to pass between the stretchers.
- D. Bars to afford support to centre pillars when attachments are loaded.
- E. Light pillars suspended from roof and carrying centre stretcher attachments. These fold up to roof, and are secured by straps when not in use.
- F. Pulleys for patients in top stretchers to help them to steady themselves or shift their position.
- G. Folding tailboard, the centre batten of which forms a step when the tailboard is down.
- H. Lathes going full length of body for light kits, &c.
- I. Rolled-up curtain which can be let down to partition off the stretchers, if necessary.
- J. Rollers to facilitate running the stretchers into the body of wagon.
- K. Hooks of pulley which take the handle of the stretchers when raising or lowering the top tiers.
- L. Winch of pulley.

APPENDIX XVIII.

DESCRIPTION OF THE CANADIAN AMBULANCE.

(Extracts from the Proceedings of a Board held in South Africa, Lieut.-Colonel R. PORTER, R.A.M.C., President.)

This wagon weighs 9 cwt., against which our ambulances weigh $18\frac{1}{2}$ cwt., and is built of very light material, the wheels being of hickory. It can carry four lying-down cases, two on stretchers on the floor of the wagon and two on stretchers above these, supported in a manner that will be hereinafter described.

The great drawbacks to this wagon as an ambulance are: (1) that there is no seating arrangement for patients; (2) that when four patients are being carried as "lying-down cases" there is no room for their kits.

The Board have had an opportunity during the last three months of seeing these wagons in daily use on the veldt, and they must record their opinion that they have stood the rough work very well indeed. Being very light however, they are perhaps better suited for the transport of sick between a field and a stationary hospital when they can keep more or less to a road, than to "trek" work over rough country, but all wagons are bound to be more or less shaky when travelling over such country as our forces have been lately operating.

The Board are of opinion, however, that a wagon for ambulance work constructed upon somewhat similar principles, but longer in the body and with wheels of a modified artillery pattern, with iron hub and spokes closer together, would be more suitable for general service work. These wagons should be so constructed that they could carry four lying-down cases and two sitting up, with spare room for kits. One great improvement on the English ambulance is a small metal tank holding nine gallons of water and fitting under the floor at the tail end of the wagon. This tank can be easily removed and boiled and then replaced. This ensures a supply of sterile water during the day's march.

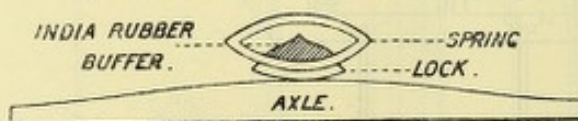
Description of Ambulance.

Light body on four wheels	Length ...	8 feet 6 inches.
	Width ...	4 " 2 "
	Height of side ...	1 foot.

Wheels of light hickory, very narrow. Fourteen spokes in large wheel. Twelve spokes in small ditto. Wheels go under the body in turning.

In front, over axle and lock, is a strong spring; two springs of a similar make behind.

DIAGRAM of Front Carriage-Lock and Spring.



In the centre of each spring and supported on the upper side of the lower half, are indiarubber buffers.

Tree known as the whiffle tree is a double tree formed as in annexed

DIAGRAM of the Double (Whiffle) Tree.

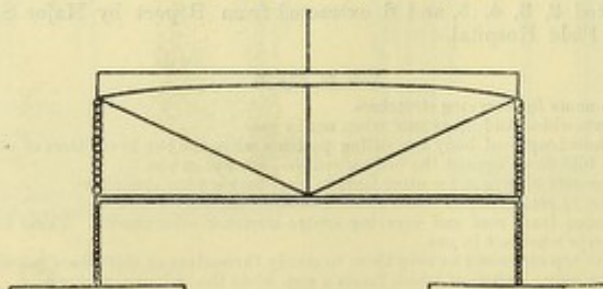
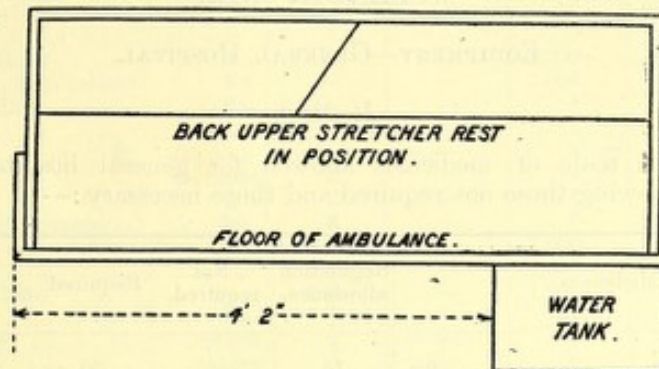


diagram. Brake is worked by foot from the driver's seat. Covered with light duck supported on four bale hoops. The duck rolls up.

Carried under the body are the following articles :—Iron tank (before described), axe, pick, jack, spade, and spanner, and back supports for upper stretchers (*see* diagram).

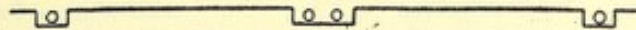
Cross-section of Ambulance without Bale Hoops and with Back Stretcher Rest in Position.



The upper stretchers are supported as follows :—

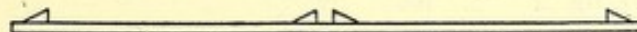
In Front.—The handles rest on the back of the driver's seat, which has spaces cut as in the accompanying diagram, the stirrups go close to the wood of seat.

DIAGRAM to show Slots in top of Driver's Seat to allow the Front Handles of Stretchers to fit in and so prevent shaking.



Behind.—By means of a special support carried under the ambulance, of wood jointed at two places and so arranged that it fits tightly into the ambulance, forming a rest 2 feet 6 inches from the floor of it. This wood has on its inner side, when in position, four catches, as in the accompanying diagram, for the stirrups of the stretchers, which are thus kept from shaking about.

DIAGRAM to show the Catches on Ambulance (inner) Surface of Back Rest for Stretchers to prevent shaking.



Loading the Ambulance.

The stretchers on the rests are first loaded. For this purpose one man enters the ambulance over the driver's seat, and takes the head handles of the stretcher and carries it up to the front of the ambulance, fitting it into the grooves in the driver's seat, the orderlies outside holding up and passing along the foot end of the stretcher, fitting it into the catches in the special rest.

The floor stretchers are loaded into the wagons in the same manner that we load the ordinary ambulance wagon, with the exception that the foot end of the stretcher is put in first.

Water Cart.

This is a metal tank shaped exactly like our own cart, and divided longitudinally down the centre by an iron plate. It has three points which make it a distinct improvement on our own. These are :—

- (a) A metal strainer to prevent pieces of stick, straw, &c., entering the body of the cart, and easily removable for cleaning purposes. This is carried in position and not in a separate "pocket" as in our carts.
- (b) It is closed by a manhole at the top with an oval door fastened down with clamps as in the portholes of a ship.
- (c) A flush hole at the bottom which is an important improvement, but which, in the opinion of the Board, is not large enough.

APPENDIX XIX.

EQUIPMENT—GENERAL HOSPITAL.

Medical.

Items in scale of medicines allowed for general hospital requiring alteration, showing those not required and those necessary:—

Medicines.	Regulation allowance.	Not required.	Required.	Remarks.
Acidum Boricum lbs.	16	—	30	
" Carb. Liquidum "	20	—	40	
" Tabloids No.	Nil	—	5,000	
" Citricum lbs.	1	Nil	—	
" Gallicum, 5-gr. tabloids ... No.	—	—	250	
" Phosphoricum ozs.	4	Nil	—	
" Tannicum lbs.	1	—	—	
Adeps Lance Hydrosus "	2	Nil	—	
Æther, Anæsthetic "	5	—	10	
Ammonii Bromidum "	4	—	2	
Aqua Desillata "	1	Nil	—	
Bucha Folia "	1	"	—	
Capsici Pulvis ozs.	4	"	—	
Chloroform lbs.	10	—	20	
" Methyl. "	1	Nil	—	
Collodium ozs.	8	—	5 lbs.	
Gallæ Pulvis "	8	—	4	
Hydrarg. Perch. Tabloids ... No.	—	—	5,000	
" " " lbs.	1	—	10	
Ipecac. Pulv. Sine Emetine, 5-grain tabloids No.	—	—	1,000	
Liq. Arsenii et Hydrarg. Iodidi ... ozs.	8	Nil	—	
Liq. Iodi Fortior lbs.	2	"	—	
Liq. Picis Carb. "	2	"	—	
Mistura Pro Diarrhœa "	1	"	—	
Oleum Cassie ozs.	1	"	—	
Paraffinum Molle c. Hg. lbs.	2	"	—	
Oxidi Rubri (iv grs. to 3i) "	2	"	—	
Phenazonum (Antipyrin) "	2	—	1	
" 5-gr. tabloids No.	—	—	250	
Pills and Tablets "	—	—	5	
Tablets No. 1 tubes	—	—	5	
" No. 2 No.	—	—	5	
" No. 3 "	—	—	5	
" No. 4 "	—	—	5	
" No. 5 "	—	—	5	
" No. 6 "	—	—	5	
" No. 7 "	—	—	5	
Pills No. 8 "	—	—	10	
" No. 9 "	—	—	100	
Tablets No. 10 "	—	—	50	
Pills No. 11 "	—	—	5	
" No. 12 "	—	—	10	
Tablets No. 14 "	—	—	50	
" No. 15 "	—	—	50	
Potassii Bicarbonas lbs.	8	—	4	
" " 10-gr. tabloids No.	—	—	250	
" Nitratis lbs.	2	—	1	
Pulvis Antimonialis ozs.	1	Nil	—	
Quin. Acid. Sulph., 2-gr. tabloids ... No.	—	—	2,000	
" " 5-gr. tabloids "	—	—	2,000	
Scammonii Pulvis ozs.	2	Nil	—	
Senega Radix lbs.	1	"	—	
Senne Radix "	2	"	—	
Sinapis Charta (Rigolot's) boxes	6	—	10	
Sodæ Salicylas, 5-gr. tabloids No.	—	—	1,000	
Tinctura Colchici Sem. ozs.	4	Nil	—	
" Hyoscyamus lbs.	6	—	8	

Medicines.	Regulation allowance.	Not required.	Required.	Remarks.
Zinci Sulphocarbolas ... lbs.	1	—	$\frac{1}{2}$	
Zymine (Ext. Pancreatin), $\frac{1}{4}$ oz. in each bottle ... doz.	—	—	12	For peptonising milk.
Salol., 5-gr. tabloids ... No.	—	—	2,000	
Easton's Syrup, 5-gr. tabloids ... No.	—	—	1,000	
Calcium chloridum ... lbs.	—	—	1	
Trional ... "	—	—	1	
Cord ... "	—	—	2	
Corks, vial ... gross	2	—	4	
" $\frac{1}{2}$ pint ... "	2	—	4	
Gallipots, nested (pannier) ... doz.	2	—	6	
Labels, ward ... No.	500	—	1,000	
" poison ... "	500	—	1,000	
" external use ... "	400	—	1,000	
Packthread... lbs.	$\frac{1}{4}$	—	1	
Paper, filtering ... quires	$\frac{1}{4}$	—	1	
Pill boxes, chip ... papers	6	—	16	
" paper ... "	3	—	10	
Bottles, vial, $\frac{1}{2}$ oz.... doz.	1	—	5	
" " 1 oz.... "	2	—	10	
" " 2 oz.... "	3	—	5	
" " 4 oz.... "	3	—	5	
" " 6 oz.... "	5	—	20	
" " 8 oz.... "	4	—	20	
" " 12 oz.... "	1	—	4	
" fluted, poison, 1 oz. ... "	3	—	5	
Measures, graduated, 2 oz. ... No.	6	—	12	
" " 4 oz. ... "	6	—	12	
Funnels, enamelled, instead of tin... "	6	—	6	
Instruments, appliances, drugs, &c., necessary for Pathological and Bacteriological Laboratory ... No.	Nil	—	1	All to be packed in one case complete.

APPENDIX XX.

EQUIPMENT—GENERAL HOSPITAL.

Surgical.

Items in surgical scale allowed for a general hospital requiring alteration, showing those not required, and those necessary :—

Surgical Materials.	Regulation allowance.	Not required.	Required.	Remarks.
Bandages, calico No.	250	—	500	
„ flannel „	50	—	100	
„ gauze, double cyanide „	250	—	5,000	
„ loose woven, sal-alemb. „	500	—	2,000	
„ triangular, sal-alemb. „	24	—	100	
Camel hair pencils „	50	—	200	
Cotton wool, absorbent lbs.	40	—	100	
„ boric „	12	—	100	
„ double cyanide „	12	—	100	
„ sal-alembroth „	12	—	50	
Catgut in carbolic oil tubes	Nil	—	6	
Drainage tubing (sizes 4 to 10) ... yds.	12	—	21	3 yards of each.
Drainage tubing in antiseptic solution (sizes 1, 2, and 3) ... tubes	12	—	12	
Dredgers, iodoform, vulcanite ... No.	6	—	20	1 for each Nursing Sister.
Eyeshades, single and double ... „	20	—	40	
Gauze, sal-alembroth yds	300	—	1,000	
„ double cyanide „	300	—	2,000	
„ iodoform „	60	—	1,000	
Gutta percha for splints lbs.	2	—	10	
Jaconet waterproof yds.	25	—	100	
Leathers, chamois No.	Nil	—	12	
Lint, boric lbs.	60	—	100	
„ fine „	50	—	200	
„ second quality „	50	—	200	
Needles, surgeons' (in vulcanite cases) No.	Nil	—	12	
Pins, common pkts.	6	—	24	
„ safety boxes	12	—	100	
Plaster, tape, 6-inch tins No.	12	—	50	
„ „ 1-inch tins „	24	—	100	
„ soap, cerate „	6	—	3	
Plaster of Paris, $\frac{1}{2}$ lb. tins No.	24	—	100	
Sheets, old linen „	12	—	Nil	
Sheeting, bleached linen yds.	6	—	24	
Silkworm in carb. glycer. tubes	Nil	—	10	
Spongio piline yds.	6	—	20	
Surgeons' sponges No.	24	—	Nil	
Syringes, male, glass „	24	—	50	
Tenax „	50	20	30	
Waterproof cloth, black yds.	12	—	50	
Air beds boxes	2	—	6	
Air pillows, round No.	6	—	24	
Anvil for making splints „	Nil	—	1	
Arm slings, leather „	4	—	10	
Caustic holders „	1	—	30	1 for each Nursing Sister.
Crutches, spring heads and rubber heels pairs	Nil	—	12	
Double inclined plane wires No.	„	—	4	
Dressing trays, glass (in place of those at present tabulated) „	—	—	24	
Fracture boxes, general „	2	Nil	—	Certain portion of contents selected.
„ cradles, iron portable „	6	—	24	
„ jaw apparatus „	Nil	—	2	
„ patella „	„	—	1	
Large box of carpenters' tools for making splints, &c. „	„	—	1	See Ordnance Mobilization List.
Hones, Arkansas, slip „	2	Nil	—	
Ice bags, head „	Nil	—	12	
Knives, opening, tin „	„	—	6	

Surgical Materials.	Regulation allowance.	Not required.	Required.	Remarks.
Measuring tapes	2	—	30	1 for each Nursing Sister.
Rods, glass... ..	6	—	30	Ditto.
Scissors, counter, long and short pairs	2	—	8	4 pairs each size.
Spatulas, bone No.	2	—	30	1 for each Nursing Sister.
Splints, common sets	6	—	12	
„ wire, arm, with tapes ... pairs	Nil	—	12	
„ „ leg, right No.	„	—	12	
„ „ leg, left	„	—	12	
„ „ thigh	„	—	12	
„ thigh, long (Liston's)	2	—	6	
Swing cradles (Salter's)	4	—	8	
Splints, elbow, jointed, wire	Nil	—	12	
„ „ (Jones')	„	—	6	
„ forearm, wire pairs	„	—	12	
„ leg, tinued-iron No.	„	—	6	
„ thigh, jointed wood	„	—	2	
Strops	2	—	4	
Thermometers, clinical, in case	12	—	150	
Trusses, steel, single (in sizes Nos. 30 to 38)	Nil	—	50	
Tubing for aspirator yds.	„	—	6	
Water beds... .. No.	„	—	2	
Apparatus, counter, extension	„	—	1	
„ dislocation	„	—	1	
Shears for cutting zinc bandages pairs	„	—	1	
„ for cutting gypsum bandages	„	—	1	
Scales of Medical and Surgical Equipment, as shown in Section 6 "Field Manual for General and Stationary Hospitals," are not required, viz. :—				
Medical companion and water bottle.				
Surgical haversack and water bottle.				
Field medical panniers.				
Reserve field medical panniers.				
Field surgical panniers.				
Field fracture box.				
Antiseptic case.				
Amputating instruments No.	1	—	—	Other provision made.
Aspirators for use with any bottle	Nil	—	2	
Bougies (Lister's), plated, in case	Nil	—	1	
Electro magnetic machine (large size)	„	—	1	
Hypodermic cases... ..	3	—	24	
Irrigators (Cripps'), with tubing	Nil	—	2	Spare glasses for same to be kept at base depôt.
Spare tubing for above	„	—	6	
Nozzles for above	„	—	6	
Microscope, large, in case (Appendix No. 22)	„	—	1	
Post-mortem instruments... ..	1	—	2	
Razors	Nil	—	6	For operating theatre.
Speculum, ani	„	—	1	
„ auris	„	—	1	
Spray producers (Listers')	1	—	—	
„ „ (Richardson's)	1	—	—	
Stethoscopes, double, aural	Nil	—	2	
Syringes, ear, brass	2	—	12	1 for each Surgical Sister.
„ enema (Higginson's)	Nil	—	25	1 for each Nursing Sister.
Tonsil guillotine	„	—	1	
Tooth instruments (Appendix No. 25)	„	—	1	
Tooth-stopping instruments (Appendix No. 24)	„	—	1	
Tourniquet screw	6	—	2	
Esmarch's solid india-rubber band tourniquets	Nil	—	10	To allow for deterioration by climate.
Esmarch's bandages	„	—	6	

Surgical Instruments.	Regulation allowance.	Not required.	Required.	Remarks.
Urinometer apparatus (Appendix No. 30) No.	Nil	—	1	Add soloids of Fehling's test for sugar.
Water analysis case (Appendix No. 13) "	"	—	1	
Forceps, polypus "	"	—	1	
Insufflators, vulcanite "	"	—	2	
Laryngoscope (Mackenzie's) "	"	—	1	
Ophthalmoscope (Morton's) "	"	—	1	
Ophthalmic lamp, for oil and gas "	"	—	1	
Pollitzer's bag apparatus... .. "	"	—	1	
Polypus snare "	"	—	1	
Rib shears, long handle "	"	—	1	
Tongue forceps "	"	—	1	
Trocar and tubes for Anasarca (Southey's) "	"	—	1	
Volckmann's scoops (set 4) "	"	—	1	
Catheters, silver (case 12) "	"	—	1	
Eye instruments case	"	—	1	
Trial lenses for testing sight "	"	—	1	
Fistula director No.	"	—	1	
Drop bottles for chloroform "	"	—	2	For operating theatre.
Forceps, haemorrhoidal "	"	—	1	Ditto.
Hooks, blunt "	"	—	2	Ditto.
" sharp "	"	—	2	Ditto.
Ligature trough, aseptic "	"	—	2	Ditto.
Needles, suture, straight, sizes ... pkts.	"	—	4	Ditto.
Needles, suture, curved (Lister's), sizes "	"	—	4	Ditto.
Scissors, curved on flat, large ... No.	"	—	1	One in case of operating instruments, two necessary.
Steriliser (Schimmelbusch) "	"	—	1	For operating theatre.
Case of operation instruments, 1903 "	"	—	1	Ditto.
Syringes, exploring "	"	—	1	Ditto.
Trays, glass, for catheters "	"	—	2	Ditto.
" " dressing, large "	"	—	6	Ditto.
" " " small "	"	—	6	Ditto.
Aseptic instrument cabinets "	"	—	2	One supplied in S. Africa too small.
" hooks for ditto "	"	—	12	Ditto.
" stands for instruments "	"	—	2	Ditto.
" stool for anaesthetist "	"	—	1	Ditto.
" washstand, with two large basins "	"	—	1	Ditto.
" table, operating (Messrs. Downes') "	"	—	1	See Ordnance Equipment List
Widal's test; apparatus and materials for "	"	—	1	
Bone drills (Archimedean), with six drills... .. "	"	—	1	
Forceps, necrosis, straight "	"	—	1	
" " curved "	"	—	1	
Trophine, conical, $\frac{1}{2}$ and $\frac{3}{4}$ inches "	"	—	2	
Mallet "	"	—	1	
Chisels, one plane, one gouge "	"	—	2	
Hernia needles sets	"	—	1	
Urethrotome (Civiale) No.	"	—	1	
Gimlets sets	"	—	1	
Silver wire, reels No.	"	—	2	One in operating case not sufficient.
Forceps, trephine (Hoffman's) "	"	—	1	
" (Sime's) "	"	—	1	
Gag, mouth "	"	—	1	
Tubes, silver, empyema "	"	—	1	
Catheter, Eustachian "	"	—	1	
Aprons, operating... .. "	"	—	8	
Jackets, operating... .. "	"	—	8	

Surgical Instruments.	Regulation allowance.	Not required.	Required.	Remarks.
Gloves, post-mortem ... pairs	Nil	—	2	
Brushes, nail ... No.	"	—	6	
" tooth ... "	"	—	100	
Murphy's buttons ... sets	"	—	1	
Large steriliser for dressings ... No.	"	—	1	
Keetley's stretchers ... "	"	—	5	

APPENDIX XXI.

ORDNANCE EQUIPMENT FOR A GENERAL HOSPITAL NOW CONSIDERED NECESSARY.

Woolwich Store Charge, No. 2—

	Number.
1. Ships' masthead lamps (in place of lanterns, tent, distinguishing, white), as stronger and not easily blown out, also more serviceable ...	—
2. Buckets, galvanised iron (instead of buckets, water, G.S., leather) ...	50
3. Tents, E.P.I.P., ordinary size... Or tents, E.P.I.P., large size, specially recommended for hospital wards (<i>see</i> Report) ... Together with above smaller size, E.P.I.P. ...	130 75 30
4. The Indian Field Officers' tent, with bath room, instead of tents, circular, double, linen, for use of Officers and Nursing Sisters (<i>see</i> Report) ...	62
5. Sheets, grounds (waterproof both sides), white, for enteric and dysentery patients' beds ...	250

Woolwich Store Charge, No. 3—

1. Lanterns, light, folding pattern, instead of candlesticks ...	100
2. Hurricane lamps, with porcelain burners and detachable reflectors, in place of lamps, F.H.P., recommended ...	100
3. Operating table, aluminium or metal, patent and portable with accessories ...	1
4. Stoves, Soyer's. Necessary ...	15
5. Primus stoves, in place of Rippingille's, for Nursing Sisters' duty tents ...	12
6. Covers, bed-pan, iron enamelled, as per design ...	150
7. Pannikin, pint, iron enamelled, and basins, iron enamelled, 6-inch soup (as per design), covers 7 inches diameter ...	650
8. Stretchers, ambulance, on light strong wheels, with collapsible hood (suggest pattern as supplied to R.V.H., Netley) ...	12

Woolwich Store Charge, No. 7—

1. Nail pullers for opening packing cases ...	2
---	---

Woolwich Store Charge, No. 11—

1. Brushes, paint, various sizes ...	6
2. " sash tools, various sizes ...	6

Woolwich Store Charge, No. 25—

	Number.
1. Baths, slipper, for Officers and ward use	6
2. Bowls, shaving, enamelled, instead of wood... ..	100
3. Boxes, bread, metal enamelled, 9 inches square	600
4. Boxes, surgical dressing, with tray on top inside aluminium or enamelled iron, with handle on top, for Nursing Sisters. Size 14" x 14" x 14"	35
5. Chairs, Bath, on wheels	4
6. Champagne wire nippers	35
7. " taps	35
8. Syringes, garden, brass, large size, for disinfecting inside of tents, &c.	4
9. Tapes, measuring (100 feet)	2
10. One large automatic syphon, Berkefeld filter, with about 250 candles, for attachment to water pipe supply	1
11. Berkefeld filters, two or three candles	6
12. Salt cellars, iron enamelled, in place of wooden ones	100
13. Testers, milk (in case, complete)	2
14. Urinals, iron enamelled (in place of earthenware)	100
15. Warmers, stomach, india-rubber (in place of metal)	25
16. " foot, india-rubber (in place of metal)	25
17. Chairs, arm, folding, hospital (a much simpler and stronger one necessary)	50
18. Kettles, tea, 2-quart, iron enamelled (instead of iron)	50
19. Stools, night, Fyffe's (recommended those made folding in place of stools, close, F.H.)	100
20. Tables, bedside (to be of light construction, with 3 shelves)	620

Woolwich Store Charge, No. 26—

1. Bedsteads, folding (2 feet 9 inches wide, 1 foot 6 inches high), with folding head-piece and legs, and no foot- piece; fitted with closely woven wire mattresses	650
2. Forms folding, 4 feet } of lighter pattern, and folding	125
3. " " 6 feet } (Pattern requires improving and strengthening.)	
4. Pails, iron enamelled, water (cleaner and easier kept clean than galvanised)	100
5. Tables, folding, 4 feet by 2 feet (for hospital wards)	125
6. Machines, mincing, large (instead of small)	2

Woolwich Store Charge No. 27—

1. Beds, hospital, hair (reduced to 2 feet 9 inches wide instead of present width)	650
2. Rugs, hospital, surgical (or coloured counterpanes, the old surgical rug an excellent pattern, in place of white counterpanes)	650
3. Blankets, G.S., to be replaced by blankets, colour dark grey, preferable to brown, and a distinct colour... ..	3,500

Stationery Office Supplies.

1. "British Pharmacopœia"	1
2. "Grey's Anatomy," with plates	1
3. A treatise on surgery	1
4. A practice of medicine	1
5. A treatise on bacteriology	1
6. Nomenclature of diseases	1
7. A Church of England Prayer Book (for burial of dead)	1
8. A Roman Catholic Prayer Book (for burial of dead)	1
9. Army Form C 345 (Orders for Patients in Military Hospitals)	100
10. " " C 343 (Orderly Medical Officers' Report)	500
11. " " A 27 (Daily State of Sick)	100
12. " " I 1203 (Diet Tables)	100

Stationery Office Supplies—continued.

	Number.
13. Mill boards, with eyelets, for ward orders, &c.	250
14. Labels, linen, for labelling kits, &c.	5,000
15. Paper fasteners boxes	12
16. Boxes, stationery, field	6

Royal Army Clothing Department Stores.

1. Chest of shoemakers' tools complete, large size	1
2. Box of tailors' necessities (should be made to contain all necessities for mending and altering clothes, including sewing machine)	1

Ordnance Stores (not Catalogued).

1. Officers' hospital, inventory, sitting, dining, and ward.	
2. Tools, carpenters', in box, large (ample supply necessary for mending tables, forms, bedside tables, &c.)	1
3. Box of sailmakers' necessities, for repairing marquees, tarpaulins, &c.	1
4. Ranges, cooking, large size, with two ovens and hot water boilers in each for hospital kitchens	6
5. Cradles, bed, for surgical use... ..	50
6. Ordnance store tents	4
7. Sanitary zinc cisterns, on wheels, large size (for removal of slops from dispensary, sculleries, operating theatre, &c.)	20
8. Hair clipping machines	4
9. Fracture boards for bedsteads	20
10. Sterilisers, milk (Aymard's), sufficient for 150 gallons milk	—
11. Machine for making ice, large	1
12. Cans, milk, various sizes, from one to four gallons ... nests	6
13. Milk ladle (size 1 pint)	6
14. Hand carts or vans, on springs, light make and portable (one painted red and one grey, dark)	2
15. Tablets, enamelled iron, designations for various huts, viz.—“Dispensary,” to be screwed on doors (set complete) ...	1
16. A typewriter	1
17. Surgical shirts... ..	100
18. Bins, with covers, for dry ward refuse, large size, 2½ feet by 1½ feet	30
19. Bicycles for messengers' use	2

ORDNANCE EQUIPMENT FOR A GENERAL HOSPITAL.

*Recommended to be Increased.**Woolwich Store Charge, No. 2—*

1. Tents, complete, circular, double, linen	60
2. Tools, entrenching { axes, pick, heads 6½ lbs.	20
“ “ helves 34½ lbs.	20
shovels, universal	20

Woolwich Store Charge, No. 3—

1. Basins, iron enamelled, 14-inch	125
2. “ “ 6-inch, soup	700
3. Jugs, “ field hospital, 2-quart	125
4. “ “ 1-quart, with covers	50
5. Panniers “ 1-pint	700
6. Pans, bed “ 	150
7. Pots, chamber, iron enamelled	150
8. Trays, soap “ 	100
9. Clocks, circular, of better pattern (not in vocabulary) ...	6

Woolwich Store Charge, No. 25—

	Number.
1. Boards diet scale	100
2. Bowls, shaving, iron enamelled (in place of wood)	100
3. Brooms, bass { heads, tropical climates	50
handles, "	50
4. Cans, gruel (Mark II)... ..	100
5. Brushes, hair	600
6. Feeders, iron enamelled (substitute for "feeders, earthen")	120
7. Glasses, looking (inclusive and for Nursing Sisters)	100
8. Mats, coir, 3 feet by 2 feet	12
9. Measures, glass, 2-oz.	75
10. Pails, slop (with cover), iron enamelled	150
11. Refrigerator, large	12
12. Salt cellars, iron enamelled	100
13. Screens, bedside (Mark II)	25
14. Sponges, bath	25
15. Stands, wash-hand, hospital	12
16. Urinals, iron enamelled, or toughened glass	100
17. Whisks, egg	25
18. Tables, bedside, increased in size to measurements, 2 feet wide by 1 foot 3 inches deep, and should have another shelf 4 inches from foot. One required for each Nursing Sisters' duty tent	630

Woolwich Store Charge, No. 27—

1. Mops, common, heads	25
2. " " handles	25

*Recommended to be Decreased.**Woolwich Store Charge, No. 26—*

1. Tables, base hospital, Mark I	75
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ORDNANCE EQUIPMENT AS NOW SHOWN IN MOBILIZATION STORE TABLES
FOR A GENERAL HOSPITAL.

"Not Required."

A.F. G.
1098-59.

Woolwich Store Charge, No. 2—

1. Tents, circular, single linen. Unsuitable—too hot in tropical climates, too cold in winter.
2. Buckets, water, G.S. leather (substitute iron galvanised 50).
3. Marquees, hospital. Unsuitable. Report attached.
4. Lanterns, tent, distinguishing, white. Unsuitable—too fragile, easily broken, light easily blown out (substitute ships' mast-head lamps).

Woolwich Store Charge, No. 3—

1. Candlesticks, enamelled (substitute light folding lantern).
2. Cases, cylinder, charcoal. Useless.
3. Cylinders, charcoal. Useless.
4. Lanterns, field hospital (substitute hurricane lamps).
5. " " glasses. Not necessary.
6. Stoves, oil, Rippingille's No. 55 (substitute "Primus").
7. Tables, operating, folding. Unsuitable. A portable patent, with accessories, required.
8. Stools, close, field hospital, nests of (substitute Fyffe's night stools).

Woolwich Store Charge, No. 25—

1. Filters, earthenware, 4-gallon, Morris, Mark II. Useless.
2. " " carbon, coarse. Useless.
3. " " " fine. "
4. Warmers, stomach. Unsuitable (substitute indiarubber).

Woolwich Store Charge, No. 27—

1. Counterpanes, white. Unsuitable—easily dirtied (substitute surgical rugs or coloured).

APPENDIX XXII.

MEDICAL AND SURGICAL EQUIPMENT RECOMMENDED FOR STATIONARY HOSPITAL.

	Number.
Medicine chest (Appendix 33)	1
Medical companions (Appendix 34A)	4
Surgical haversacks (" 35A)	4
Field medical panniers (Appendix 36A)	2
Reserve field medical panniers (Appendix 38A)	2
Surgical instruments and appliances (Appendix 16), without case of surgeon's instruments, one case already in field surgical pannier (Appendix 39A)	1
Field surgical panniers (Appendix 39A)	2
General fracture boxes (" 32)	2
Antiseptic cases (Appendix 42)	4
Tablet medicine case (Appendix 46)	1
The case of surgeon's instruments (Appendix 20A) now in field surgical pannier (Appendix 39A) should be replaced by case of operation instruments, 1903	1
The field fracture box (Appendix 40A) should be replaced by general fracture box (Appendix 32)	
Post-mortem instruments case	1
Syringes, ear, brass	2
Nail brushes	4
Aspirator, for use with any bottle	1
Speculum, ani	1
" auris	1
Tongue forceps	1
Esmarch's solid india-rubber tourniquets	4
Aprons, operating, and jackets, ditto of each	4
Gloves, post-mortem pairs	1
Inhalers (Burney Yeo's)	6
Clinical thermometers (in addition)	25
Water cushions, 2 feet by 3 feet	25

APPENDIX XXIII.

ORDNANCE EQUIPMENT.

Articles proposed to be added and increased—Stationary Hospitals.

Articles.	Totals.	Remarks.
<i>Woolwich Store Charge, No. 2.</i>		
Axes, pick, heads	6	Increased.
" helves	6	"
Shovels	6	"
Buckets, water, G.S., leather or canvas ...	20	Increased, in case of fire, &c.
Sheets, waterproof	50	In place of ground sheets, Mark III.
Stools, camp, Mark III	25	Increased.
Tents, complete hospital, E.P.I.P., with tarpaulins for floors.	30	Added. Changed from marquees to E.P.I.P. Includes 2 Officers' and Sisters' mess each, 1 night duties, 1 operating, stores, Officers, &c.
Tents, complete, double circular, with tarpaulins for floors.	45	Added. Changed from single to double.
Tents, store, ordnance	2	Added, for stores.
Lamps, ship's masthead	4	Added, in place of lanterns, tent, distinguishing, white.
<i>Woolwich Store Charge, No. 3.</i>		
Basins, iron, enamelled, 14-inch	25	Increased.
" " 7½-inch	25	"
" " 6-inch, soup	150	"
Cups, iron, drinking, 1 pint	150	Increased. (To be enamelled.)
" egg	50	" " "
" spitting	25	" " "
Feeders, iron, enamelled	50	Increased and changed from earthenware to enamelled.
Filters, Pasteur-Chamberland or Berkefeld ...	4	Increased and changed from charcoal to Pasteur-Chamberland or Berkefeld.
Candles, for above (extra)	12	Added.
Curtains, mosquito	20	"
Flannel, white yards	18	Increased.
Pans, bed, iron, enamelled	25	Increased and changed from zinc to enamelled iron.
Plates, dinner, iron, enamelled	150	Increased.
Pots, chamber, " "	35	"
" tea, " "	12	"
Stoves, Soyer's	4	Added.
" or ranges, Congo	2	In place of stoves, portable.
Dishes, butter, iron, enamelled, F.H. ...	150	Added.
Forks, dinner, electro-plated	13	Added, for Sisters' use.
Tongs, sugar, " "	2	" " "
Knives, dinner, white-handled	13	" " "
Jugs, iron, enamelled, with covers, 2 quarts ...	25	Added, 13 for Sisters.
" " " 1 quart	15	Added.
Ladles, soup	1	Added, for Sisters' use.
Lanterns, hurricane lamp with reflectors ...	60	In place of lanterns F.H. 13 for nursing Sisters' use.
Stoves, oil, Primus	6	Added.
Chairs, Officers' folding, F.H.	6	Added. Stronger pattern necessary.
Lamps, bull's-eye	4	In place of lamps, hand, small.
Stands, cruet, electro-plated	2	Added, for Sisters' use.
Lamps, operating (acetylene suggested) ...	4	In place of lamps F.H. N.P.
Tureens, soup, metal	1	For Sister's use.
Trays, soap, iron, enamelled	25	Added.
Clocks, circular	2	"
Whisks, fly	100	"
Netting, fly (yards)	100	"

Articles.	Totals.	Remarks.
<i>Woolwich Store Charge, No. 25.</i>		
Basins, washing, zinc	25	Added.
Brushes, scrubbing, hand, Mark II	24	Increased.
" hair	24	"
" shaving	24	"
" whitewash	12	"
" sweeping, long, complete	24	"
Cans, gruel, Mark II	24	"
Chairs, arm, folding	24	Added. A very strong pattern necessary.
Combs, dressing	24	Increased.
" small tooth	6	Added.
Colanders	2	"
Corkscrews... ..	12	Increased.
Boxes, iron, enamelled, white, bread, 9 inches square.	150	Added.
Forks, dinner	150	Increased.
" toasting	1	Added.
Knives, dinner	150	Increased.
Salt cellars, iron, enamelled	24	Changed from wood to enamelled.
Scissors, lamp	4	Increased.
" hair cutting	16	Increased, 12 for Sisters' ward use.
Machines, hair cutting, clipping... ..	4	Added.
Shapes, pudding, 1 pint	24	"
Warmers, foot, indiarubber	12	} Changed from metal to india-rubber.
" stomach, indiarubber... ..	12	
Baths, arm	2	Added.
" long, open	1	"
" hip	6	Added, 2 for nursing Sisters.
Bells, hand... ..	1	Added.
Boards, diet scale	25	"
" inventory	25	"
" knife	4	"
" bedheads	150	"
" notice	6	"
Bowls, shaving	24	"
Boxes, library, with shelves	4	Added, for nurses' duty tents.
Brooms, bass, heads	12	Added.
" handles	12	"
Castors, pepper	12	"
Cradles, bed	10	"
Cups, tea, iron, enamelled	24	Added, for Sisters' use.
Saucers, "	24	" " "
Forks, carving	2	" " "
Games, packs of cards	50	Added.
Knives, carving	2	Added, for Sisters' use.
" bread	1	" " "
" tin-opening	12	Added.
Glasses, looking	36	Added, 13 for Sisters' use.
Measures, glass, toughened, 4 ozs.	36	Added.
" oil, iron, enamelled, 1 quart	1	"
" " " 1 pint	2	"
" " " 1 gill	2	"
Gridirons	2	"
Graters, bread	1	"
Infusers, tea	6	"
Inkstands	3	"
Mats, coir fibre, 3' x 2'	6	"
Refrigerator, large	1	"
" small	1	"
Screens, bedside	6	Added. (Strong pattern and hinges, 3-fold.)
Spittoons	10	Added.
Sponges, bath	20	Increased.
Spoons, gravy	2	Added.
" table	150	Increased.
" salt	24	Added.
" mustard	24	"
" electro-plated, tea	20	Added, for Sisters' use.
" electro-plated, dessert	20	" " "
Stand, wash-hand, H.P.	15	" 13 for Sisters.
Sterilisers, milk, large	1	Added.
Strainers, gravy	1	"
" hair	1	"
Tables, bedside	150	Added. Should have 3 shelves.

Articles.	Totals.	Remarks.
Trays, diet, 10 diets	24	Added.
" dinner	24	"
" dressing	4	"
Urinals, toughened glass or iron enamelled ...	25	Increased and changed from zinc.
Whisks, egg	6	Added.
Kettles, fish	1	"
" tea, 2-quart	24	"
Mops, common, handles	12	"
Pails, slop, iron, enamelled	30	"
Pots, coffee, iron, enamelled	2	Added, for Officers.
" mustard	24	Added.
Squeezers, lemon	6	"
Trays, diet, with tins	3	"
" dressing	4	"
Tumblers, $\frac{1}{2}$ pint	50	Added, for ward use.
" "	26	" for nursing Sisters.
<i>Woolwich Store Charge, No. 26.</i>		
Pails, iron, galvanised	24	Increased.
Bedsteads, Lawson Tait, folding, H.P., ...	150	Added. Size, 2' 9" x 6' 6" x 1' 6" for patients and nursing Sisters' use.
Tables, folding, 4' x 2'	50	Special size for hospitals recommended.
Forms, folding, 4 feet	50	Added.
Machine, weighing	1	In place of balance spring, 200 lbs., Mark I.
" mincing, large	2	Increased.
Pokers, soldiers	4	Added.
Shovels, "	4	"
Tubs, ablution, large	6	Added, for disinfecting purposes.
" wood, large	4	" " " "
" coal	12	Added, for refuse.
Steam disinfecting apparatus	1	" portable, on wheels.
<i>Woolwich Store Charge, No. 27.</i>		
Belts, restraint, lunatic	1	Added.
Blankets, G.S. (grey)	500	Increased.
Towels, hand, H.P.	400	"
Bolsters, H.P.	150	Added.
Beds, H.P., in three pieces (reduced size) ...	150	"
Cases, slip, bed, H.P.	200	"
" bolster, H.P.	200	"
" pillow, H.P., large	400	"
" " small	100	"
Mops, common, heads	12	"
Nets, potato	4	"
Cloths, table	50	"
Pillows, H.P., large	150	"
" small	25	"
Towels, H.P., round	50	"
Rugs, H.P., surgical, or coloured counterpanes...	150	Added, instead of counterpanes.
Sheets, H.P., cotton	500	Added.
Napkins, table	24	Added, for Sisters' use.
<i>Also Hospital Clothing.</i>		
Necessary for 120 patients	—	Added.
<i>Woolwich Store Charge, No. 29.</i>		
Safe, iron	1	Added, in place of "boxes, cash."
Wagons, ambulance, Mark V	3	Added.
" G.S., complete	2	"
Carts, forage	1	"
" water tank	2	"
Harness sufficient for transport	—	"
<i>Stationery Office Supplies.</i>		
Stationery boxes	2	Added. To include, in addition, "Nomenclature of Diseases." A "Treatise on Surgery" (Erichsen's). A "Practice of Medicine." 200 labels for kits and rifles.

Articles.	Totals.	Remarks.
<i>Woolwich Store Charge, No. 2.</i>		
Sheets, ground, Mark III	50	Reduced.
Tents, circular, single, linen	—	Not required. Withdrawn. Double circular substituted.
" operating	—	Substitute E.P.I.P.
" marquee, H.P.	—	Not required. Substitute E.P.I.P.
<i>Woolwich Store Charge, No. 3.</i>		
Cases, cylinder, charcoal	—	} Not required. Out of date. Berkefeld filters substituted.
Cylinders, charcoal	—	
Filters, charcoal	—	} Not required. Now a surgical equipment.
Tables, operating, folding	—	
Mattresses, operating table	—	Not required. Not necessary.
Panniers, canteen, empty, with padlock and keys (A, B, C, D)	—	
Stretchers, ambulance, Mark IV	12	Reduced. Beds folding, hospital substituted.
<i>Woolwich Store Charge, No. 25.</i>		
Charcoal, animal, granulated, powdered	—	Not required. Withdrawn. Not necessary.
Inhalers	—	Not required. See medical equipment.
Inhalers, tubes for	—	Not required. See medical equipment.
Scoops, flour, $\frac{1}{2}$ pint	2	Reduced.
Straps, bed	—	Not required. Withdrawn. Not necessary.
Urinals, zinc	—	Not required. Out of date. Withdrawn. Enamelled substituted.
Warmers, stomach, metal	—	Withdrawn. Indiarubber substituted.
<i>Woolwich Store Charge, No. 26.</i>		
Balance, spring, 200 lbs., Mark I	—	Not required. Machine, weighing, substituted.
<i>Woolwich Store Charge, No. 27.</i>		
Cases, bolster and paillasse, barrack	—	Withdrawn. Not necessary. Bedding substituted.
Sheets, barrack	—	Withdrawn. Sheets H.P. substituted.

APPENDIX XXIV.

MORNING STATE.

Hospital at _____

Date _____

—	Remained.	Admitted or transferred from	Discharged or transferred to	Died.	Remaining.	Enteric fever.	Dysentery.	G.S. wounds.	Other diseases.	Total.
Officers									
Other ranks									

Officers in Hospital.

Corps.	Rank and name.	Disease.	Progress.	Date of being on or off list.	Remarks.

Dangerously Ill.

Corps.	No.	Rank and name.	Disease.	Date wired to "Casualty."	Remarks.

(3959)

Deaths.

Corps.	No.	Rank and name.	Disease.	Date wired to "Casualty."	Remarks.

Signature _____

3 A

APPENDIX XXV.

Army Medical Corps,
Victoria Barracks, Sydney,
February 10th, 1902.

From
Colonel W. D. C. WILLIAMS, C.B.,
P.M.O., New South Wales Military Forces.
To
Surgeon-General Sir W. D. WILSON, K.C.M.G.,
P.M.O., Army.

Subject—Army Medical Corps, Australian Commonwealth Contingent.

SIR,

I have the honour to forward in duplicate the establishment of organisation, personnel, transport, horses, and harness of the 100-bed field hospital and half bearer company Federal Army Medical Corps units, which will embark to-morrow, February 11th, 1902, for South Africa, by transport "Manchester Merchant."

It has been arranged by the Imperial Government that the medical and surgical field equipment shall be drawn in South Africa.

Ordnance stores of both units are practically complete.

I have, &c.,
W. D. C. WILLIAMS,
Colonel, P.M.O.

New South Wales Military Forces.—General Order 16.

Headquarters, Victoria Barracks, Sydney,
Tuesday, January 28th, 1902.

Commonwealth Contingent.—The following is the establishment of the Army Medical Corps unit for service in South Africa:—

(1) Field Hospital of 100 Beds, 60 all Ranks.

Distribution.	Personnel.										Horses.			Vehicles.			Harness.	Saddlery.	
	Major.	Captains.	Lieutenant.	Quartermaster.	Wt. Officer.	Staff Sergeants.	Sergeants.	Corporals.	Privates.	Total.	Public.		Total.	Transport wagons.	Water cart.	Total.			
											Private.	Riding.							Drayht.
Officer in charge	1		1							1				1					
General duty
Quartermaster	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Chief Wardmaster	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Assistant Wardmaster	1*	...	...	...	...	...	...	...	...	...	...	...	...	...
Stewards	14	...	...	...	...	...	...	...	...	...	...	...	...	...
Compounders
Cooks
Pack store keeper
Clerks
Ward orderlies
Messenger
Washermen
Supernumeraries
Servants and batmen
Total medical details	1	2	1	1	1	2	5	4	26	43	5	1	1	6	1	1	1	1	1
<i>Transport.</i>																			
Staff sergeant	1*	1	1	1	1	1	1	1	1	1	1	1	1	1
Sergeant
Corporals	2	...	...	...	...	...	...	...	...	...	...	...
Shoing and carriage smith	1	...	...	...	...	...	...	...	...	...	...	...	...
Drivers, transport wagons	10	10	...	...	20	20	10	1	10	10	...
" water cart	1	1	...	...	2	2	1	1	1	1	...
" supernumerary	1	1	...	...	...	...	...	...	...	...	...
Total transport details	1	2	2	12	17	...	2	22	24	10	1	11	11	2
Total in the field	1	2	1	1	1	3	7	6	38	60	5	3	22	30	10	1	11	11	3

* Second-class staff sergeant.

† First-class staff sergeant.

(2) *Beaver Company, 50 all Ranks,*

Distribution.	Personnel.								Horses.				Vehicles.				Harness.		Saddlery.		
	Major.	Captain.	Lieutenant.	Warrant Officer.	Staff Sergeant.	Sergeants.	Buglers.	Corporals.	Privates.	Total.	Private.	Public.		Total.	Ambulance wagons.	Transport wagons.	Water cart.	Total.		Wheel and lead sets.	Wheel, double.
												Riding.	Drayht.								
One stretcher section	1	1	1	1	1	1	1	1	16	18	1	1	1	1	1	1	1	1	1	1	1
Collecting station	1	1	1	1	1	1	1	1	2	4	1	1	1	1	1	1	1	1	1	1	1
Wagon orderlies	1	1	1	1	1	1	1	2	2	4	1	1	1	1	1	1	1	1	1	1	1
Dressing station	1	1	1	1	1	1	1	2	1	4	2	1	1	2	1	1	1	1	1	1	1
General duty	1	1	1	1	1	1	1	1	1	4	1	1	1	2	1	1	1	1	1	1	1
Compounder...	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
Cook ...	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1
Quartermaster-Sergeant	1	1	1	1	1*	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1
Batmen ...	1	1	1	1	1	1	1	1	3	3	1	1	1	1	1	1	1	1	1	1	1
Total medical details ...	1	1	1	1	1	2	1	4	22	34	3	1	1	4	1	1	1	1	1	1	1
<i>Transport.</i>																					
Sergeant ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Farrier ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Collar-maker	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Drivers, ambulance wagons...	1	1	1	1	1	1	1	1	8	8	1	1	1	16	4	4	1	4	4	4	4
" transport wagons ...	1	1	1	1	1	1	1	1	4	4	1	1	1	8	1	1	1	4	4	4	4
" water cart ...	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1
Total transport details...	1	1	1	1	1	3	1	1	13	16	1	1	1	26	4	4	1	9	4	5	1
Total in the field ...	1	1	1	1	1	5	1	4	35	50	3	2	26	31	4	4	1	9	4	5	2

* First-class staff sergeant.

APPENDIX XXVI.

No. 2 AMBULANCE TRAIN.

General Totals for Months and Years.

—	Officers.	N.C.O.'s and Men.	Total.	Deaths.	Mileage.	Short Trips.	Long Trips.	Total.
November, 1899	17	345	362	2	2,440	2	4	6
December, "	35	732	767	3	5,164	7	8	15
January, 1900	18	286	304	1	3,893	3	6	9
February, "	28	435	463	—	6,246	2	9	11
March, "	19	540	559	—	6,316	3	10	13
April, "	28	349	377	—	5,952	2	6	8
May, "	35	622	657	1	5,567	10	5	15
June, "	59	375	434	—	3,805	6	3	9
July, "	22	267	289	—	4,558	2	4	6
August, "	7	172	179	—	3,280	2	3	5
September, "	8	160	168	—	3,492	—	4	4
October, "	23	349	372	—	4,538	2	5	7
November, "	3	426	429	—	3,168	2	4	6
December, "	12	178	190	—	2,480	2	2	4
January, 1901	20	401	421	—	4,853	3	4	7
February, "	4	88	92	—	2,080	—	2	2
March, "	3	99	102	—	2,080	—	2	2
April, "	8	228	236	—	3,496	—	4	4
May, "	1	140	141	—	1,241	2	1	3
June, "	10	265	275	—	2,248	4	2	6
July, "	13	176	189	—	2,497	—	3	3
August, "	4	110	114	—	2,080	—	2	2
September, "	5	213	218	—	3,246	—	4	4
October, "	6	201	207	—	2,146	4	2	6
November, "	—	96	96	—	1,498	—	2	2
December, "	13	357	370	—	3,104	7	2	9
January, 1902	14	425	439	—	4,714	8	3	11
February, "	16	881	897	—	3,406	19	—	19
March, "	4	397	401	—	2,903	7	2	9
April, "	3	255	258	—	2,693	1	3	4
May, "	13	212	225	—	2,878	2	4	6
June, "	11	254	265	—	3,238	—	5	5
July, "	8	141	149	—	2,480	2	1	3
August, "	1	50	51	—	749	—	1	1
Totals ...	471	10,325	10,796	7	114,539	104	122	226

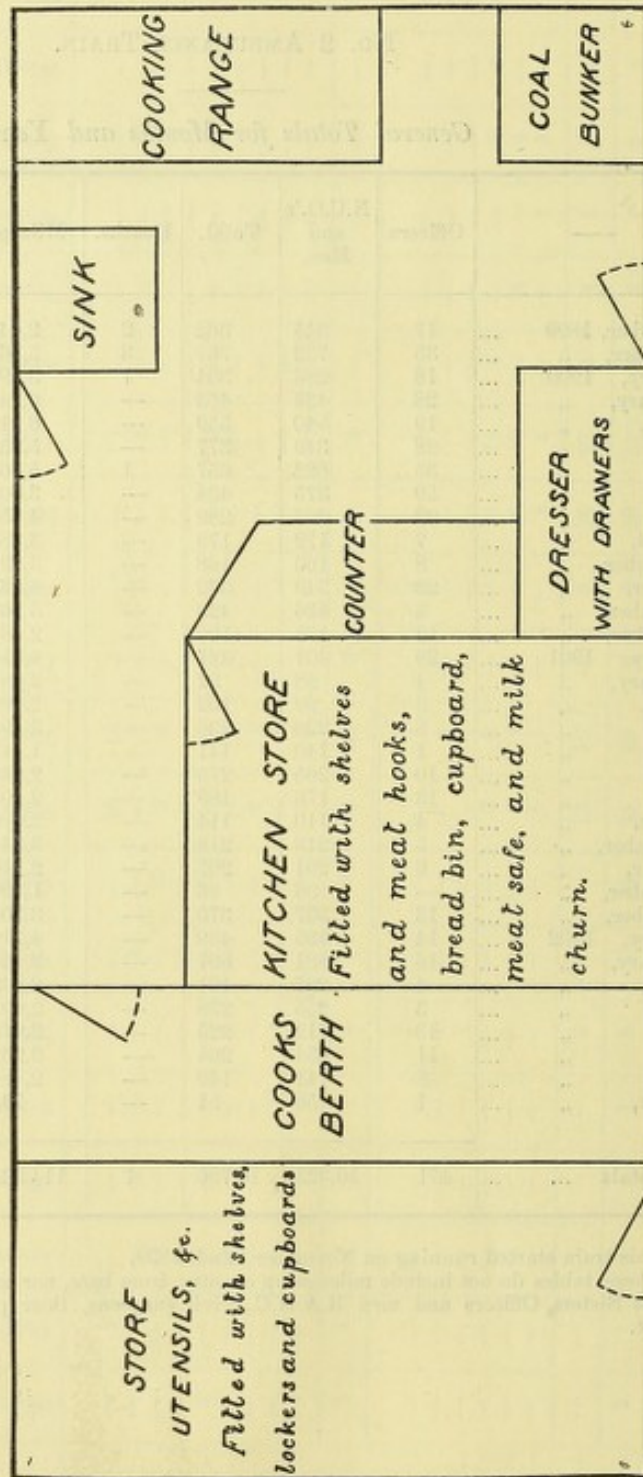
This train started running on November 22nd, 1899.

These tables do not include mileage up country from base, nor are passengers up country such as Sisters, Officers and men R.A.M.C., civil surgeons, Boer prisoners, &c., taken into account.

APPENDIX XXVIA.

AMBULANCE KITCHEN AND STORE WAGON.

Rough Sketch, giving Idea for Construction of Wagon.
 (Surgeon-General W. H. McNAMARA, C.B., C.M.G.)



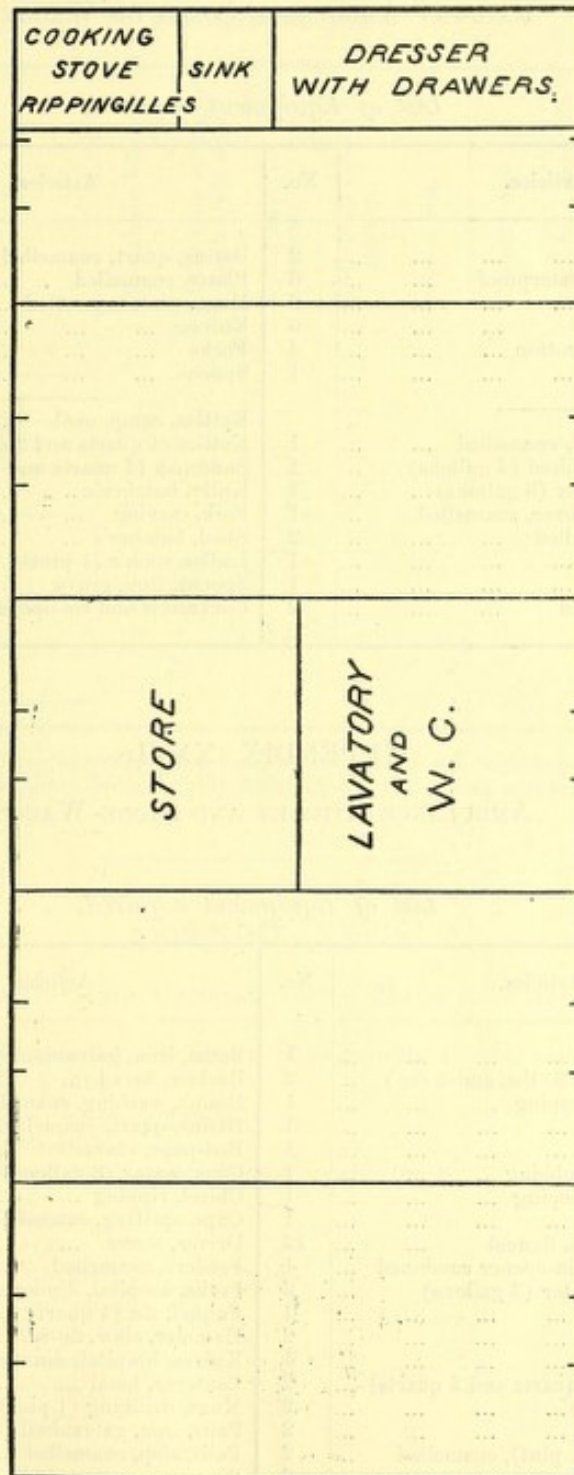
Water cistern, 50 gallons, to be fitted over sink.

APPENDIX XXVIB.

RAILWAY AMBULANCE, COACH, OR WAGON.

Rough Sketch, giving Idea for Construction of Ambulance.

(Surgeon-General W. H. McNAMARA, C.B., C.M.G.)



Each compartment to be fitted with two beds, one over each seat. Beds constructed so as to fold back against compartment partition.

Accommodation.

Water cistern, 20 gallons, to be fitted above sink.
Each compartment, 4 lying down or 8 sitting up.
Each ambulance, 12 lying down or 24 sitting up.

APPENDIX XXVIc.

RAILWAY AMBULANCE COACH OR WAGON.

List of Equipment required.

Articles.	No.	Articles.	No.
Blankets, G.S.	2	Basins, quart, enamelled	12
Sheets, ground, waterproof	6	Plates, enamelled	12
Pillows, feather	6	Mugs, pint, enamelled	12
Slips, case, pillow	6	Knives	6
Sheets, hospital, cotton	4	Forks	6
Towels, hand	1	Spoons	6
Basin, wash-hand, enamelled	1	Kettles, camp, oval	2
Bath, iron, galvanised (4 gallons)	1	Kettles (4 quarts and 2 quarts)	2
Can, soup or water (3 gallons)	1	Saucepan (4 quarts and 2 quarts)	2
Pail, slop, with cover, enamelled	1	Knife, butcher's	1
Pans, bed, enamelled	2	Fork, carving	1
Lantern	1	Steel, butcher's	1
Stool, close	1	Ladles, cook's (1 pint)	1
Urinals, enamelled	2	Spoons, iron, gravy	1
		Corkscrew and tin-opener combined	1

APPENDIX XXVI d.

AMBULANCE KITCHEN AND STORE WAGON.

List of Equipment required.

Articles.	No.	Articles.	No.
Axe, felling	1	Baths, iron, galvanised (4 gallons)	4
Balance, spring (80 lbs. and 4 lbs.)	2	Baskets, bread	4
Board, meat, chopping	1	Basins, washing, enamelled	4
Board, inventory	1	Basins, quart, enamelled	100
Box, wood, salt	1	Bed-pans, enamelled	4
Brush, hand, scrubbing	1	Cans, water (3 gallons)	6
Brush, hand, sweeping	1	Chisel, ripping	1
Chopper, meat	1	Caps, spitting, enamelled	6
Clothing—Shirts, flannel	12	Driver, screw	1
Corkscrew and tin-opener combined	1	Feeders, enamelled	2
Cans, soup or water (3 gallons)	2	Forks, hospital, dinner	24
Dredger, flour	1	Funnel, tin (1 quart)	1
Forks, carving	2	Hammer, claw, 20-oz.	1
Hook, bill	1	Knives, hospital, dinner	24
Kettles, iron (4 quarts and 2 quarts)	2	Lanterns, hand	2
Knives, butchers	2	Mugs, drinking (1 pint), enamelled	24
Knives, carving	2	Pails, iron, galvanised (3 gallons)	2
Ladles, cook's (1 pint), enamelled	2	Pails, slop, enamelled	4
Nets, potato	6	Pincers pair	1
Pail, iron, galvanised (3 gallons)	1	Plates, dinner, enamelled	24
Pan, frying	1	Nail-puller	1
Pans, stew (4 quarts)	2	Saw, cross-cut	1
Pots, cooking (10 gallons)	3	Scissors, hair-cutting pair	1
Steel, butcher's	1	Spoons, G.S., large	100
Saw, butcher's	1	Urinals, enamelled	6
Stools, night	2	Warmers, stomach	2
Sheets, hospital, cotton	6		
Towels, hand	24		

APPENDIX XXVI.

INFORMATION WHICH SHOULD BE ON THE NOMINAL ROLL SENT WITH
INVALIDS BY RAIL.

Rank and Name.		Ambulance wagon.	Ambulance or wagon with night stool.*	Lying down for long journey.	Sitting up for short journey.	Special diet.	Ordinary diet.	Fit for duty on journey.	Fit to take care of kit.	Unfit to take care of kit.
Sergeant		—	—	1	1	—	1	1	1	—
Private		1	—	—	—	1	—	—	—	1
Private		—	1	—	—	1	—	—	1	—
Sergeant		—	—	1	—	—	1	—	1	—
Corporal		—	—	—	—	—	—	—	—	—
Private		—	—	—	—	—	—	—	—	—
Private		—	—	—	—	—	—	—	—	—
Private		—	—	—	—	—	—	—	—	—

* Convalescents from dysentery, diarrhoea, or enteric fever not requiring ambulance accommodation. The stools should be thoroughly disinfected in these cases, and properly disposed of.

APPENDIX XXVI.

DIET FOR ORDINARY CASES CARRIED ON A MADE-UP AMBULANCE TRAIN.

Field ration to be drawn from Supply Depot, and

Milk, $\frac{1}{4}$ pint
Butter, 2 ozs.
Bacon, 4 ozs. } per man.

Ordered by Medical Officer in charge—

Eggs.
Jam.
Marmalade.
Potted meats.
Fresh milk.
Condensed milk.
Extract carnis.
Bovril.
Tinned chicken.
Tinned rabbit.
Tinned tongue.
Mineral waters.
Medical comforts—

Brandy.
Port wine.
Ale.
Stout.

APPENDIX XXVIII.

List of surgical materials, medicines, &c., required for ships carrying 1,000 up to 2,000 troops. The list of drugs enumerated below is made out on the hypothesis that a regulation medicine chest is also supplied. These are to supplement the articles most used:—

Articles.	Quantity.	Articles.	Quantity.
Bandages, calico... No.	50	Cork, vial ... gross	1
" flannel ... "	10	" pint ... "	1
" loose woven ... "	150	" quart ... "	1
" " Sal-alem ... "	50	Labels, blank... No.	100
Christia... yds.	2	" poison... "	50
Cloth, waterproof... "	4	Measures, graduated, 4-oz., glass ... "	1
Cotton wool, absorbent ... lbs.	12	Pill boxes, chip ... papers, gross	$\frac{1}{2}$
" " boric ... "	4	" paper ... "	$\frac{1}{2}$
" " double cyanide... "	1	Acid, boric ... lbs.	1
" " Sal-alemb. ... "	2	" carbolic... "	1
Flannel for fomentations ... yds.	1	" nitric, pure ... ozs.	1
Gauze, double cyanide... "	72	" sulphuric dil ... lbs.	1
Jaconet, waterproof ... "	4	Alumen ... ozs.	8
Lint, fine ... lbs.	4	Ammot. Brom. ... "	8
" boric ... "	4	Bismuth Subnit. ... "	8
Pins, common ... pkts.	1	Chloroform B.P. ... lbs.	1
" safety ... boxes	2	Emp. Belladonnæ, sp. yds.	1
Plaster, adhesive ... yds.	10	Glycerinum ... "	1
Syringes, male, pewter ... No.	10	Lin. Farina ... "	28
" " glass ... "	10	Linament Camph. Co. ... "	1
Tow, surgeons' ... lbs.	10	" Saponis ... "	1
Tubing, drainage, in aseptic solution ... tubes	1	Liq. Ammon. Acet. Fort. ... "	1
Thermometers, clinical ... No.	4	Mag. Sulph. ... "	20
Medicine chest, with all instruments ... "	1	Oleum Ricini ... "	4
Tabloid medicine chest ... "	1	" Terebinthini ... "	2
General fracture box ... "	1	Paraffin Mollé... "	1
Spirit, Ammon. Arom. ... "	1	Pot. Bicarb. Pulv. ... "	1
" Chloroform ... ozs.	8	" Brom. ... ozs.	8
Syrup Scillæ ... lbs.	2	" Chloras ... "	8
Tinct. Camph. Co. ... "	$1\frac{1}{2}$	" Iodidum ... "	8
" Catechu ... ozs.	8	" Nitrate Pulv. ... "	8
" Ferri Perchlor... "	8	Sodii Bicarb. ... lbs.	1
" Scillæ ... lbs.	2	" Salicylas ... "	1
Ung. Boric ... "	1	Spirit, Ætheris Nit. ... "	1
" Zinci ... "	1		
" Hydrarg. ... "	1	<i>Stock Mixtures.</i>	
Vinum Ipecac... "	1	Glyc. Tannic Acid ... ozs.	8
Zinci Oxidum ... ozs.	8	Mist. Copaiba... lbs.	10
" Sulph. ... "	4	" Astringent ... "	10
Bottles, vial, $\frac{1}{2}$ -oz. ... doz.	1	" Diaphoretic ... "	5
" " 1-oz. ... "	1	" Expect. ... "	10
" " 2-oz. ... "	1	" Sennæ Co. ... "	4
" 4-oz. ... "	1	Pill No. 8 ... gross	$1\frac{1}{2}$
" 6-oz. ... "	1	" No. 9 ... "	4
" 8-oz. ... "	1	" No. 12 ... "	$1\frac{1}{2}$
" blue, poison ... "	1	Tablet No. 13... "	$1\frac{1}{2}$
		Pulv. Seidlitz Cond... lbs.	$1\frac{1}{2}$

APPENDIX XXIX.

List of surgical materials, medicines, &c., required for ships carrying invalids, or a hospital ship when there is no fitted dispensary, but the vessel is supplied with a medicine chest:—

Articles.	Quantity.	Articles.	Quantity.
Bandages, calico ... No.	100	Jaconet, waterproof ... yds.	8
" loose woven ... "	200	Lint, fine ... lbs.	8
Bandages, loose woven, sal		" boric ... "	8
alembroth ... "	200	Pins, common ... pkts.	3
Bandages, flannel ... "	20	" safety ... boxes	6
" suspensory ... "	6	Plaster, adhesive ... yds.	10
" triangular ... "	6	Silk, twisted fine and medium,	
" sal alem. ... "	6	in aseptic solution ... tubes	1
Bandages, plaster of paris ... "	24	Sponges, surgeons' ... No.	6
Christia ... yds.	4	Spongio piline ... yds.	2
Calico ... "	2	Syringes, male, pewter ... No.	20
Cloth, waterproof ... "	6	" glass ... "	20
Catgut in carbolic oil ... tubes	1	Tabloid medicine chest ... "	1
Cotton wool, absorbent ... lbs.	10	General fracture box ... "	1
" boric ... "	10	Tow, surgeons' ... lbs.	20
" double cyanide ... "	10	Tubing, drainage, in aseptic	
" sal alembroth ... "	10	solution ... tubes	2
Flannel for fomentation ... yds.	2	Thermometers, clinical ... No.	6
Gauze, sal alembroth ... "	100	Medicine chest, with all	
" double cyanide ... "	50	instruments ... "	1

Or, for hospital ships, instead of the above chest and extra drugs, a dispensary fitted with the contents of the chest, the quantities of each drug varying from 1 to 2 lbs. according to the frequency with which it is likely to be used.

If fitted dispensary used, and no medicine chest, a selection of the surgical instruments, materials, and appliances authorised for use in station hospitals in Appendices 15, 16, 17, *et seq.*, "Regulations for Army Medical Services," will be required.

If medicine chest supplied, the following drugs to supplement it:—

Articles.	Quantity.	Articles.	Quantity.
Acidum boricum ... lbs.	2	Paraffinum Molle ... lbs.	2
" carbolicum ... "	4	Pot. Chlor. ... "	1
" sulphuricum dil. ... "	1	" Brom. ... "	1
" nitricum ... ozs.	2	" Iodidum ... "	2
Alumen ... lbs.	1	" Nitrat. Pulv. ... "	1
Ammon. Brom. ... ozs.	8	" Permang. ... ozs.	4
" Carb. ... "	8	Sinapis Charta ... boxes	1
Bismuth Subnit. ... "	8	Sodii Bicarb. ... lbs.	1½
Chloral Hydras. ... "	4	Labels, blank ... No.	200
Chloroform B.P. ... lbs.	2	Sodii Salicylas ... lbs.	1½
Cocaine Hydrochlor. ... ozs.	¼	Spirits Ætheris Nit. ... "	2
Emp. Belladonna Sp. ... yds.	2	" Ammon. Aromat. ... "	2
Ferri et Quin. Cit. ... ozs.	8	" Chloroform ... "	1
Glycerinum ... lbs.	2	" Methylated ... "	2
Hydrarg. Perchlor. ... "	1	Syrup Scillæ ... "	2
Iodoform ... "	1	" Triplex ... "	2
Linæ Farina ... "	28	Tinct. Camph. Co. ... "	2
Lin. Camph. Co. ... "	2	" Catechu. ... "	1½
" Saponis ... "	2	" Chloro. et Morph. ... ozs.	4
Liq. Ammon. Acet. Fort. ... "	2	" Ferri Perchlor. ... lbs.	1
Mag. Sulph. ... "	28	" Nucis Vomice ... ozs.	4
Oleum Morrhuæ Emulsio ... "	2	" Belladonnæ ... "	4
" Ricini ... "	4	" Digitalis ... "	6
" Terebinthæ ... "	2	" Scillæ ... lbs.	2

Articles.	Quantity.	Articles.	Quantity.
Ung. Borici lbs.	2	Measures, graduated, glass,	
" Hydrarg. "	2	10-oz. No.	1
" Zinci "	2	Pill boxes, chip papers, gross	1
Vinum Ipecac. "	1½	" paper "	1
Zinci Oxid. "	1		
" Sulph. ozs.	8		
Bottles, vial, ½-oz. ... doz.	2	<i>Stock Mixtures.</i>	
" " 1-oz. "	2	Glyc. Acid, Tannic ozs.	8
" " 2-oz. "	2	Mist. Copaiba... .. lbs.	15
" " blue, poison "	2	" Astringent "	15
" " 4-oz. "	2	" Diaphoretic "	10
" " 6-oz. "	2	" Expect. "	15
" " 8-oz. "	2	" Sennæ Co. "	8
Corks, vial gross	2	Pulv. Seidlitz, Cond. "	2
" pint "	2	Pills, No. 8 gross	2
" quart "	2	" No. 9 "	6
Labels, blank No.	100	" No. 12 "	1
Measures, graduated, glass,		Tablets, No. 13 "	2
4-oz.... "	2		

When lunatics embarked, œsophageal tube and glass funnel for feeding purposes.

APPENDIX XXX.

NOMINAL ROLL OF INVALID OFFICERS FOR EMBARKATION.

[illegible]

NOMINAL ROLL OF N.C.O.'s AND MEN FOR EMBARKATION.

[illegible]

APPENDIX XXXI.

SPECIMENS OF THE TICKETS ISSUED TO THE MEN WHEN BERTHING INVALIDS
ON HOMEWARD BOUND TRANSPORTS.

HOSPITAL. Lower (or Upper) Berth.
Swing Cot No. 10. Mess No. 1. Swing Cot Deck.
Hammock. Troop Deck No. 3. Mess No. 21.

NOTE.—The Embarking Medical Officer was responsible that there was sufficient of each kind of accommodation available for the number of tickets issued, and, as stated in the body of the Report, a certain percentage of the first two were always left unoccupied, to provide for relapse cases.

APPENDIX XXXII.

LIST OF EXTRAS THAT SHOULD BE AVAILABLE FOR THE USE OF SICK IN
THE NON-DIETED HOSPITALS ON BOARD TRANSPORTS.

Milk.—(a) Concentrated sterilised Australian milk; this was the best kind, but vessels should be stocked in England or Australia, as it is difficult to obtain a sufficient supply in other ports. (b) Tinned unsweetened milk. There are many brands on the market; the "Viking" or "Ideal" were generally found the most reliable. (c) Fresh milk. This was obtainable for special cases on all the Union Castle Company's mail steamers and some few other vessels, as they carried a cow in milk. Milk that has been frozen is not palatable and not desirable.

Beef Tea.—(a) Fresh beef tea (made from frozen meat) of excellent quality was generally available. (b) Valentine's meat extract. (c) Liebig's meat extract. (d) Bovril. (e) Tinned soups.

Fish.—12 ozs. for a dish should be obtainable from the saloon supply on all ships carrying a refrigerator.

Chicken.—Half of a roast chicken or minced chicken should be obtainable in a similar way as required.

Eggs and Butter.—As required from purser's stores.

Custard Puddings, Rice Puddings.—As ordered, to be supplied from the saloon galley.

Bread.—For use of patients in hospital should be indented for daily from the bakery. The theory of sending a man's bread from the mess to hospital always fails in practice, and there is constant trouble in obtaining sufficient bread in hospital for patients able to eat their ordinary rations.

Vegetables and Tinned Fruit.—Might be made available for use in special cases; they would be drawn from the saloon stores.

Liquors.—Champagne, brandy, port, claret, ale, stout, soda water, and lemonade.

With the exception of the bread alluded to above, and the meat, a joint of which (for a given number of men on rations in hospital) is usually drawn direct from the troops' galley, any of the above stores should be obtainable daily in the quantity required from the purser or chief steward, or an indent from Army Book 30 furnished the evening before by the Medical Officer in charge. They are accounted for on I 1202, "Diet Sheets," as extras.

The Medical Officer in charge should furnish a daily return to the purser giving the number of men in hospital on meat ration and the number of their troop deck mess, so that their portion can be subtracted from the issue to the troops, otherwise it is issued twice over, to their own mess and to the hospital where they are.

APPENDIX XXXIII.

OUTLINE OF A SUPERIOR DIET SUGGESTED FOR CONVALESCENT INVALIDS RETURNING HOME.

Breakfast.—Cold meat, hash or fish, bread and butter, jam or marmalade, tea or coffee, milk and sugar. On some mornings porridge instead of meat.

Dinner.—Soup, fresh meat (beef or mutton), potatoes. Four days a week carrots or turnips. Four days a week plum pudding, rice, or sago.

Tea.—Cold meat, corned beef, pickles, bread and butter and jam. Tea with milk and sugar.

Supper.—Bread and cheese or biscuits and cheese, or, for those who like it, gruel.

A diet such as this, which resembles the ordinary third-class passengers' scale used on large transports when in their ordinary trade, can be well and easily supplied.

APPENDIX XXXIV.

ARMY STANDING ORDERS.

(Published with the Army Order 4 of 6th November, 1899, with amendments up to May 31st, 1900.)

Supplies.—Provisions, Fuel, Light, &c.

1. The daily ration for the troops in the field will be as follows :—

Meat.—1 lb., fresh or preserved.

Equivalents.—Cheese, 2 ozs. equals 4 ozs. fresh or 3 ozs. preserved meat. Bacon, 4 ozs. equals 4 ozs. fresh or preserved meat. Maconochie's ration equals ration of meat and vegetables.

N.B.—When the supply of cattle is abundant the ration of fresh meat may, during active operations, be increased to $1\frac{1}{4}$ lbs.

Bread Stuff.— $1\frac{1}{4}$ lbs. fresh bread, or 1 lb. biscuit, flour, or meal. When flour or meal is issued seven cakes of patent yeast will, if available, be supplied per 100 lbs. of flour.

N.B.—When flour or meal is issued a good cake or damper may be made as follows ;—Mix a small quantity of yeast cake or baking powder and a little salt with 1 lb. of dry flour, then add sufficient water to make it into a stiff dough ; place on a gridiron, frying pan, or in the ashes of a coal or wood fire, and bake for half an hour. One of Gillet's yeast cakes will suffice for every 15 lbs. of flour.

Groceries.— $\frac{2}{3}$ oz. coffee or $\frac{1}{3}$ oz. tea, or half the ration of each, or 1 oz. chocolate with 3 ozs. sugar, $\frac{1}{2}$ oz. salt, and $\frac{1}{32}$ oz. pepper. The sugar ration includes any required for lime juice. $\frac{1}{2}$ oz. chocolate in addition to the ordinary grocery ration may, when available, be issued to nursing orderlies on night duty at the discretion of Medical Officers in charge of hospitals.

Vegetables.—1 oz. compressed vegetables or $\frac{1}{4}$ lb. onions, or $\frac{1}{2}$ lb. potatoes or other fresh vegetables, or 2 ozs. split peas, or 2 ozs. rice, or one tin pea soup.

2. *Emergency Rations.*—One field service ration will be carried on the person by each Officer and soldier for use only in extremity.

3. *Fuel.*—2 lbs. of wood or 1 lb. of coal per man as a maximum. Fuel will not be issued when it can be obtained on the march by the troops.

N.B.—Dried cowdung is an excellent substitute for fuel, and should, whenever practicable, be collected by the troops on the line of march.

4. *Light.*—Hospitals, as required. Guards, horse picquets, and offices, one candle per night for each authorised lantern. Officers.—When ample supplies are available, one candle per Officer per night may be issued in standing camps.

For Occasional Issues, when Available.

Lime Juice.— $\frac{1}{2}$ oz. ($\frac{1}{10}$ of a gill) when fresh vegetables are not obtainable, and the Medical Officer considers the issue necessary. (Issues of lime juice will not be made when a jam ration is issued.)

Spirits.— $\frac{1}{4}$ of a gallon ($\frac{1}{2}$ gill), at the discretion of General Officers Commanding Divisions or detached bodies of troops, but not oftener than twice a week. (An extra ration of tea or other equivalent may be issued to abstainers in lieu of spirits whenever a ration is sanctioned for the troops.)

Jam or Marmalade.—Quarter of a 1 lb. tin (about 4 ozs.) may be issued to the troops daily, when a sufficient supply is available.

Tobacco.—In quantities not exceeding 1 lb. per man per month, on repayment, at 1d. per ounce.

Special Issues.

Whenever special issues are made of articles not referred to in the foregoing scales, the equivalents laid down in the "Allowance Regulations" will be followed, or, if not mentioned therein, the equivalents at which they are to be issued will be decided by the Commander-in-Chief.

Scale of Extras for 1,000 Hospital Diets.

The requirements as regards medical comforts and disinfectants are calculated on the following scales:—

Arrowroot	...	...	...	...	...	lbs.	6
Bovril (in 4 oz. tins)	...	...	...	...	...	"	5
Brandy	...	...	...	...	...	bottles	10
Calves' foot jelly	...	...	...	...	...	pint bottles	10
Champagne	...	...	...	...	...	"	6
Cocoa paste	...	...	...	...	...	tins	20
Corn flour	...	...	...	...	...	lbs.	6
Fowls, roast, preserved	...	...	...	...	...	1 lb. tins	20
Meat, extract or essence of (in 4 oz. pots)	...	...	...	...	...	lbs.	6
Milk, condensed, sweetened	...	...	...	...	...	tins	150
" " unsweetened	...	...	...	...	...	"	150
Pearl barley	...	...	...	...	...	lbs.	10
Oatmeal...	...	...	...	...	...	"	4
Soups	...	...	...	...	...	"	6
Port wine	...	...	...	...	...	bottles	24
Sago	...	...	...	...	...	lbs.	6
Sugar	...	...	...	...	...	"	30
Whisky	...	...	...	...	...	bottles	10

Disinfectants.—When available and certified as necessary by the Medical Officer:—

For every 1,000 British Troops per day.

Carbolic acid powder	...	...	...	...	lb.	$\frac{1}{3}$
Chloride of lime	...	...	...	...	lbs.	2
McDougall's disinfectant powder	...	...	...	...	lb.	1
Izal	...	...	...	...	gallon	$\frac{1}{2}$

Medical Officers will be careful to adhere to these scales as far as possible,

APPENDIX XXXV.

REPRINT OF CIRCULARS ISSUED BY THE DIRECTOR OF SUPPLIES, ARMY
HEADQUARTERS, SOUTH AFRICA.

(Reprint of Circular dated 12th November, 1900; revised to 1st April, 1902.)

(a) *Scale of Rations for Troops in the Field.*

Description.	Quantity.	Remarks.
Breadstuffs—		
Bread lbs.	1½	When flour or meal is issued, seven cakes of patent yeast will, if available, be supplied per 100 lbs. of flour; baking powder, 19 ozs. to 50 lbs. flour.
Or biscuit "	1	
Or flour "	1	
Or meal "	1½	
Meat, or equivalents—		
Fresh meat "	1½	In issuing preserved meat to columns, small tins should be issued, 1 lb. tins if possible, but none larger than 2 lb. tins.
Or preserved meat "	1	
Or Maconochie's rations "	1	Maconochie's or similar ration equals a ration of meat and vegetables.
Bacon "	¼	In lieu of 4 ozs. fresh or 3 ozs. preserved meat.
Cheese ozs.	2	Ditto.
Biltong ration "	4	In lieu of full meat ration.
Bovril "	½	In lieu of full meat ration for extra mobile columns.
Flour lbs.	½	In lieu of ½ lb. of meat; to be issued to troops in blockhouses when available.
Groceries—		
Coffee ozs.	1	½ oz. coffee extra, when available, for early morning coffee. When early morning coffee is drawn, the ration issue will be tea, not coffee.
Tea "	½	
(or half ration of each)		
Or chocolate or cocoa "	1	½ oz. of chocolate extra, when available, for hospital orderlies on night duty.
Sugar "	3	Includes any required for lime juice and early morning coffee.
Salt "	½	
Pepper "	⅓	
Vegetables—		
Potatoes lbs.	½	When potatoes and onions or other fresh vegetables are available at the same time they should be issued in proportion of 2 to 1. Total ration, ½ lb.
Or other fresh vegetables "	½	
Or onions "	¼	
Or compressed vegetables ozs.	1	When available an additional ration of ½ lb. of fresh vegetables may be drawn in lieu of the jam ration.
Or split peas or rice "	2	
Or pea soup 2-oz. tins.	1	
Or pickles ozs.	2	
Jam or equivalents—		
Jam lbs.	¼	In lieu of ¼ lb. of jam.
Fruit, common "	1	In lieu of ¼ lb. of jam.
" superior "	½	In lieu of ¼ lb. of jam. When rhubarb issued the troops will find the sugar.
Rhubarb "	1	
Lime juice (⅓ gill) ozs.	½	Daily, when fresh vegetables are not available.
" " " " " " "	½	On four days a week when fresh vegetables are issued.
Rum galls.	⅓	Not oftener than three times a week (under authority of G.O.C.) when malt liquor is not obtainable. An extra ration of tea or other equivalent may be issued to abstainers in lieu of spirit rations.

N.B.—On no account should an issue for more than one day (and that the day of issue) be made. Back rations are not to be claimed or issued under any circumstances. Officers will see that all rum not consumed by the persons for whom it is issued on the day of issue is destroyed.

*(b) Scale of Rations for Civilian Employees.**(a)* White conductors: A soldier's ration.*(b)* Native headmen, and white or coloured drivers, leaders, Cape bastards, intelligence scouts, and wiremen, and head boys employed under the director of Transvaal telegraphs: A soldier's ration of meat, breadstuffs, groceries, and fuel only.

Other South African natives as under:—

Mealies or meal	...	...	...	...	lbs.	3
Fresh meat (on Sundays)	...	...	...	...	"	1½
Salt	...	...	...	...	oz.	1½

N.B.—For coloured drivers, leaders, and natives 1½ lbs. of meal will ordinarily be issued as the ration of breadstuffs, and when meat is not available the ration of meal may, when practicable, be doubled.

(c) Rations for Indian Natives.

Native clerks, native agents, native hospital assistants, and N.C. Officers and men of Indian regular forces:—

Atta or rice or flour	...	...	...	...	lbs.	1½
Dal or peas	...	...	...	...	ozs.	4
Ghi or sweet oil	...	...	...	...	"	2
Salt	...	...	...	...	oz.	2½
Chillies or curry powder	...	...	...	...	"	1½
Amchur or tamarind	...	...	...	...	"	1½
Goor or sugar	...	...	...	...	ozs.	2
Onions or other fresh vegetables	...	...	...	...	oz.	1
Meat (three times a week)	...	...	...	...	ozs.	8
Fuel wood	...	...	...	...	lbs.	1½

Non-meat eaters may receive 3 ozs. goor or sugar in lieu of the meat ration.

Extras, issuable on recommendation of Medical Officers when approved by General Officer Commanding: Rum ½ dram ($\frac{1}{16}$ pint), or to abstainers tea ¼ oz., and goor or sugar ½ oz.

During the winter months (April to September) the following additions may be made to the ration for Indian natives:—

Tea (daily)	...	...	...	...	oz.	¼
Sugar "	...	...	...	...	"	1
Rum (weekly)	...	...	...	...	dram	½

(d) Fuel.

The ration of fuel for all services is: Wood 2 lbs., or coal 1 lb. as a maximum, except where otherwise stated.

For Detachments—

1 to 5 men: 15 lbs. of coal per diem for the detachment.

6 to 10 men: 2½ lbs. of coal per man per diem, but not to exceed a total of 20 lbs. per diem for the detachment.

11 to 20 men: 2 lbs. of coal per man per diem (or the equivalent of wood in each case).

Over 20 men as per scale already authorised.

An addition of 1 lb. of wood or ½ lb. of coal per man per diem may, subject to the approval of General Officers Commanding districts be issued for boiling drinking water at such stations as the Principal Medical Officer of the district may recommend.

Recreation tents: Coal 140 lbs. per week; wood, authorised issue.

(e) *Rations, Convalescent Camps, &c.*

1. On the recommendation of the Principal Medical Officer, Army Headquarters, the following diet scale is sanctioned for (a) convalescent soldiers at convalescent depôts; (b) N.C. Officers and men attached to the Royal Army Medical Corps for duty in military hospitals under Army Order No. 1 of December 4th, 1901:—

Bread	...	...	...	...	...	lbs.	1½ per diem.
Meat	...	...	...	...	...	lb.	1 "
Tea	...	...	...	...	...	oz.	¼ "
Coffee	...	...	...	...	...	"	½ "
Sugar	...	...	...	...	...	ozs.	3 "
Salt	...	...	...	...	...	oz.	½ "
Pepper	...	...	...	...	...	"	⅓ "
Jam (when available)	...	...	...	...	...	ozs.	4 "
Potatoes (or other fresh vegetables)	...	...	...	...	...	"	8 "
Lime juice (when fresh vegetables are not obtainable)	...	...	...	...	...	oz.	½ "
Lime juice (on four days a week when fresh vegetables are issued)	...	...	...	...	...	oz.	½ "
Bacon	...	...	...	...	...	ozs.	2 per diem.
Milk, condensed...	...	...	...	...	...	tin	⅓ "
Onions	} On two days a week, but not on the same day					lb.	1 "
Rice						"	1 "

The following may be issued as a substitute for the bacon and milk rations above referred to:—

Oatmeal	...	...	...	...	...	ozs.	2
Milk, condensed...	...	...	...	...	...	oz.	⅓

(f) *Care of Food Supplies.*

It has been observed that in many units food supplies are drawn and stored in a very careless manner. No attempt is made to keep the various articles from being souled by dirty vehicles, dirty coverings, or by contact with natives and others employed in carrying them.

There is no doubt that this carelessness is the cause of many cases of such diseases as enteric and dysentery, and the most careful precautions must be taken to obviate any possible contagion from this source.

Officers commanding units are directed to give this matter their personal consideration. No special knowledge is required, strict cleanliness in every respect is sufficient.

(g) *Scale of Extras for Hospital Diets.*

The requirements as regards medical comforts and disinfectants are calculated on the following scales:—

Scale of Extras for 1,000 Hospital Diets.

Arrowroot	...	...	...	...	...	lbs.	12
Brandy	...	...	...	...	...	bottles.	48
Bovril (in 4 oz. tins)	...	...	...	...	...	lbs.	10
Brand's essence...	...	...	...	...	...	"	2
Calves' foot jelly	...	...	...	...	...	pint bottles	25
Champagne	...	...	...	...	...	"	20
Claret	...	...	...	...	...	pints	25
Cocoa paste	...	...	...	...	...	tins	20
Corn flour	...	...	...	...	...	lbs.	6
Fowls (roast)	...	...	...	...	...	lb. tins.	40
Meat, extract or essence of (in 4 oz. pots)	...	...	...	...	...	lbs.	8
Milk (condensed)	...	...	...	...	...	tins	300

Pearl barley	...	...	...	...	...	lbs.	10
Oatmeal	...	...	...	...	...	"	21
Soups	...	...	...	...	...	"	6
Port wine	...	...	...	...	...	bottles	28
Sago or tapioca	...	...	...	...	...	lbs.	11
Sugar	...	...	...	...	...	"	30
Whisky	...	...	...	...	...	bottles	10
Stout	...	...	...	...	...	$\frac{1}{2}$ pint bottles	150

Disinfectants.—When available and certified as necessary by the Medical Officer :—

For every 1,000 British Troops per day.

Carbolic acid powder	...	...	...	...	lb.	$\frac{1}{3}$
Chloride of lime	...	...	...	...	lbs.	2
McDougall's disinfectant powder	...	...	...	...	lb.	1
Izal	...	...	...	...	gallon	$\frac{1}{2}$

Medical Officers will be careful to adhere to this scale as far as possible.

(h) *Fruit, Vegetables, and Milk.*

All fruit in the various districts should be very carefully preserved, collected, and issued to the troops whenever possible.

It is of the utmost importance that a good supply of fruit and vegetables should always be arranged for at stations in low-lying districts, such as, for instance, the stations on the line east of Machadodorp and north of Waterval North.

Another question of importance is that of supply of fresh milk to hospitals. Dairy farms for this purpose should be arranged for wherever there are sufficient cows amongst the captured cattle, or wherever they can be otherwise obtained.

Every possible supply arrangement should be made for the comfort and welfare of the troops generally.

Military Agricultural Farming.

It is hoped that all concerned will bear in mind that the object of these farms is the custody and management of captured and surrendered stock, supply of milk to hospitals, forage for horses and other animals, vegetables and fruit to the troops and hospitals, meat to the troops and civil population, and the stamping out of disease. No efforts should be spared to attain these objects, and each district should vie with the others to excel in these directions.

(k) *Extract from Lines of Communication Orders.*

(By Lieut.-General Sir F. W. E. F. FORESTIER-WALKER, K.C.B., C.M.G.,
Commanding Lines of Communication, South Africa.)

No. 243.

Cape Town,

September 8th, 1900.

* * * * *

10. *Rations.*—On the recommendation of the Principal Medical Officer at headquarters the following diet scale is sanctioned for convalescent soldiers in any convalescent depôts which may be established at or near coast ports, viz. :—

An ordinary soldier's ration of bread, meat (1 lb.), groceries, vegetables, and jam, also 2 ounces of bacon, and one-tenth tin of preserved milk daily, one-seventh pound of onions, and one-fourteenth pound of rice, two days a week each, but not on the same days.

When the unconsumed portion of the bread ration cannot be utilised for making puddings, &c., the ration will be reduced to 1 lb. C.R., No. B-3490-1.

* * * * *

APPENDIX XXXVI.

REPRINT OF CIRCULARS ISSUED BY THE DIRECTOR OF SUPPLIES, ARMY HEADQUARTERS, SOUTH AFRICA.

Medical Comforts.—Proportion to be included with all Supply Convoys.

1. When convoys of supplies are being sent to out-stations the Supply Officer responsible for their loading will see that a good proportion of medical comforts of all descriptions is invariably included, also disinfectants.

2. When possible to communicate beforehand with the station to which the supplies are being sent, the commandant there should be informed what number of days' ordinary supplies are being sent, and asked to state what medical comforts will be required for that period.

3. Where such information cannot be obtained the quantities to be sent may be calculated in diets by multiplying 20 per cent. of the numbers in garrison by the number of days' supplies. Thus, if the garrison is 1,000 men, and they are being supplied for 30 days, the number of diets will be—

$$20 \text{ per cent. of } 1,000 \times 30 = 6,000 \text{ diets.}$$

APPENDIX XXXVIA.

PROPOSALS BY SURGEON-GENERAL W. H. McNAMARA, C.B., C.M.G.

I.—Scale of Medical Comforts for 10 days.

Articles.	For 100 beds.	For Army Corps, 4,000 beds.	Remarks.
*Arrowroot lbs.	12	480	
Bacon, tinned "	5	200	
*Brandy bottles	48	1,920	
*Bovril, in 4-oz. tins... .. lbs.	10	400	
*Brand's Essence "	2	80	
Calves' foot jelly pint bottles	25	1,000	
Champagne "	10	400	
Claret "	25	1,000	
*Cocoa paste tins	20	800	
*Cornflour lbs.	6	240	
Fowls, roast lb. tins.	40	1,600	
Fruit, bottled, assorted bottles	5	200	
" dried (prunes, apples, figs)... .. lbs.	5	200	
*Meat extract or essence, 4-oz. pots "	8	320	
*Milk, condensed tins	300	12,000	
Oatmeal lbs.	21	840	
Pearl barley "	10	400	
*Port wine bottles	28	1,120	
*Soups, assorted tins	6	240	
Sago or tapioca lbs.	11	440	
Sardines tins	2	80	
Stout ½-pint bottles	150	6,000	
Sugar... .. lbs.	30	1,200	
Sparklets doz.	20	800	If mineral waters not available.
" bottles for No.	4	160	
Tongue, tinned tins	2	80	
Rabbit, tinned "	10	400	
Vegetables, preserved "	5	200	
*Whisky bottles	10	400	
Valentine's Meat Essence "	3	120	
Cigarettes No.	500	20,000	
Pipes "	5	200	
Tobacco lbs.	5	200	

* The most important items to carry when all cannot be.

II.—Scale of Disinfectants for 10 days to be supplied by Army Service Corps.

Articles.	For 100 beds.	For Army Corps, 4,000 beds.	Remarks.
Carbolic powder lbs.	2 ¹ / ₂	13 ¹ / ₂	
Chloride of lime "	2	80	
McDougall's disinfecting powder "	1	40	
Izal galls.		20	
Sulphur lbs.		10	
Alum for clearing water "		20	

A similar quantity would be required for the regimental camps, &c., of the Army Corps.

III.—Scale of Disinfectants for 10 days to be supplied by Medical Department.

Articles.	For 100 beds.	For Army Corps, 4,000 beds.	Remarks.
Corrosive sublimate lbs.	1	40	
Hydrochloric acid "	2	80	
Formalin tabloids	50	2,000	

APPENDIX XXXVII.

REPORT ON FOOD STUFFS.

(Major W. W. O. BEVERIDGE, D.S.O., R.A.M.C., in charge, the Laboratory, Pretoria.)

The number of samples of food sent to this Laboratory for analysis during the war has been fortunately few, owing to the care with which the various supplies were selected. Those samples which, on analysis, were found to be unfit for issue and rejected were chiefly faulty through long keeping and from the effects of climate. The majority of the samples were sent from the hospitals, and many also from the Director of Supplies to ascertain their suitability for hospital requirements.

In some instances certain articles of food, such as coffee, tea, cheese, and jam, might have been of better quality; occasionally the tinned meat rations were faulty from long keeping, especially noticeable in the case of mixtures of meat and vegetables, but, on the whole, the rationing of the troops could hardly be surpassed. If one considers the great difficulties in anticipating supplies and the care and storage of rations for troops in war time in a hot climate, it is little wonder that some at least become unfit for issue.

The Boers in the latter part of the war, and many of our columns occasionally, subsisted on mealy meal and meat only with no marked ill effects.

Maize, Indian corn, or mealies is largely grown as a staple article of diet over the whole of South Africa. In the Transvaal it is particularly suited to the dry soil, and is grown largely by both Boers and natives. There are two varieties of maize grown in the Transvaal, one of which has a white seed, the other a yellow. The former is more prized as a food by the natives. On analysis of the two varieties I found that there was probably some truth in this, owing to the fact that, as a rule, the white variety showed a less acidity than the yellow, producing, therefore, a cake of better quality on baking.

During the war a large amount of foreign maize was imported to meet the great demand, being used as a food chiefly for natives and cattle. As mealy meal it was sometimes used by the troops in the form of porridge. Owing to the large amount of nitrogen it contains, it constitutes a stimulating food of high nutritive value, and on which man can subsist for some time. Many of the natives at one time suffered from a form of disease, diagnosed as scurvy by some and as beri-beri by others.

The disease was evidently a form of pellagra, caused by the ingestion of old or inferior corn in which a fungus had developed. In three samples of corn from Bloemfontein, Flandersfontein, and Middelburg, where many of the natives who ate it were suffering from a disease considered to be scurvy, I found a fungus of the nature of the *sporisorium maidis*. I understand that the disease ceased on the mealies in question being condemned and a fresh supply substituted.

The following foods were submitted for analysis:—

Milk.—The fresh milk supplied to the Pretoria hospitals was received from the vendors and sterilised at a milk depôt before being issued to the hospitals. During the war practically only the hospitals were supplied with fresh milk, and no disease of any kind was directly traceable to its use.

Two samples of milk were sent twice weekly to the laboratory for analysis. Of the samples submitted 20 were condemned and two of the vendors were prosecuted in the civil courts. In each case the vendors were warned. The samples varied considerably in their constituents, owing to the variety of the breeds of cattle, the conditions of feeding, &c.

Condensed Milk.—Ten different brands of condensed milk, forwarded by the Director of Supplies, were analysed. Four of these were considered unfit for hospital use.

Australian Sterilised Milk.—This was a solid preparation supplied in tins, and was found to be very good as far as analysis was concerned, but it was found that on keeping it becomes practically insoluble in water.

Butter.—Eleven samples were examined (chiefly tinned), four of which were condemned as unfit for issue.

Cheese.—One sample of tinned Dutch cheese was examined and found to be of excellent quality, and well suited for issue to troops in the field. Many brands of tinned cheese are preferable to the ration cheese that was issued during the war, which rapidly deteriorated owing to the effects of climate and want of sufficient storage.

Eggs.—Prepared yolks of eggs and desiccated eggs were submitted for examination, and both preparations were excellent in their way and suitable for hospital use, but cannot replace fresh ones.

Coffee.—The rations of coffee which I first examined were not of good quality, the beans being old and inferior. After my report on these a much better article was supplied.

Two samples of roasted coffee, locally grown, on analysis gave the following:—

Specific gravity of 10 per cent. extract at 15° C—1010 and 1008.

Dried extract 26.00 and 20.00 per cent.

Mineral matter 9.50 and 3.50 „

and contained no adulteration.

Twelve samples were analysed in all, six of these were of very inferior quality. In this most important article of diet for troops in the field it is most imperative that only the very best coffee should be supplied, and if sent out in the form of coffee beans these should not be kept for any length of time before use.

Tea.—Five samples were analysed; two of these were of inferior quality.

Bread.—Samples were examined chiefly on account of complaints regarding the quality of bread supplied to hospitals. In one case the bread was found to have been made from inferior flour, and in some the baking was at fault.

Corned Beef, Ham, Bacon (tinned).—Samples of these articles of food were submitted to determine their suitability for issue. The tinned ham and bacon were complained of but they appeared to be of excellent quality.

Tinned Meat Rations.—One consignment of these rations was condemned owing to their having deteriorated as the result of bad preparation or long keeping. From my own experience in the field I am of opinion that generally these rations were of good quality. In some cases, however, the emergency rations of extract of meat and cocoa were found to be deteriorated and mouldy from long keeping.

Calves' Foot Jelly.—Three samples were analysed. One of these was condemned owing to fermentation having taken place and rendered the jelly unfit for consumption.

Lime Juice.—Owing to a War Office cablegram that lead had been detected in certain samples of lime juice, especially in Rose's lime juice cordial, an analysis was made of various samples issued by the Director of Supplies, but in only one case was the merest trace of lead discovered and no ill-effects have been recorded.

Marmalade and Jam.—Two samples of marmalade were condemned, having deteriorated by keeping and showing traces of metallic impurity. I am of opinion that for supply during a campaign jams, jellies, and marmalade would be better preserved in glazed or earthenware jars, as the danger of acid fermentation which sometimes ensues, and the consequent production of acid and solution of metal, would be thereby eliminated.

Atta (Indian Flour).—One sample was forwarded which by analysis was found to be acid.

Molassine Meal.—This is used as a feed for horses. A sample was sent by the Director of Supplies, and consisted of forage impregnated with molasses. It possessed high nutrient properties.

Beverages.

The following beverages were sent for analysis:—Hop beer, ginger beer, hop ale, lemonade, hop stout, and champagne cider. Some of these were brewed and some aerated. Many were found to be undesirable, and their issue was stopped.

Alcoholic Drinks.—A large proportion of these were sent by the Medical Officers in charge of hospitals for analysis owing to complaints of patients as to their quality, the sick Officers being the most particular in this respect. A few of the complaints were well founded, but in many the wines and spirits were found to be of average quality.

Brandy.—In a number of cases the brandies did not seem to me to be altogether wine-derived spirit, and I submitted that unless the brandies for hospital use contained a fair proportion of natural ethers, they did not act as rapidly diffusible stimulants, and therefore they had no special value as compared, for instance, with whisky. The opinion on the quality of wines and spirits is largely a matter of palate, but I submit that supplies for hospitals should be selected by Medical Officers, who are the best judges as to the brands suitable for the sick. I made an analysis of as many brands of brandy as could be procured in this country, to ascertain which was the most suitable to the requirements of the sick at a moderate price, and came to the conclusion that the Spanish brandy was a genuine wine-derived spirit, moderate in price, and suitable for hospital requirements.

The Director of Supplies, Pretoria, also sent many brands of wines and spirits for report as to their quality and fitness for hospital use.

Whisky.—In one case the whisky was found to be overproof. Complaints were made that in some instances the spirit was raw, and this complaint was justified in two instances.

Rum.—A case of suspected peculation occurred at Harrismith, and a cask was forwarded for analysis, the proceedings of a board stating that it was probably adulterated with water. On analysis it was found 50 per cent. water had been added. The rum generally has been of excellent quality.

Champagne.—Three brands were sent for analysis.

Beer.—Lead having been found in some of the Cape beers, I was directed by the Principal Medical Officer, Army, South Africa, to make an analysis of all the brands of beer issued by the Army Service Corps in the Transvaal,

including local beer, English beer, stout, and Natal beer, in none of which was there any lead found.

Stout.—One locally-brewed sample was condemned as unfit for consumption.

Port.—Two samples were complained of, but the analysis did not confirm the objection.

Claret.—Eleven samples of claret were analysed. These were all of the lighter kinds, and three samples out of these were found to have become unsuited for hospital use, probably from the effect of climate.

Foods and Beverages.

Samples.	Total number sent.	Fit for issue.	Unfit for issue.	Remarks.
Coffee	12	6	6	
Yolks of eggs...	2	2	—	
Bakers' eggs ...	1	1	—	
Marmalade	4	2	2	
Condensed milk ...	11	7	4	
Sterilised milk ...	1	1	—	
Whisky	6	5	1	
Butter... ..	11	7	4	
Claret	11	8	3	
Jam	2	1	1	
Tea	5	3	2	
Port	2	2	—	
Lime juice	4	3	1	
Milk	124	104	20	
Bread	3	—	3	
Beer	10	10	—	
Corned beef	1	1	—	
Nestle's food	1	1	—	
Stout	3	2	1	
Brandy	17	13	4	
Ginger beer	1	—	1	
Hop beer	2	—	2	
Champagne cider ...	2	—	2	
Champagne	3	1	2	
Carcass of sheep ...	1	—	1	
Emergency rations ...	13	—	13	
Atta	1	—	1	
Dutch cheese... ..	1	1	—	
Molassine meal	1	1	—	
Ham	1	1	—	
Bacon	1	1	—	
Calves' foot jelly ...	3	2	1	
Rum	1	—	1	

TABLE SHOWING THE RESULTS OF THE ANALYSIS OF THE FUEL OILS

ANALYSIS XXXIII

No.	Name of Fuel Oil	Specific Gravity at 60° F.	Viscosity at 60° F.	Flash Point at 60° F.	Fire Point at 60° F.	Sulfur Content, %	Ash Content, %	Water Content, %	Total Solids, %	Remarks
1	Light Fuel Oil	0.88	10	100	120	0.5	0.1	0.1	99.3	
2	Light Fuel Oil	0.88	10	100	120	0.5	0.1	0.1	99.3	
3	Light Fuel Oil	0.88	10	100	120	0.5	0.1	0.1	99.3	

PLAN N^o 1.

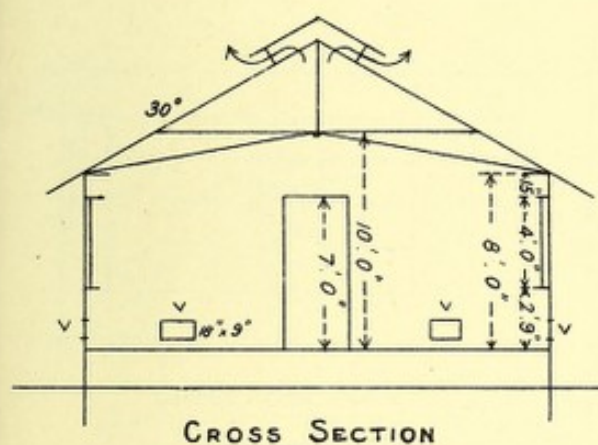
MEN'S WARD HUT.

(Permanent or Portable)

(20 Beds)

— Notes —

- 1 Ventilators in roof, for huts in temperate climates are required, for those abroad foul air outlets 18" x 9" above each window instead of Ventilator in Roof.
- 2 In tropical climates the whole hut to be raised 3' 0" above natural ground line. In temperate climates sufficient ventilation must be provided under floors about 1 foot space.

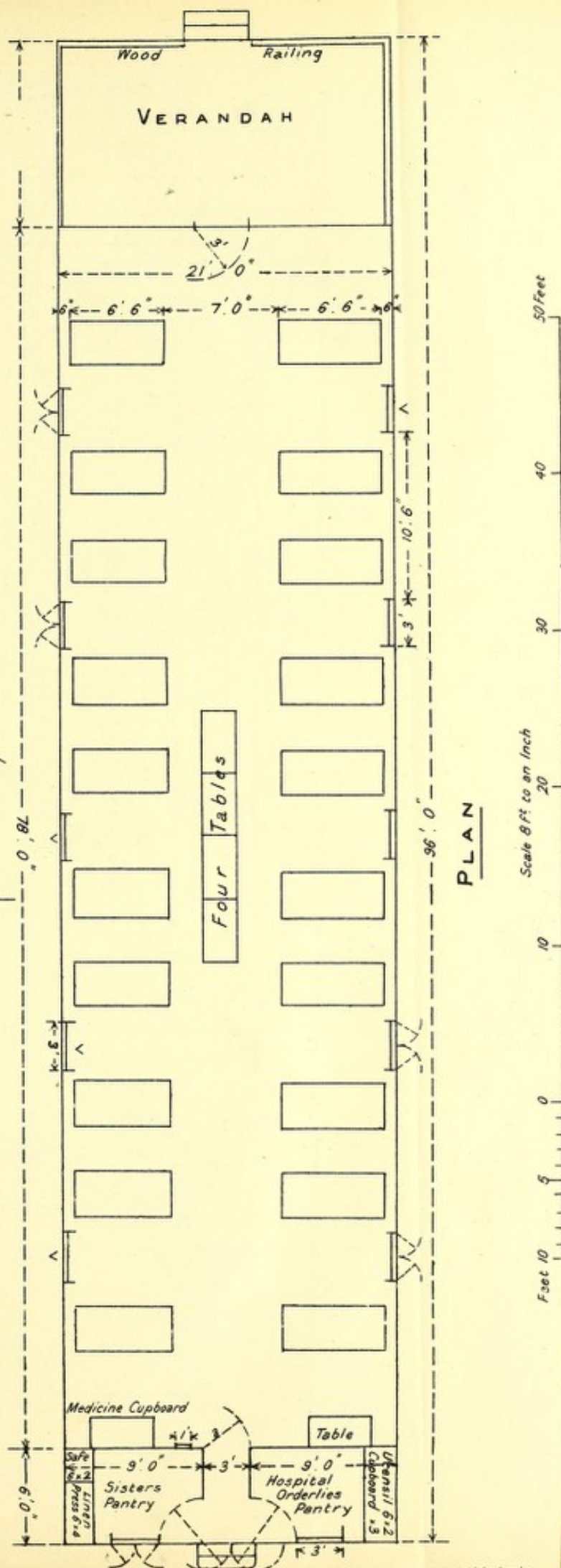


CROSS SECTION

4 V.V.V. Denotes positions of Fresh Air Inlets 18" x 9" perforated zinc with sliding shutter to regulate them.

5 All windows to open outwards & fastened on sill with bar fastener.

6 Concrete Floors to Pantry.



PLAN

Scale 8 ft to an inch

50 Feet

40

30

20

10

0

5

10

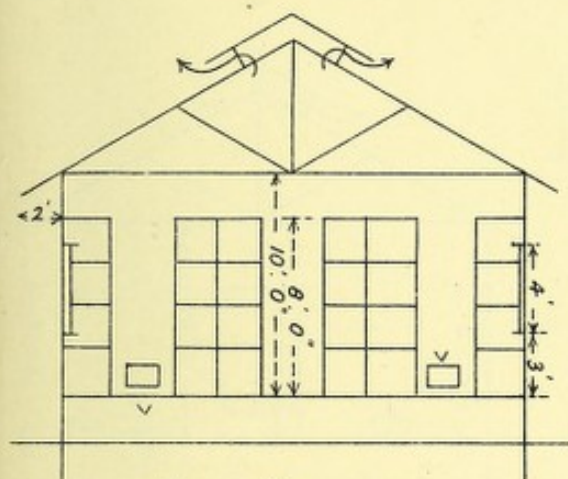
Feet

PLAN N° 2.

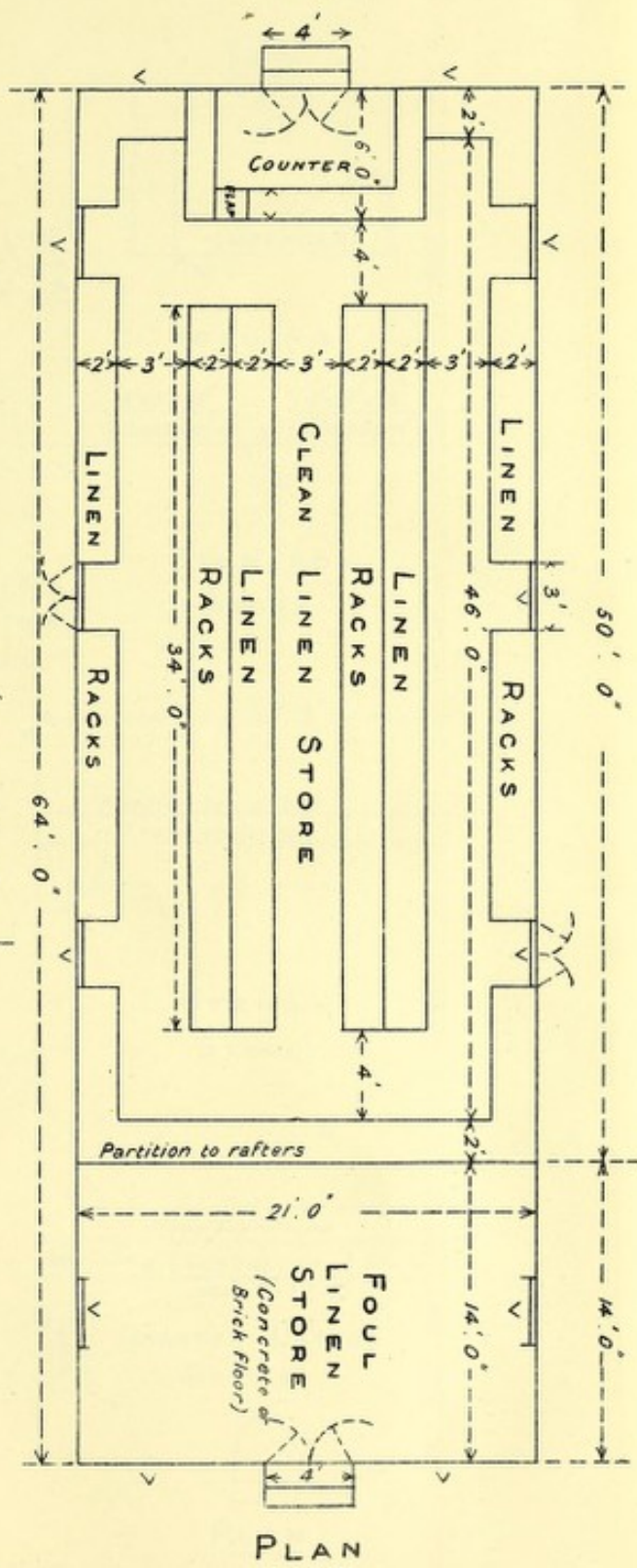
CLEAN & FOUL LINEN STORES

(Permanent or Portable)

Notes on plan N^o 1 are applicable to this hut

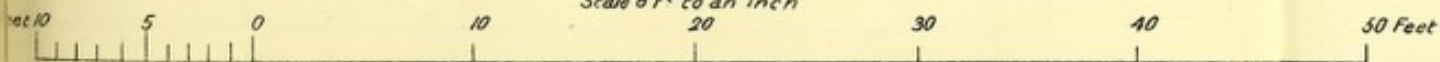


CROSS SECTION



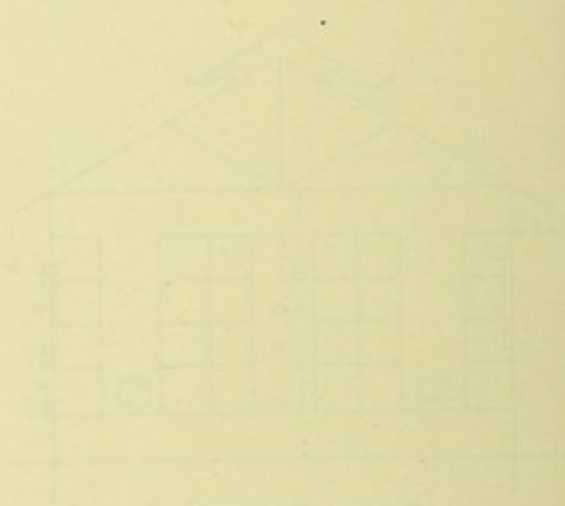
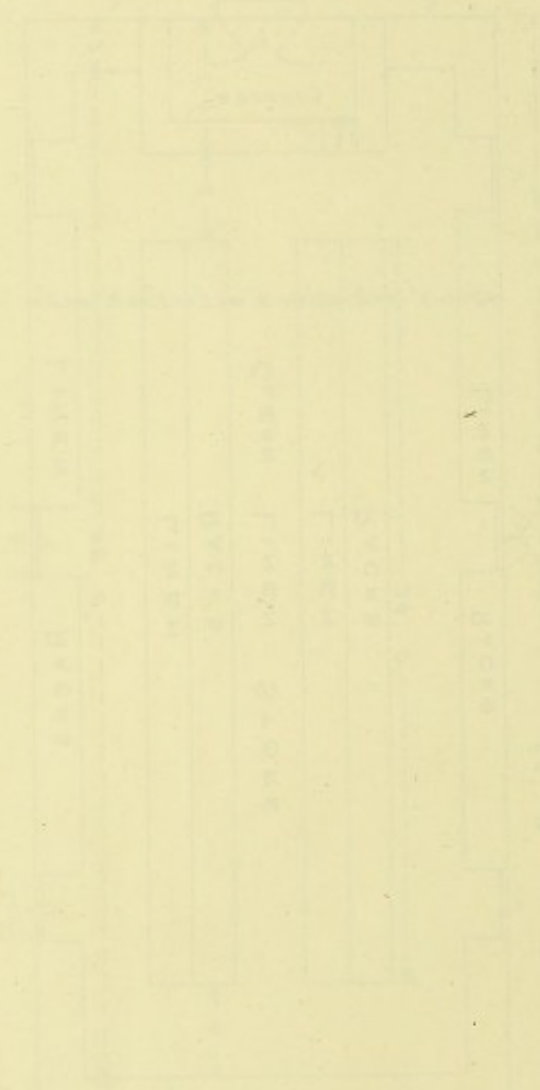
PLAN

Scale 8 ft to an inch



PLAN No 2

PLAN A FOUR LINE
STORES



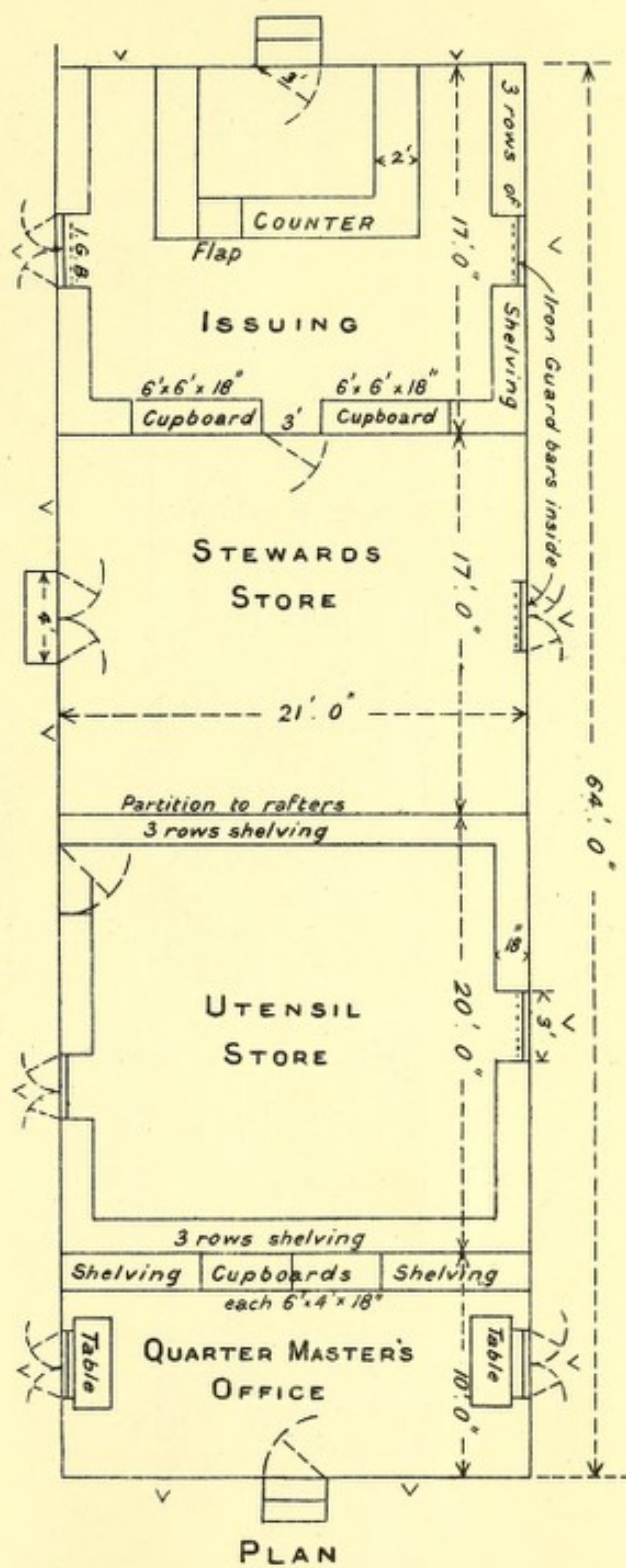
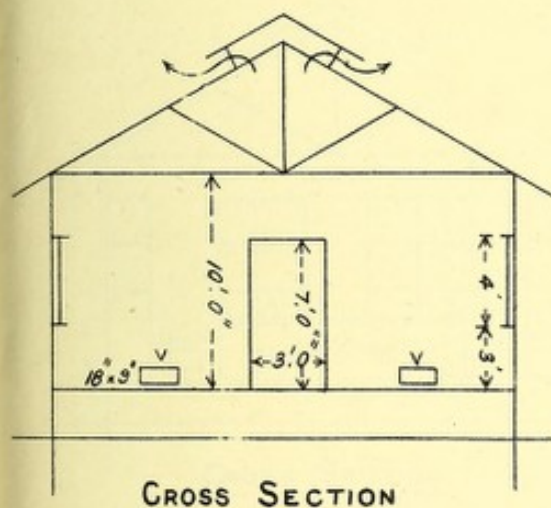
PLAN No 2

PLAN N^o 3.

QUARTER MASTER'S OFFICE, STEWARDS' UTENSIL AND ISSUING STORES.

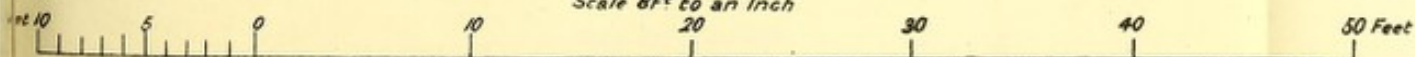
(Permanent or Portable)

Notes on plan N^o 1 are applicable to this hut

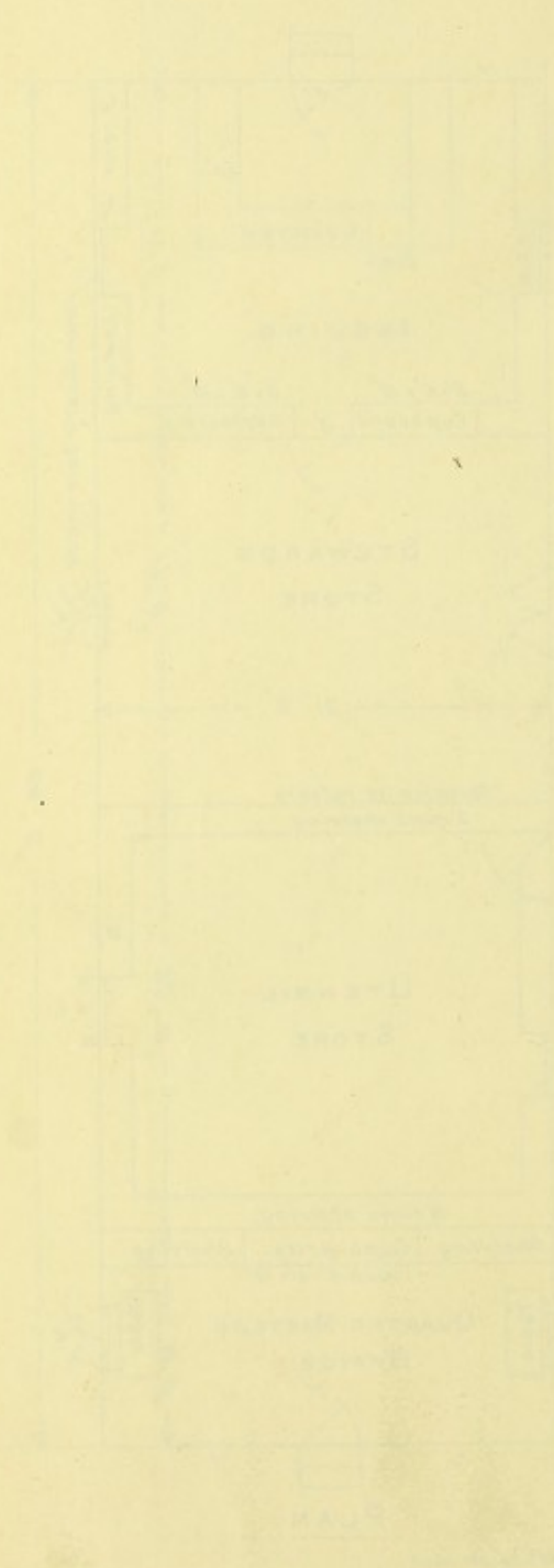


PLAN

Scale 8ft to an Inch



PLAN No. 3.



WATER MASTER'S OFFICE
WARD'S UTILITY AND
LAKING STORES

STORAGE OF MATERIALS
(See page 10)



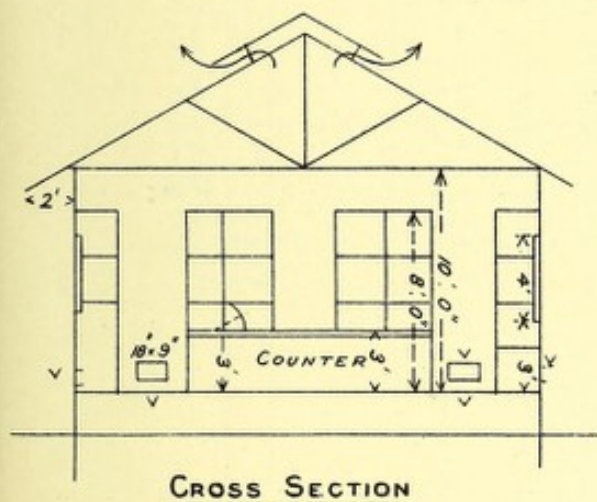
Cross Section

PLAN N^o 4.

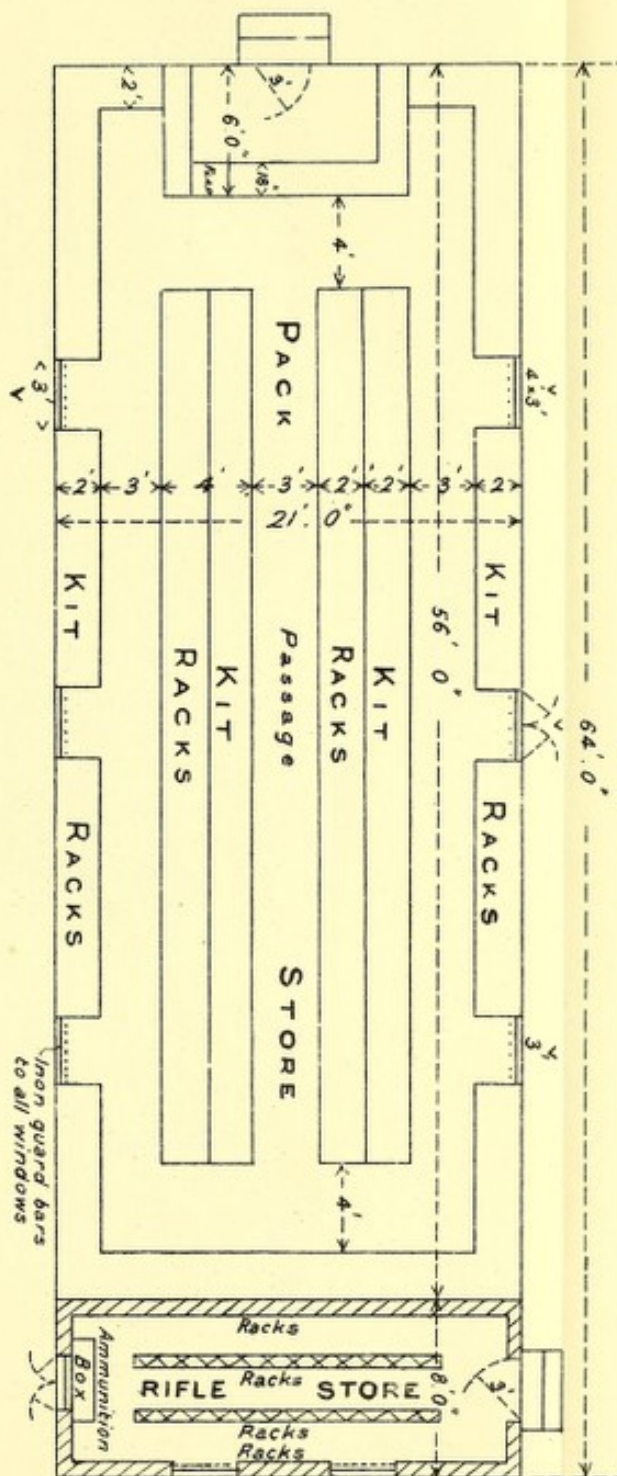
PACK AND RIFLE STORE

(Permanent or Portable)

Notes on Plan N^o 1 are applicable to this hut

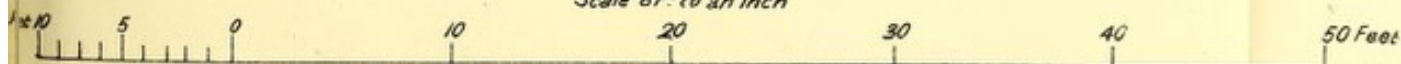


CROSS SECTION



PLAN

Scale 8Ft to an Inch

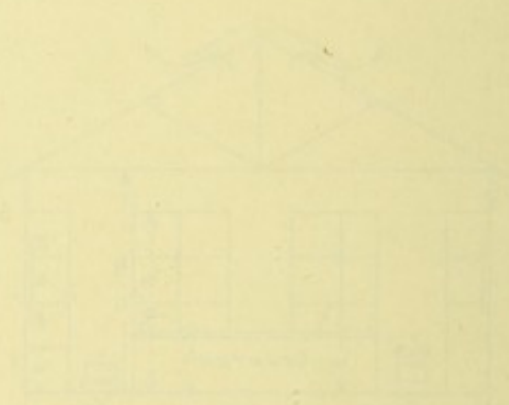
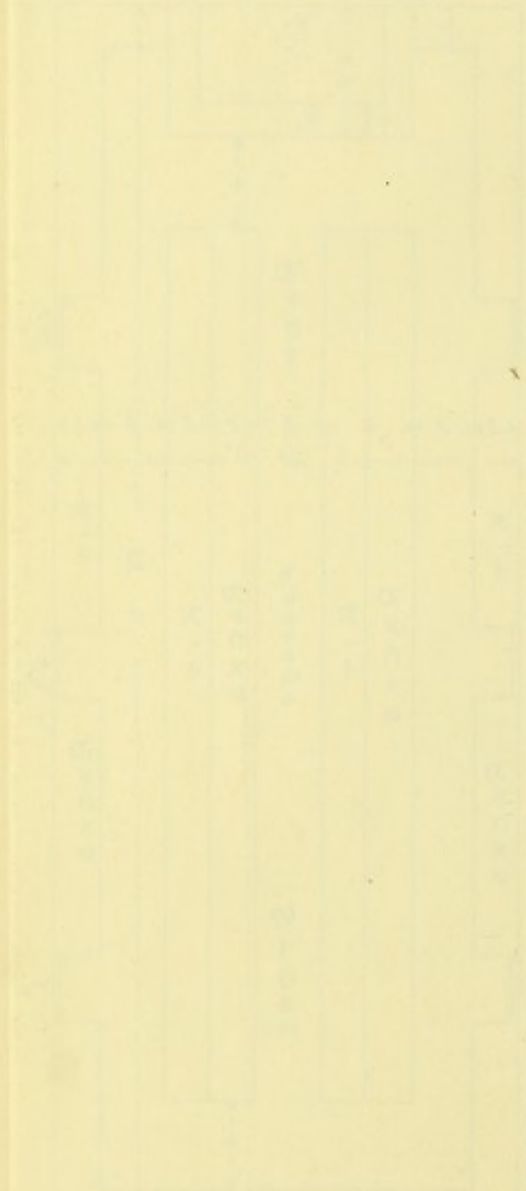


PLAN No. 4

PLAN AND ELEVATION OF STORE

(FURNITURE STORE)

Scale 1/4" = 1'-0"



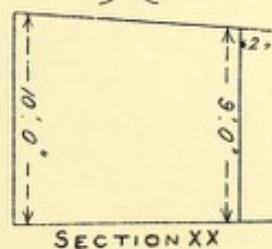
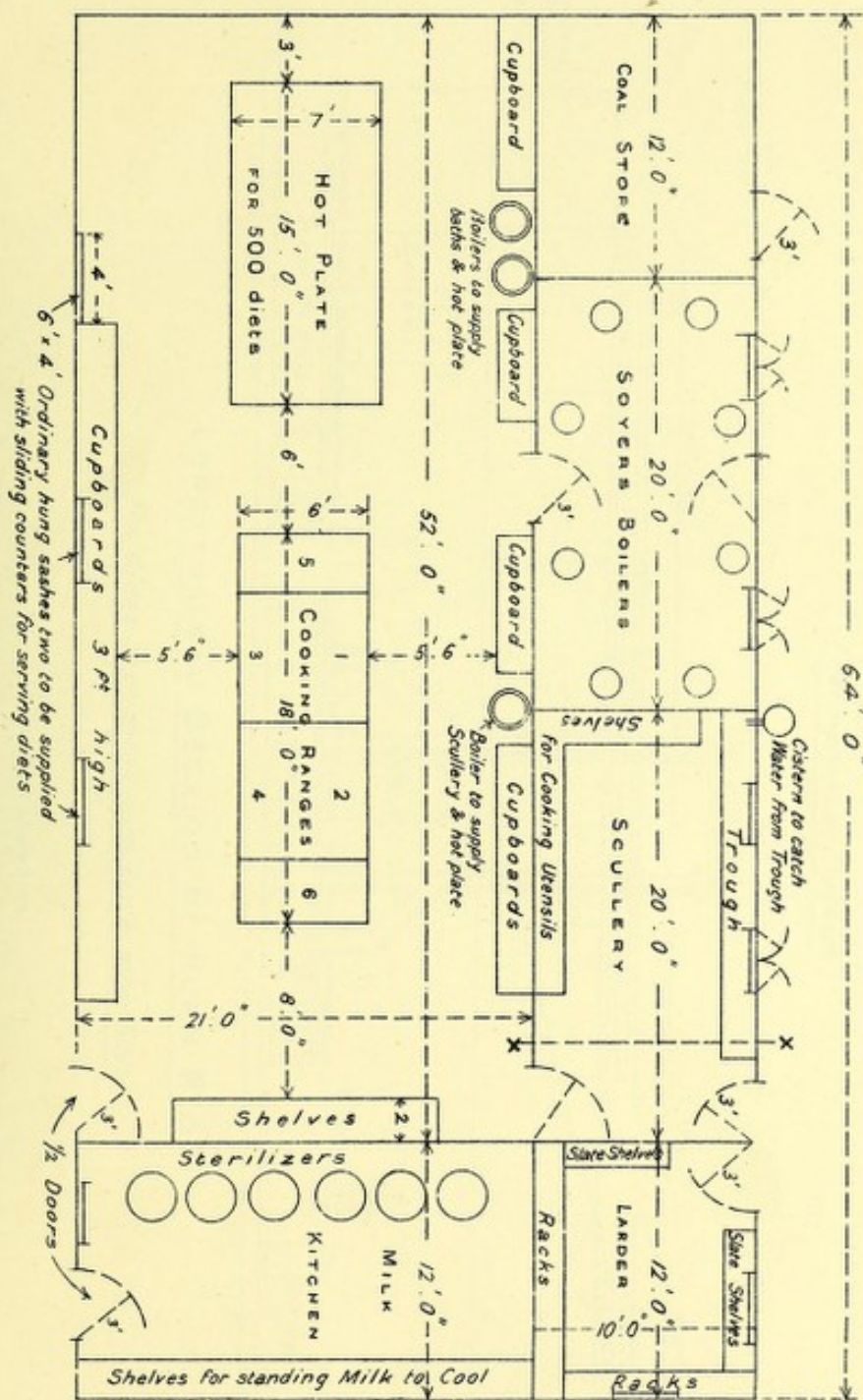
Notes:
1. All dimensions are in feet and inches.
2. The plan is for a single-story building.
3. The elevation is for the front facade.

PLAN N^o 5.

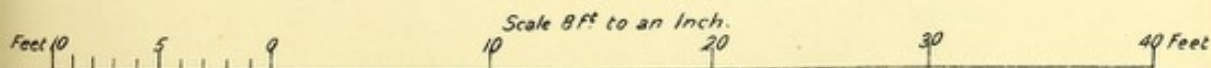
KITCHEN, SCULLERY, BOILER ROOMS &c.

(Permanent or Portable)

Drainage to be considered locally. Concrete or Brick on Edge Floors.



SECTION XX



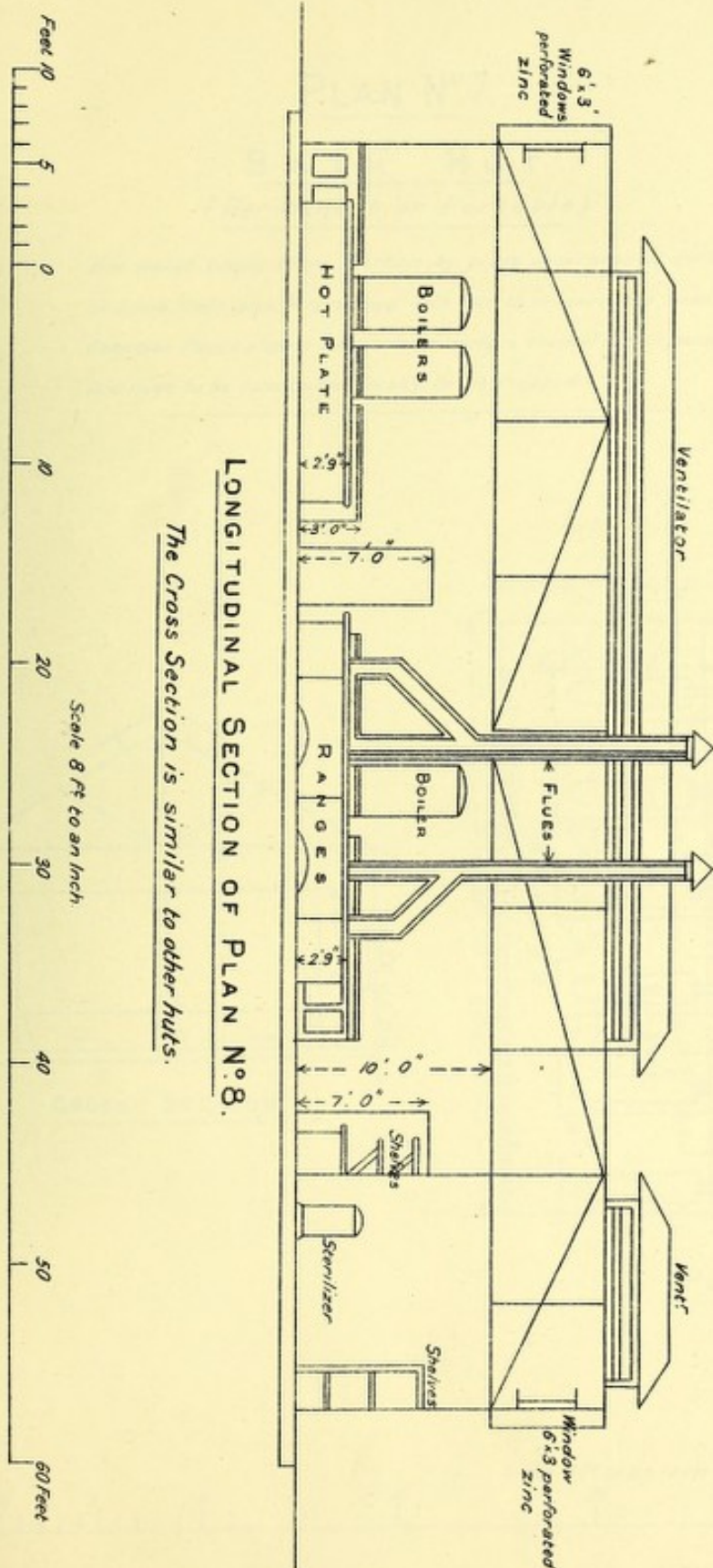
KITCHEN, SCULLERY, BOILER ROOMS &C.

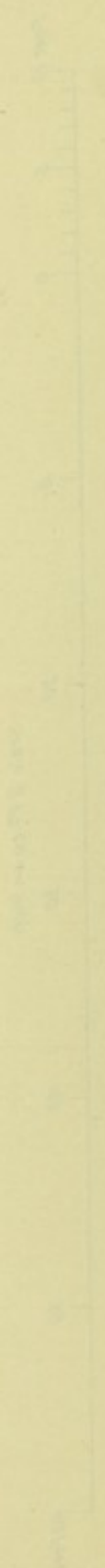
(Permanent or Portable)

PLAN N° 6.

LONGITUDINAL SECTION OF PLAN N° 8.

The Cross Section is similar to other huts.





See plan section in Appendix to report

LONGITUDINAL SECTION OF PLAN No 6



(Symmetrical section)

KITCHEN SCULLERY BOILER ROOMS &c

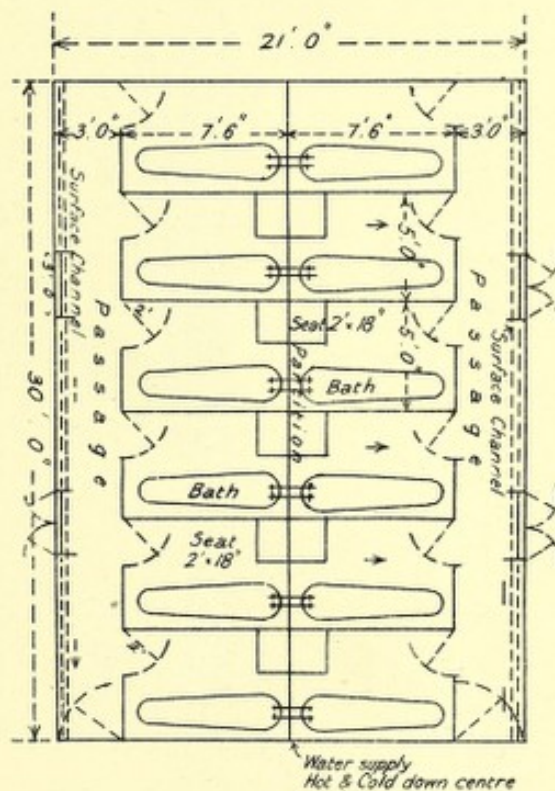
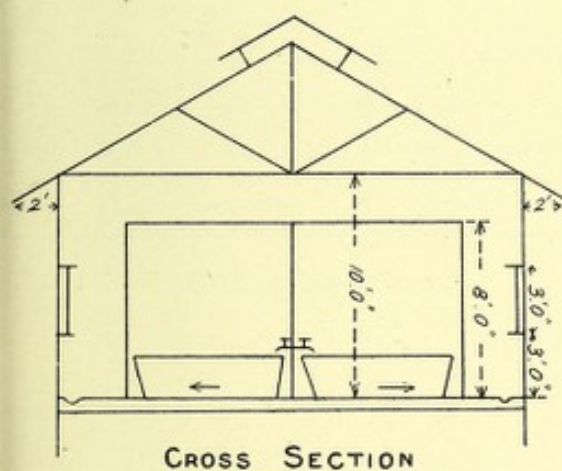
PLAN N°7.

BATH HUT (Permanent or Portable.)

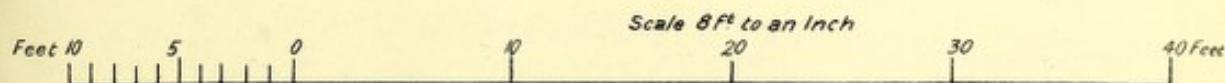
Hot water supply from Kitchen by pipes underground enclosed
in 3 inch drain pipe & wrapped with felt to preserve the heat.

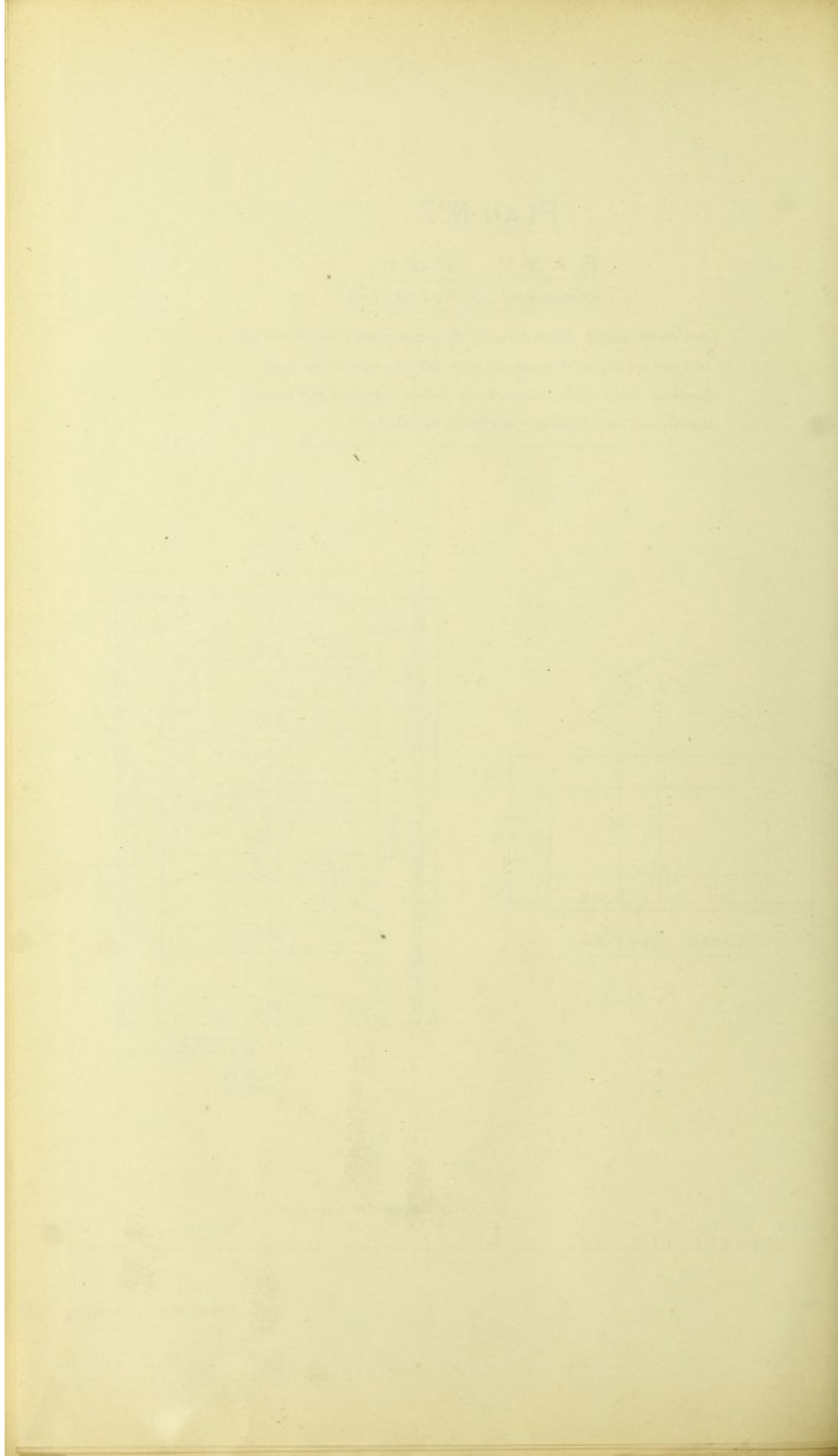
Concrete floors sloping outwards to surface channel in each passage.

Drainage to be considered locally to be trapped.

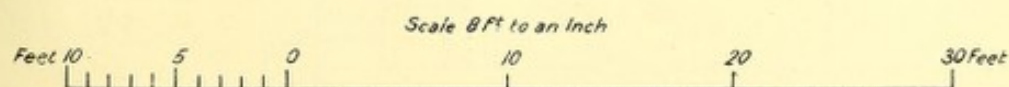
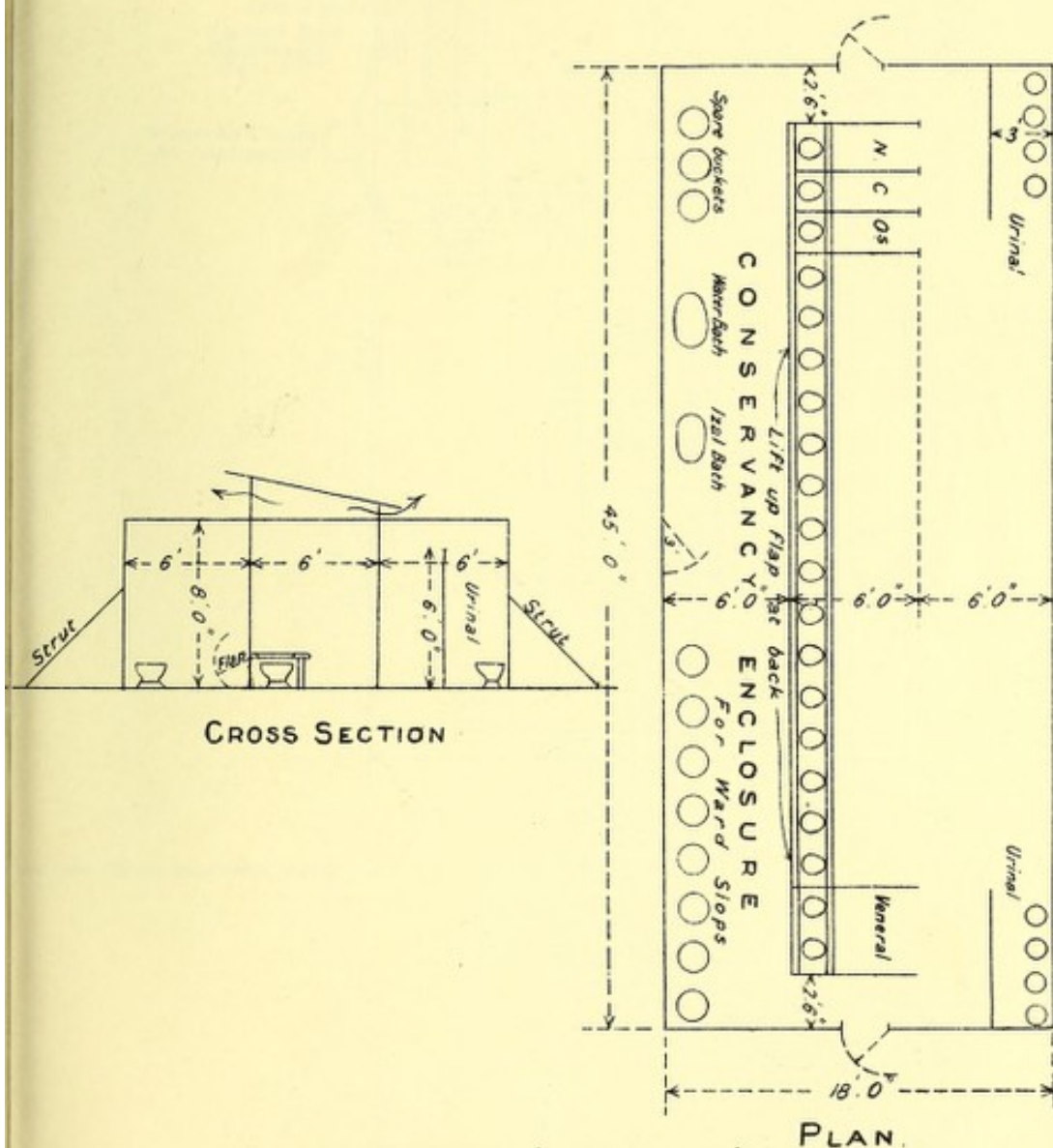


PLAN



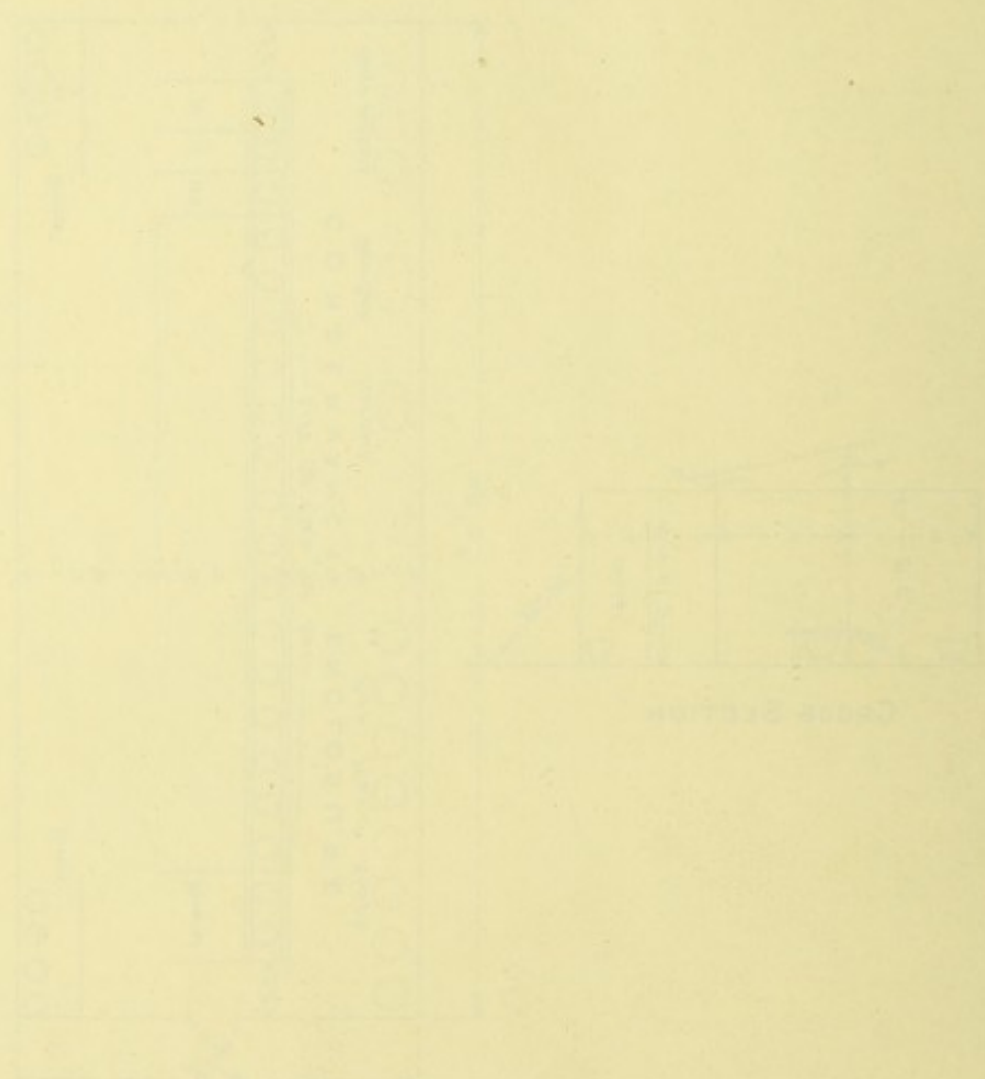


PLAN N^o 8 HOSPITAL LATRINE



PLAN NO. 1

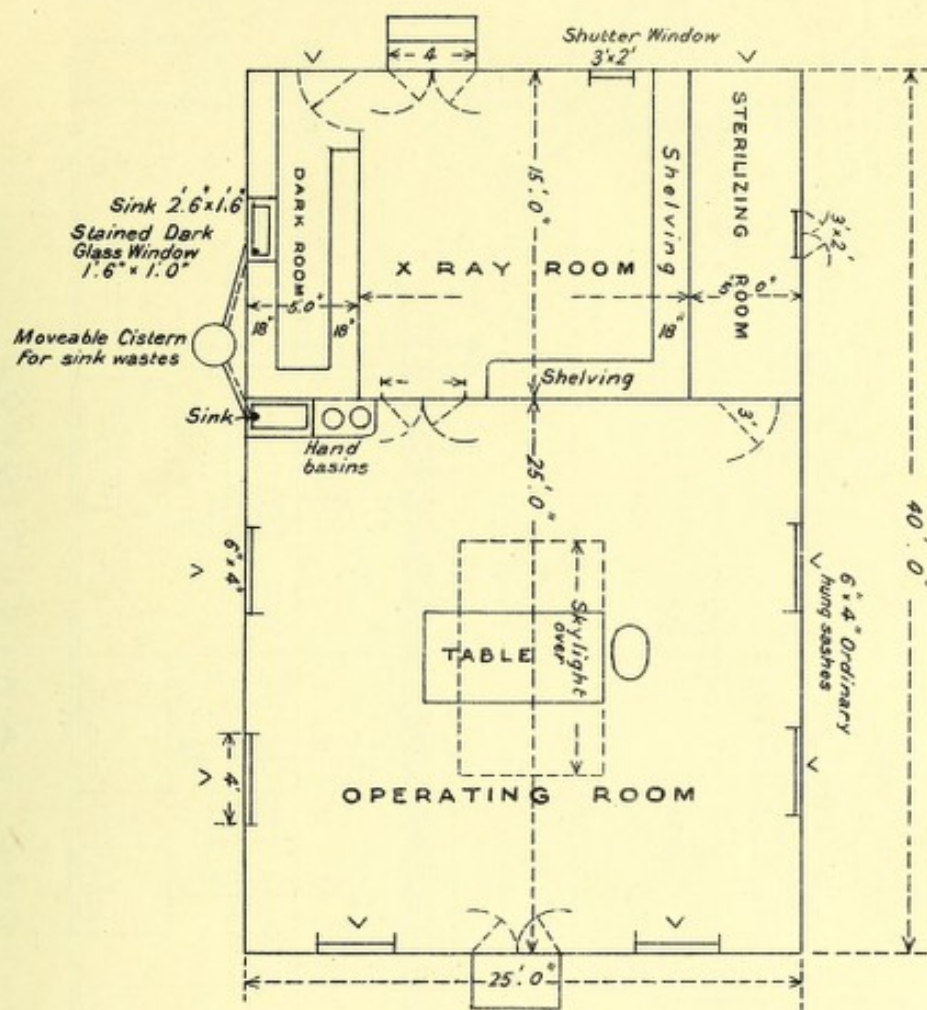
HOSPITAL LATERAL



PLAN N^o 9.

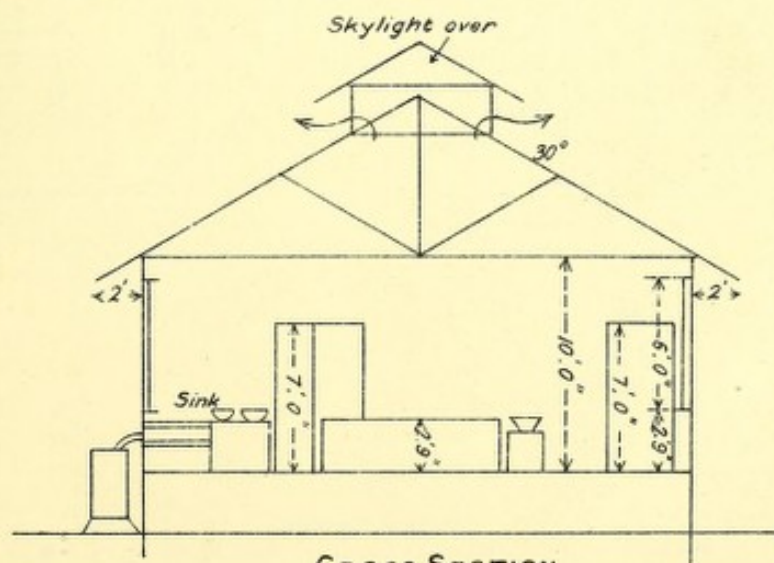
OPERATING THEATRE & C.

(Permanent or Portable)



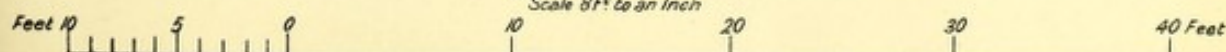
PLAN

Notes on plan N^o 1 are applicable to this hut.



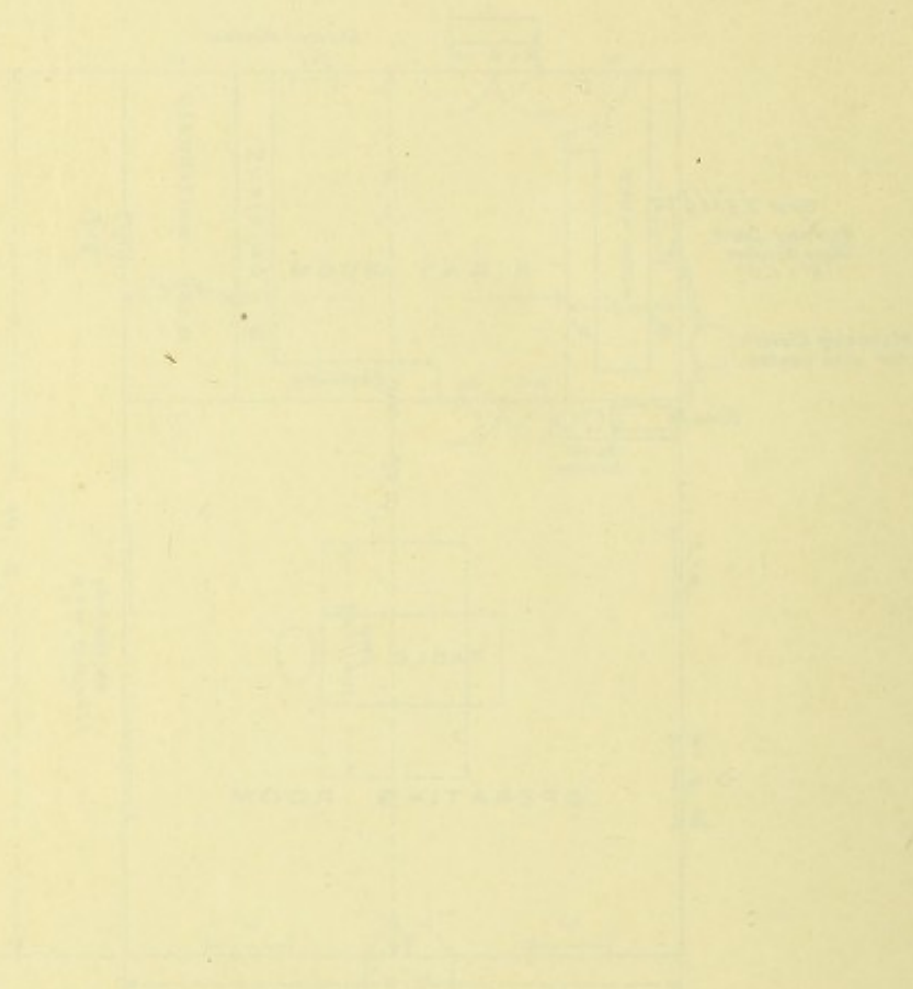
CROSS SECTION

Scale 8 Ft. to an Inch



OPERATING THEATRE NO.

THEATRE NO. 1

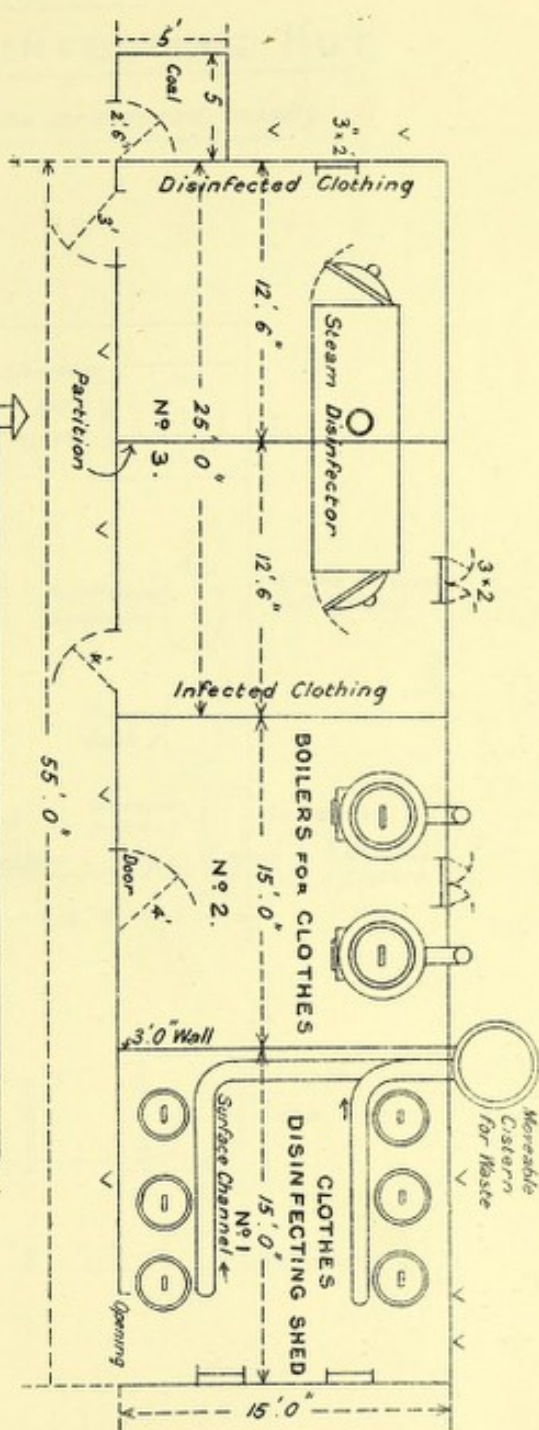


THEATRE NO. 2

PLAN N° 10.

CLOTHES DISINFECTING SHED.

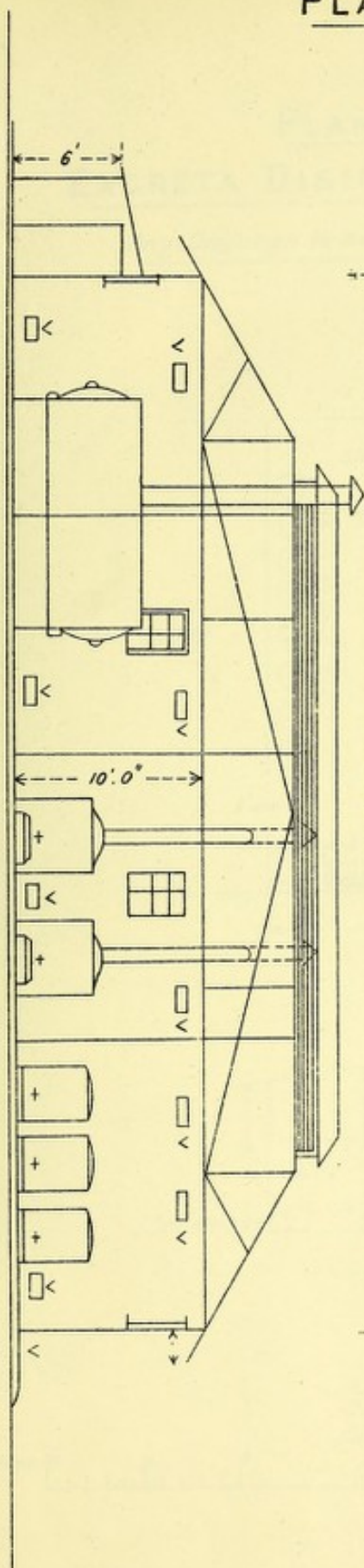
(Permanent or Portable)



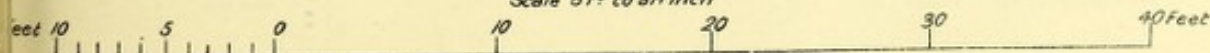
PLAN

LONGITUDINAL SECTION

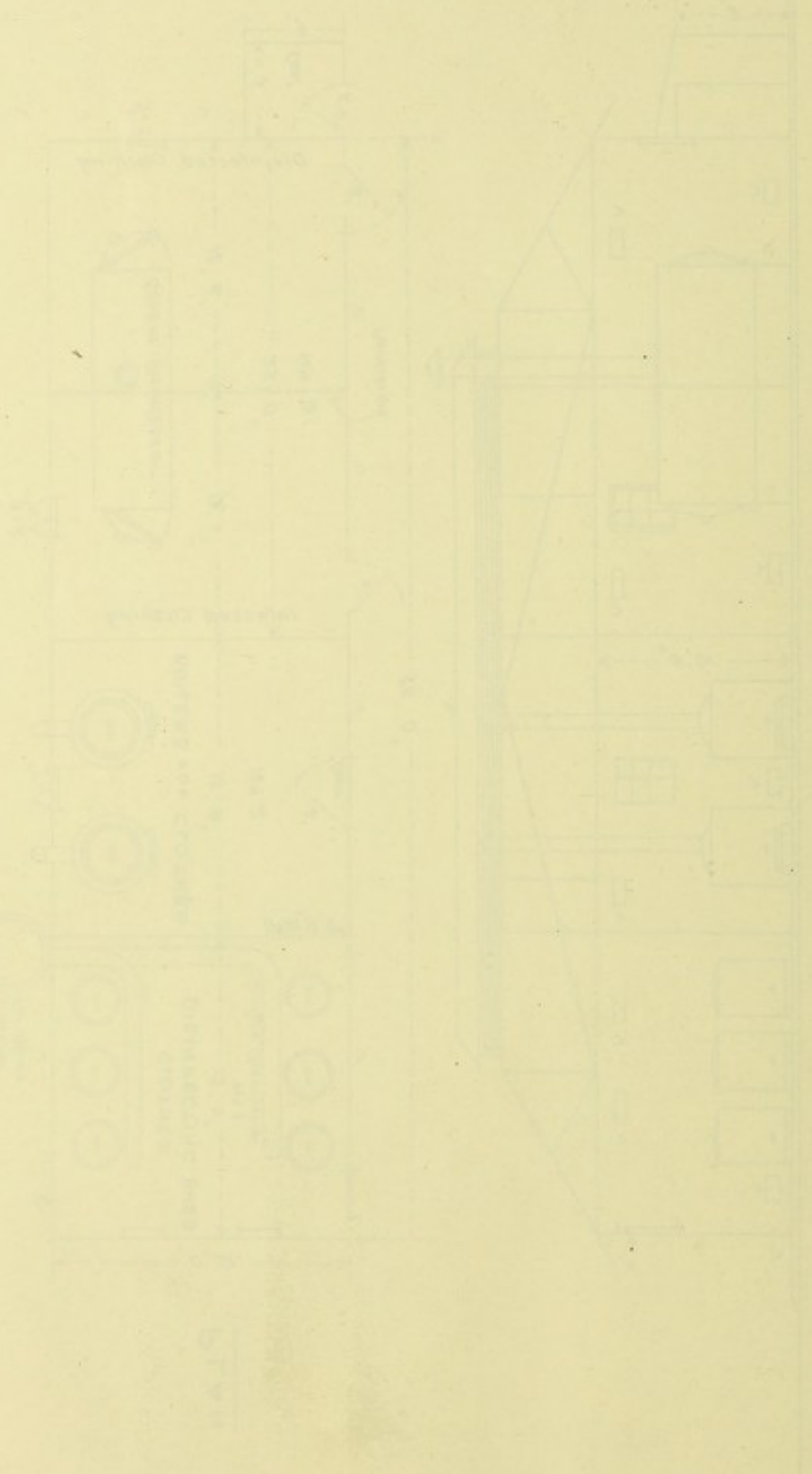
All Floors Concrete or Brick on Edge



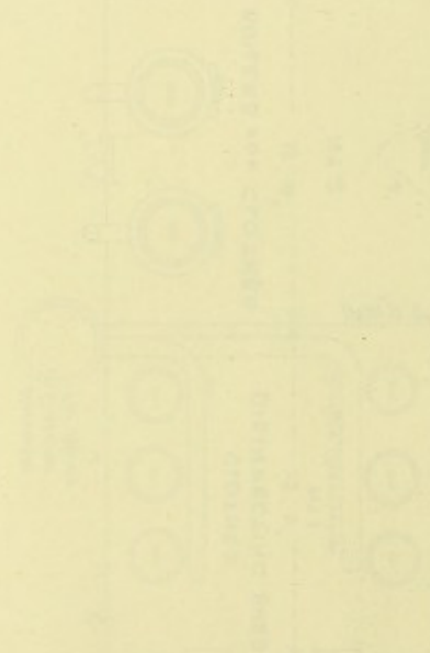
Scale 8 1/2" to an Inch



LONGITUDINAL SECTION

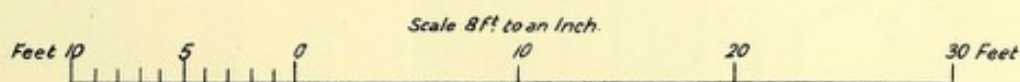
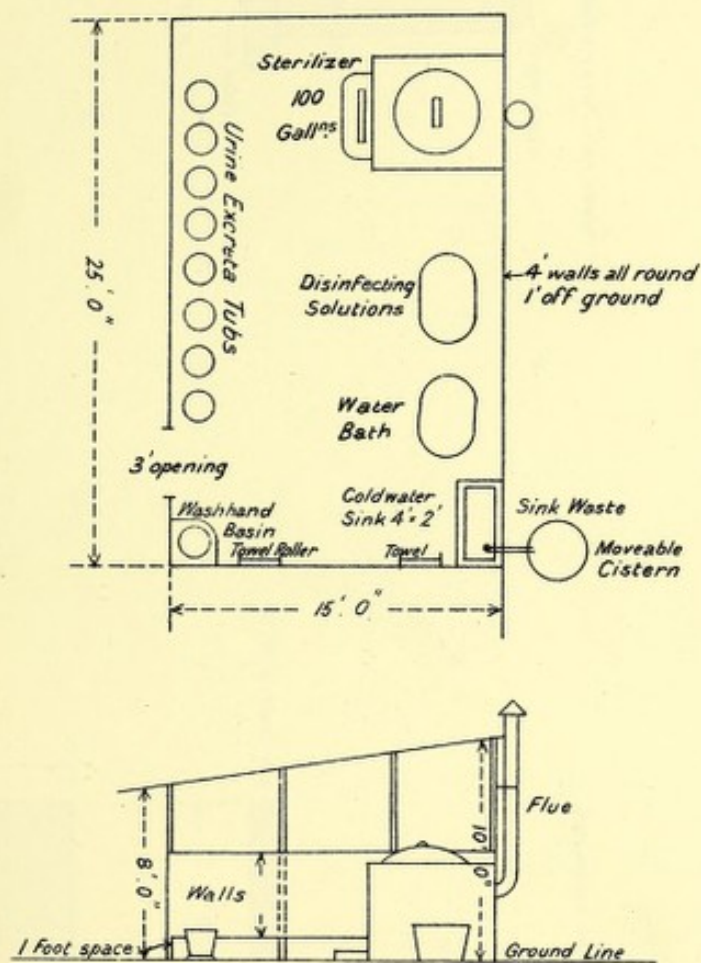


CROSS SECTION



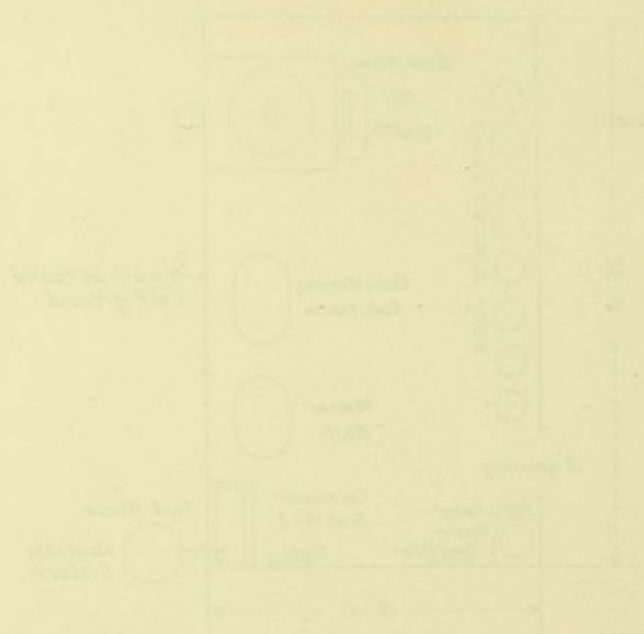
PLAN N^o II. EXCRETA DISINFECTING HUT

Any Drainage to be considered locally



PLAN No. II. EXCRETA DISINFECTING HUT

This drawing is to be considered locally.



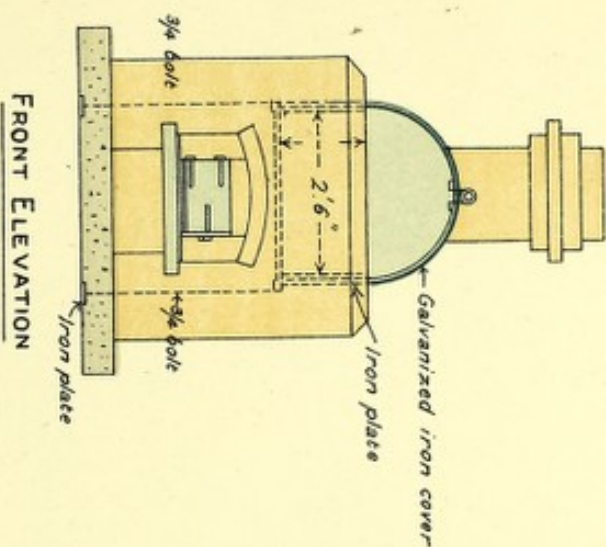
Scale 1" = 10' 0"

Drawn by J. H. Smith

PLAN N^o 12

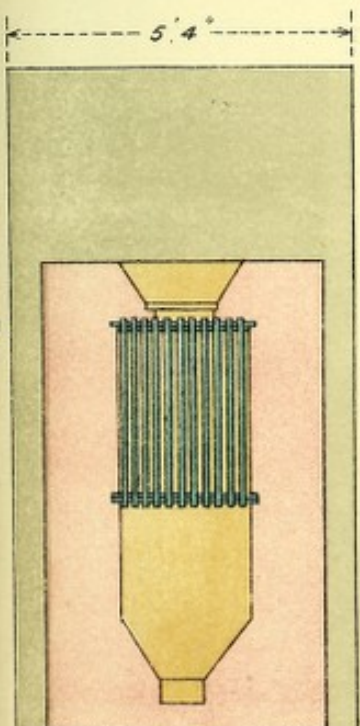
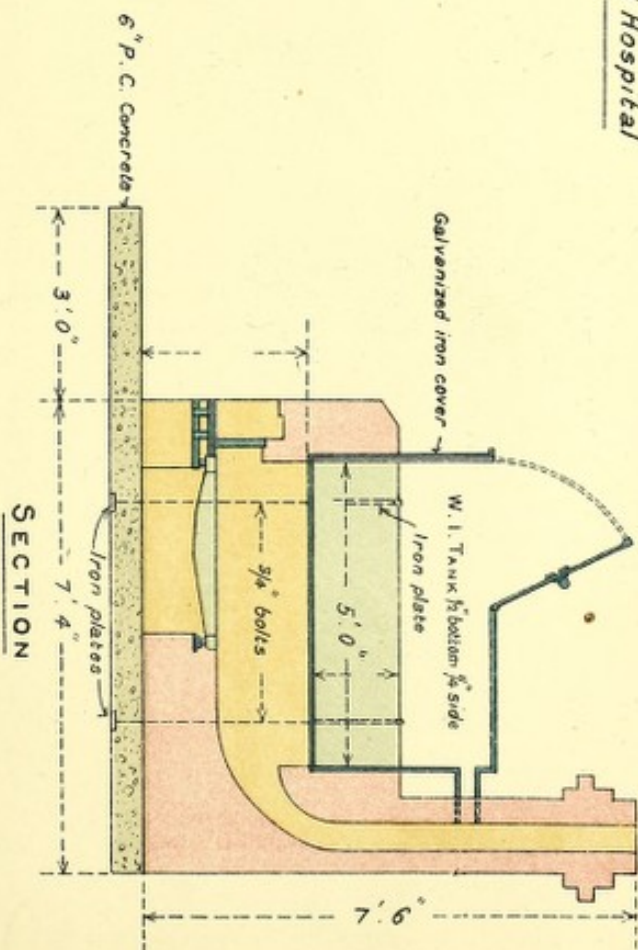
DETAIL OF INCINERATOR

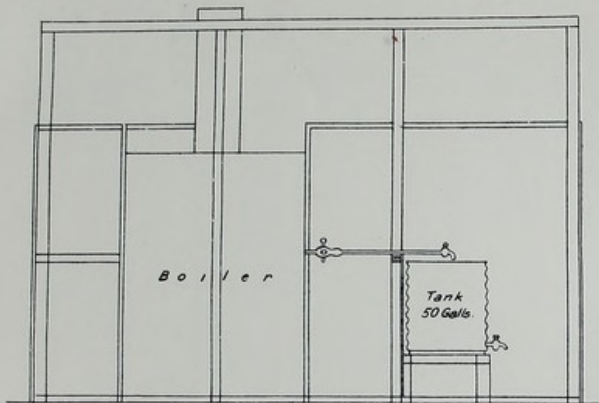
N^o 4 General Hospital



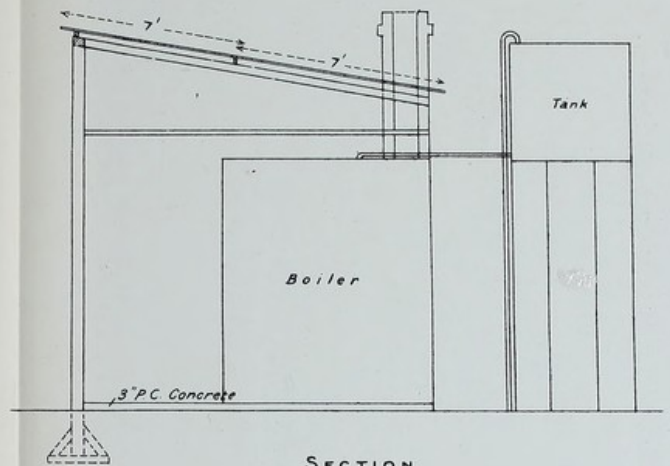
Scale R.F. 32' 3/8" to 8 Feet

inches 12 6 0 1 2 3 4 5 6 Feet

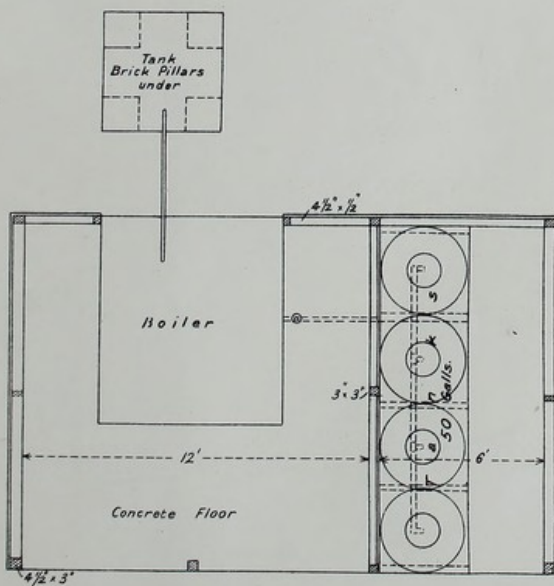




ELEVATION



SECTION

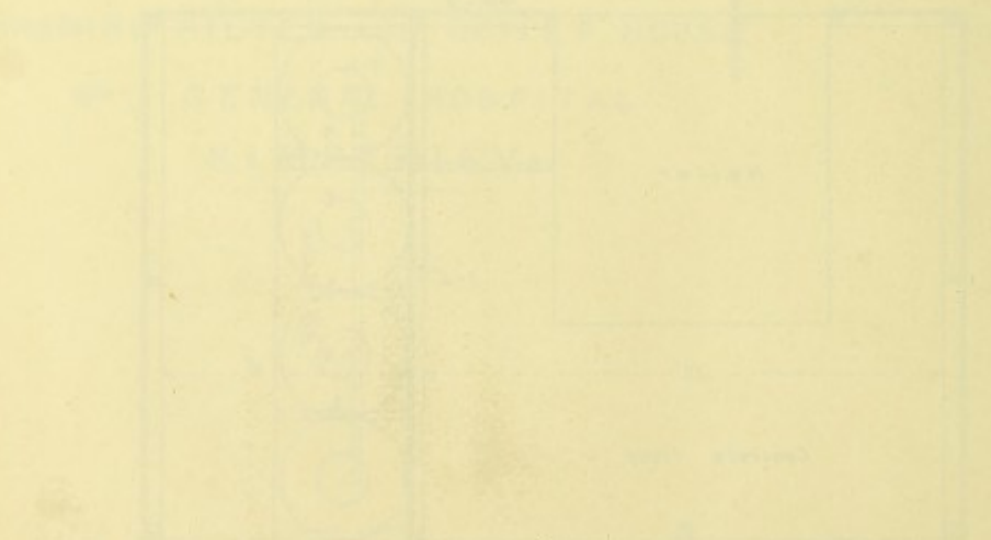
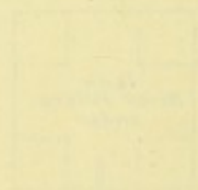


PLAN

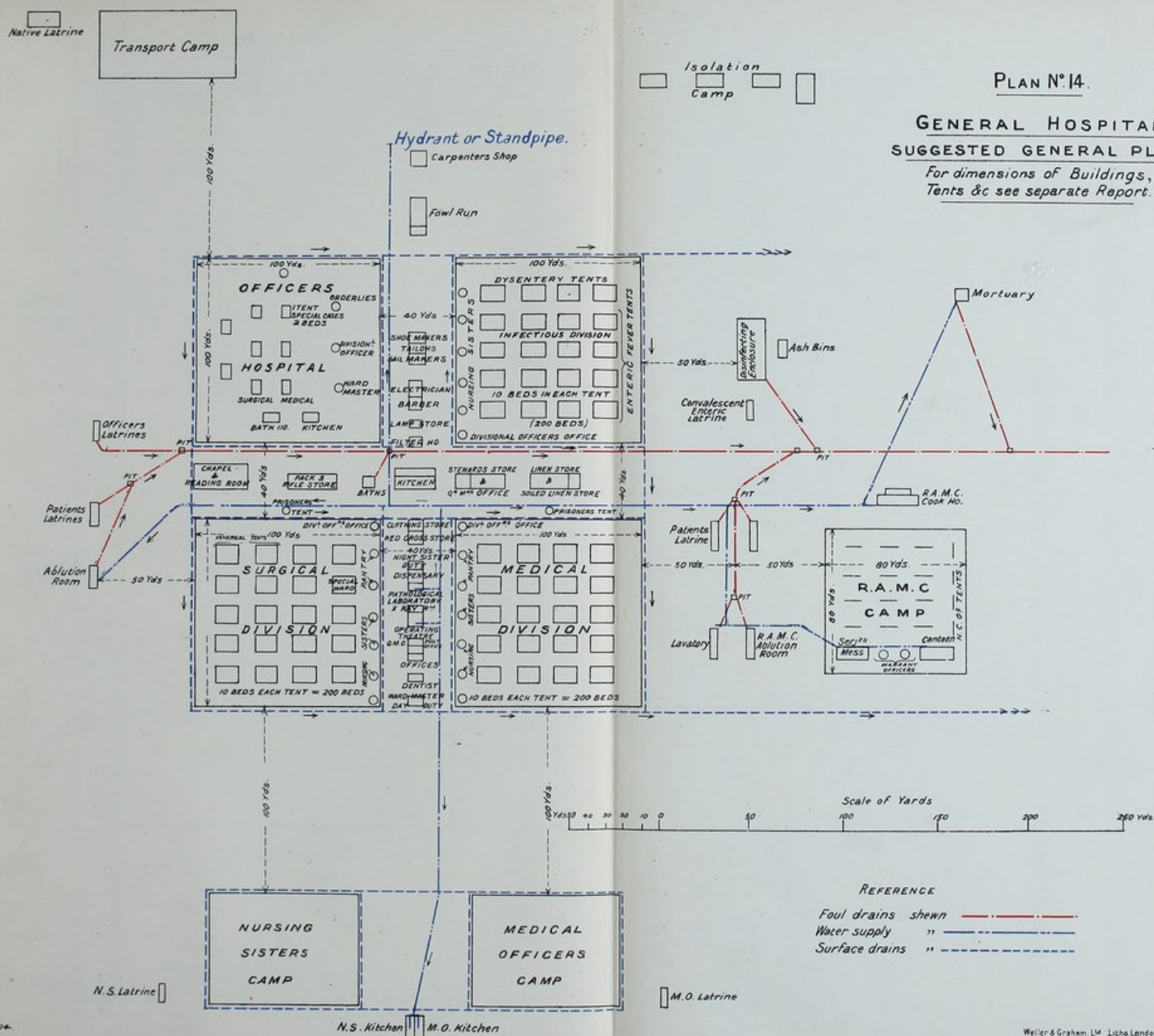
PLAN N^o 13.
 SHEWING FILTER AND BOILER HOUSE
 AT
 N^o 11 GENERAL HOSPITAL
 KIMBERLEY.



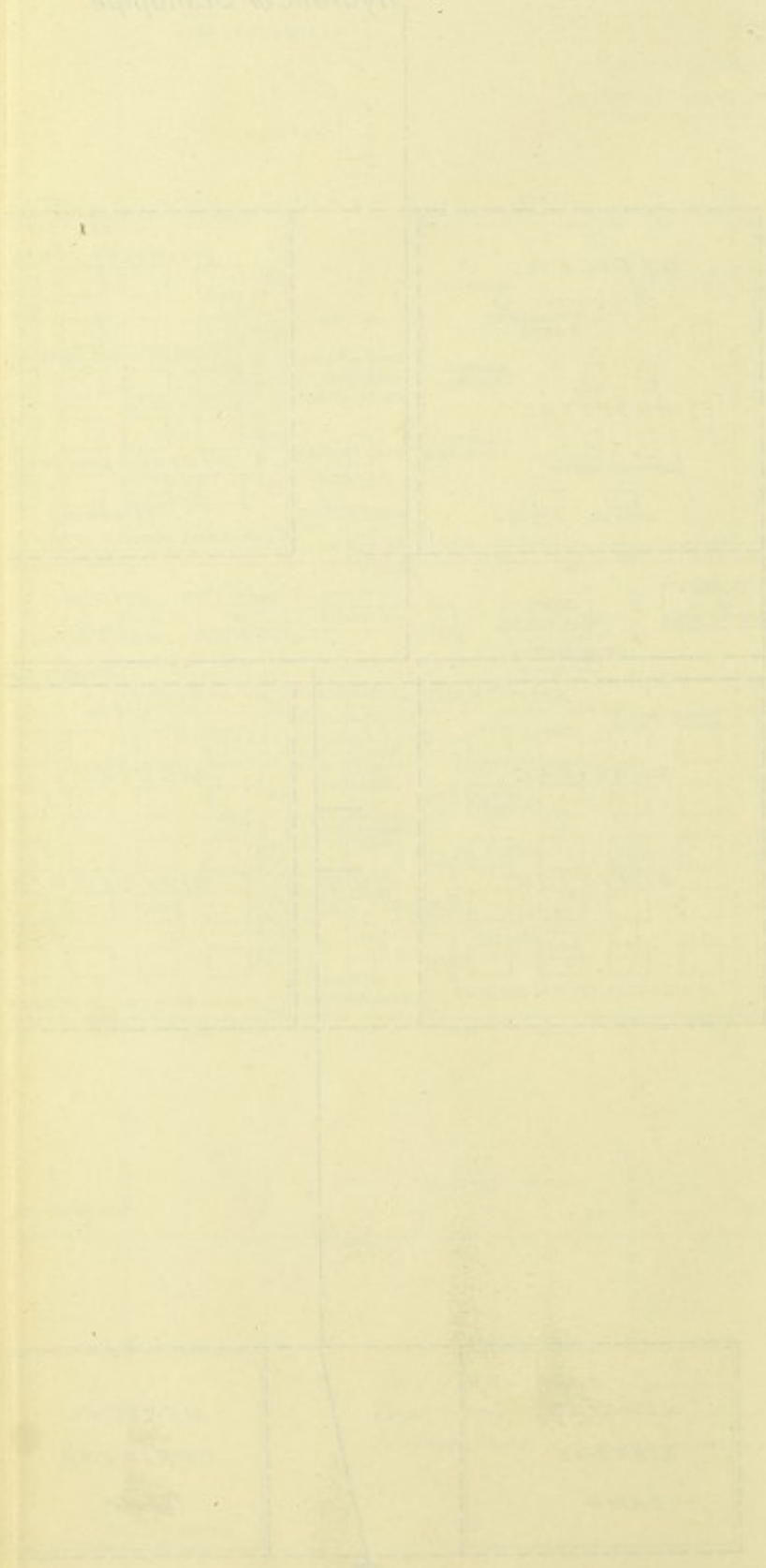
Floor Plan



Floor Plan



Hydrogen or Standpipe



○ Mortuary

□ Ash Bin

Disinfecting
Enclosure

Bath Rm

Kitchen

Ablution Rm

Latrines

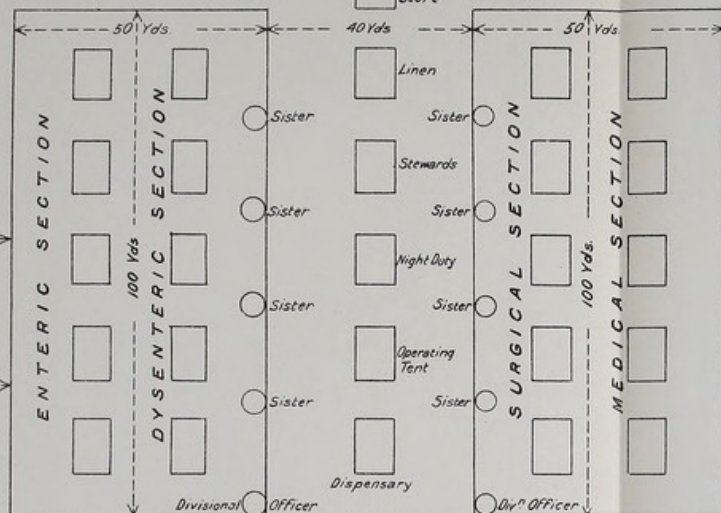
Latrines

Ablution Ho.

R.A.M.C

Pack &
Rifle
Store

INFECTIOUS
DIVISION



NON-INFECTIOUS
DIVISION

R.A.M.C.
CAMP

PLAN N°15 STATIONARY HOSPITAL

(120 BEDS)
(E.P.I.P. TENTS)

(Water supply & Drainage to be considered locally)

Scale of Yards
Yds. 25 20 15 10 5 0 25 50 75 Yds

NURSING
SISTERS
CAMP

MEDICAL
OFFICERS
CAMP

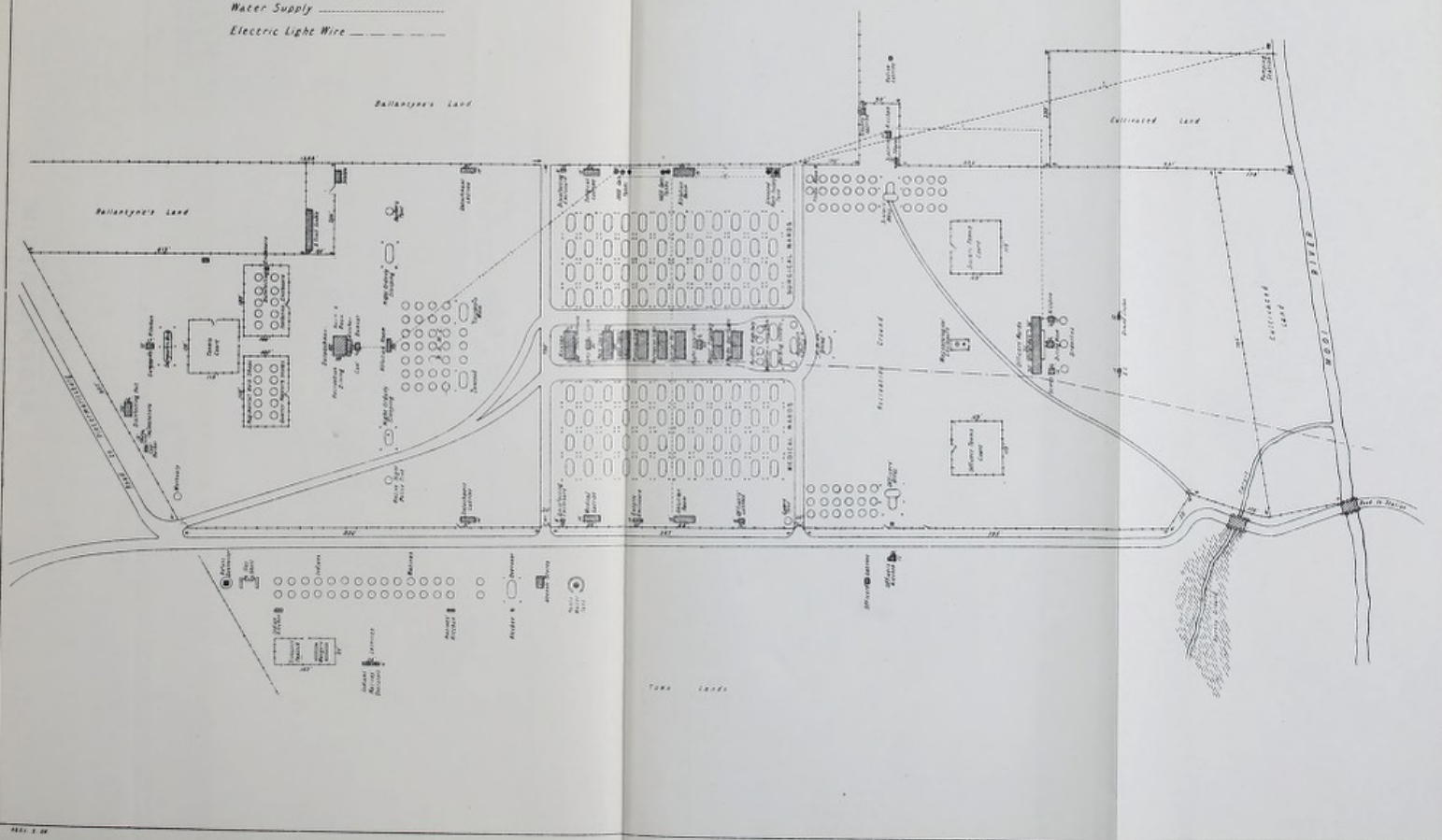
N. S. Kitchen

M.O. Kitchen

PLAN OF NO 4 GENERAL HOSPITAL, MOOI RIVER, NATAL.

Scale 200 ft = 1 in.

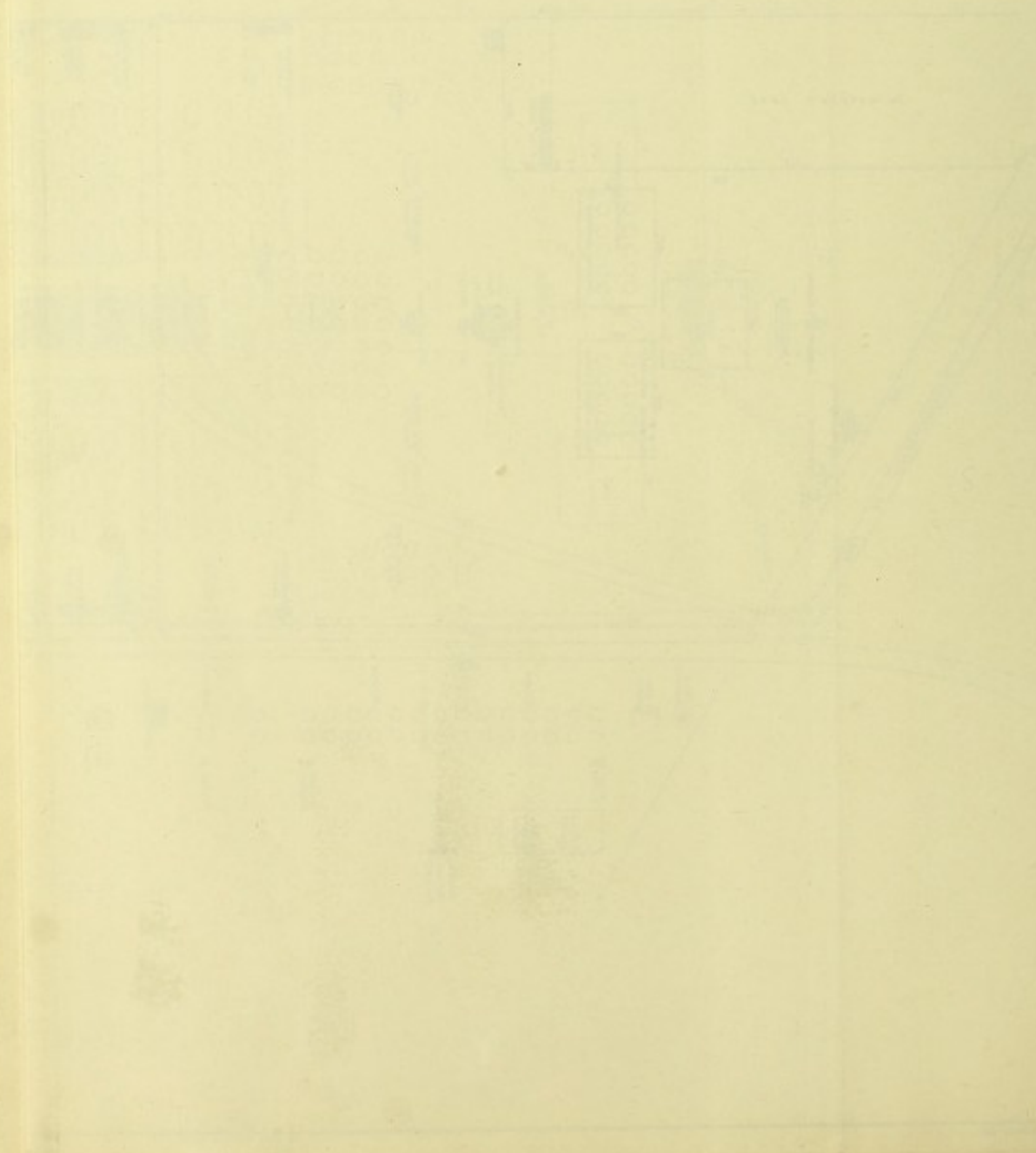
Note: Fences marked ————
Water Supply ————
Electric Light Wire ————



1400-2239

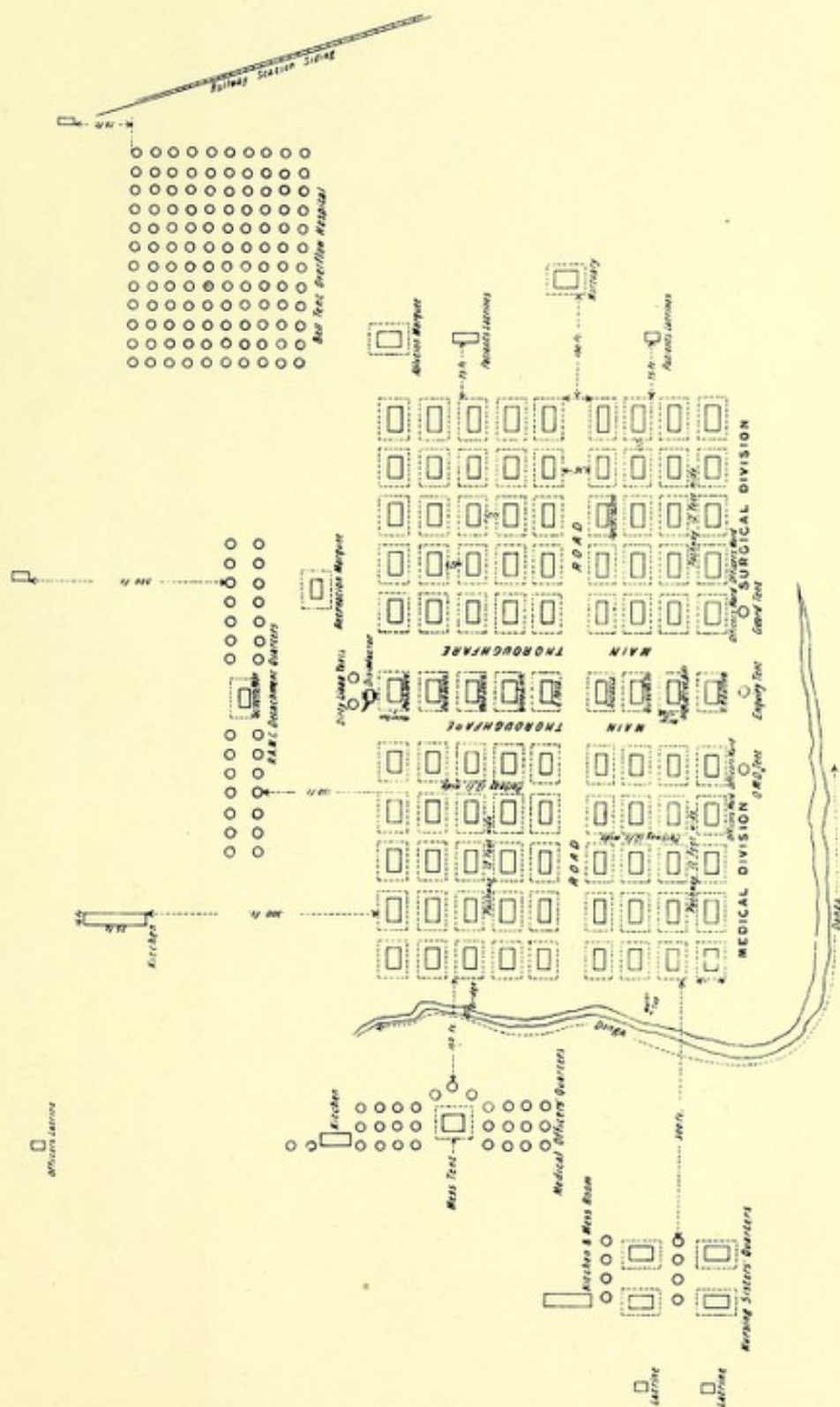
HOSPITAL

GOWER, NATAL



PLAN OF N° 9 GENERAL HOSPITAL
BLOEMFONTEIN.

Scale 200 ft. = 1 in.



N° XX GENERAL HOSPITAL ELANDSFONTEIN

25. 11. 01

COL. G.E. TWISS P.M.O.

Water Supply
Drain washing water etc. only
open from.
Surface drains.

R.A.M.C. CAMP
4 Rows of 9 Tents

Diet Canteen & Dining Tent

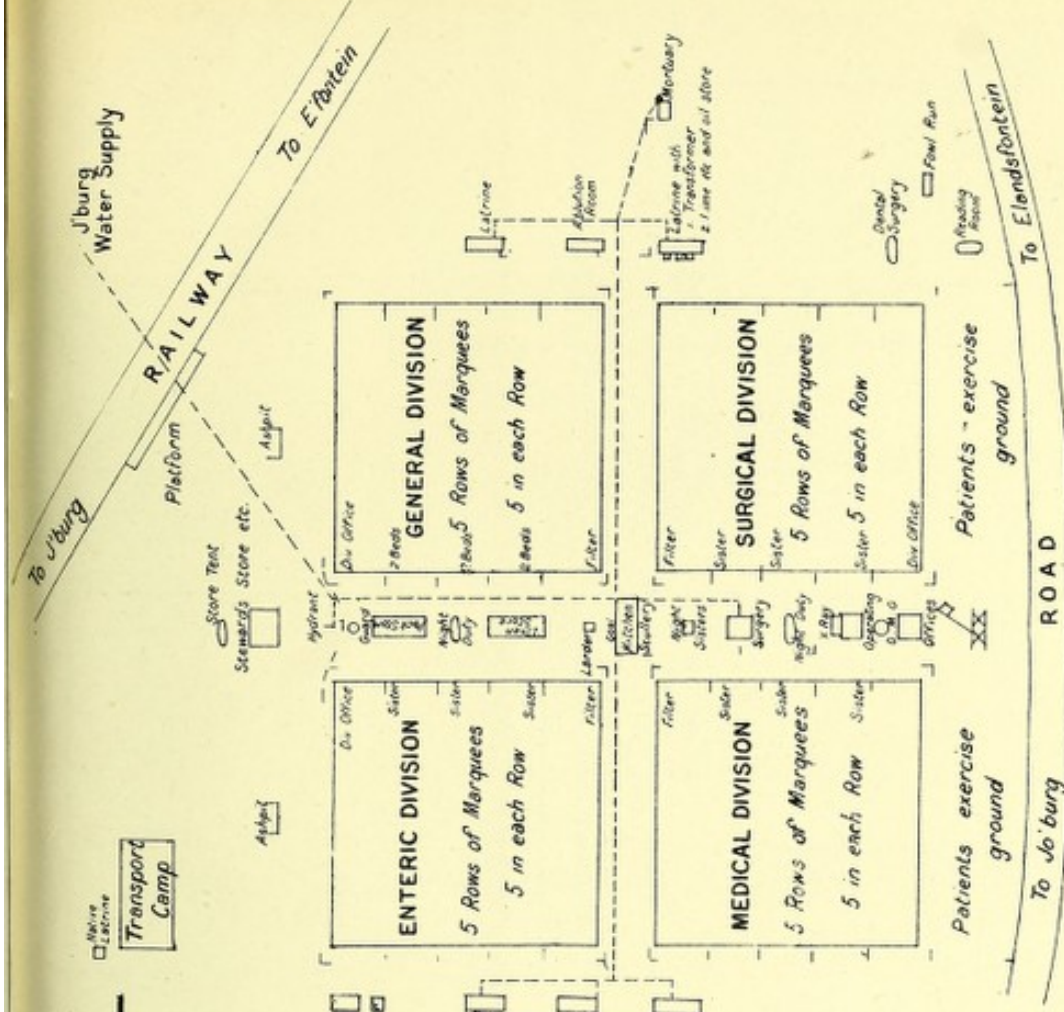
Sergeant's Mess

To Sluit 400 Yds.

DIMENSIONS OF BUILDINGS ETC.

- Offices 24' x 24' x 8'
- O.M.O. D.C. Tent
- Operating room 24' x 24' x 8'
- X-ray room 20' x 12' x 8'
- Night duty H. Marquee
- Surgery 24' x 24' x 8'
- Night sisters' room 12' x 14' x 9'
- Scullery 31' x 9' x 8' to 9'
- Cool Bunk 40' x 6'
- Larder 6' x 16' x 8'
- Linen Store 63' x 22' x 8'
- Pack Store 63' x 22' x 8'
- Guard Tent S.O.
- Stewards Store etc. 40' x 30' x 9'
- Railway Platform 150' x 12'
- ramp in centre. 18' wide.
- Latrine (1) 48' x 18' x 8' to 9'
- Line etc. & oil store 6' x 6' x 6' to 7'
- Electric transformer 6' x 6' x 6' to 7'
- Latrines (3) 38' x 18' x 8' to 9'
- Ablution & bathrooms 42' x 18' x 8'
- Enteric enclosure 30' x 15' x 7'
- contains incinerator 9' x 6' x 6'
- Mortuary 18' x 12' x 10'
- Fowl run (house included) 123' x 8' x 6' to 7'
- Store Tent
- Reading Room
- Canteen

Where one height only is given it is that from floor to eaves.

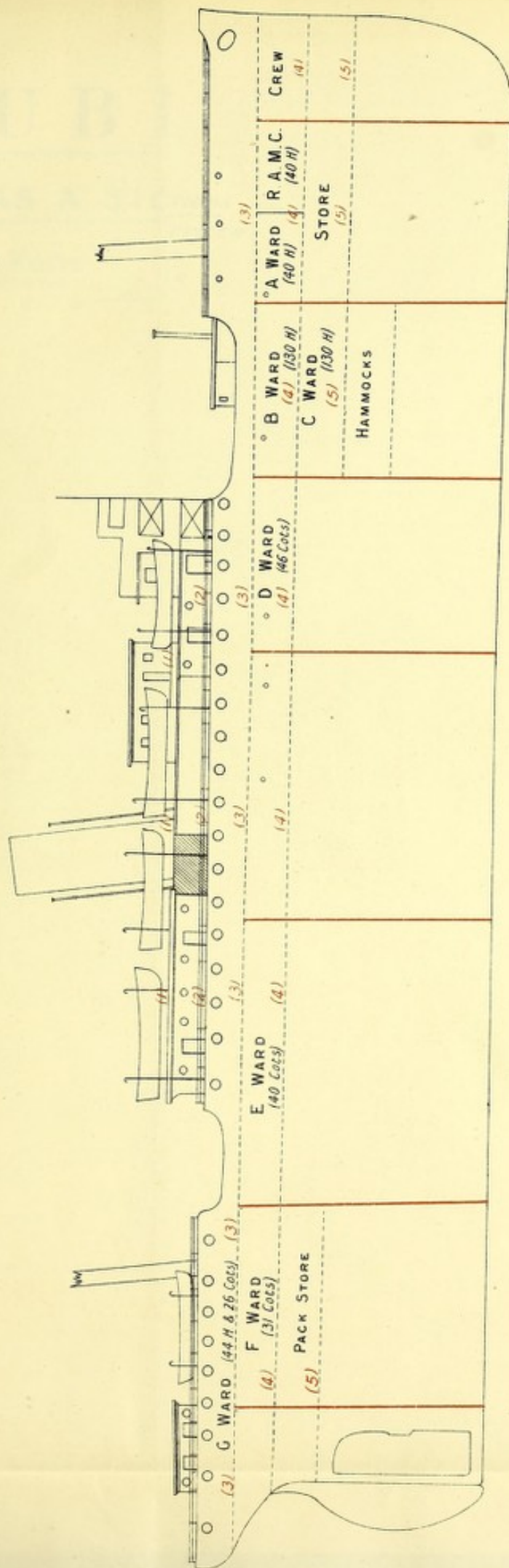


Scale 200 Ft. = 1 Inch.

ИСТОРИЯ

ИСТОРИЯ

H. S. NUBIA.



The vertical red lines show the watertight iron bulkheads through which wards communicate by watertight doors on both sides of the ship. These doors are closed by the Orderlies R.A.M.C. whenever the Fire or other alarm is sounded. Every compartment of the ship has a separate hatchway by which occupants can gain the deck.

No.	Name	Age	Sex	Religion	Marital Status	Occupation	Education	Literacy	Income	Assets	Liabilities	Remarks
1	John Doe	35	M	Christian	Married	Farmer	High School	Yes	\$1000	\$500	\$200	
2	Jane Smith	28	F	Christian	Single	Teacher	College	Yes	\$1200	\$300	\$100	
3	Robert Johnson	45	M	Christian	Married	Engineer	University	Yes	\$1500	\$800	\$300	
4	Mary White	55	F	Christian	Widowed	Homemaker	High School	Yes	\$800	\$200	\$50	
5	William Brown	60	M	Christian	Married	Retired	High School	Yes	\$900	\$400	\$150	
6	Elizabeth Green	30	F	Christian	Single	Nurse	College	Yes	\$1100	\$350	\$120	
7	James Black	40	M	Christian	Married	Businessman	University	Yes	\$1300	\$600	\$250	
8	Sarah Davis	25	F	Christian	Single	Student	College	Yes	\$600	\$100	\$0	
9	Michael Wilson	50	M	Christian	Married	Doctor	Medical School	Yes	\$1800	\$1000	\$400	
10	Linda Taylor	48	F	Christian	Married	Manager	High School	Yes	\$1400	\$700	\$300	

AS FITTED FOR SERVICE AS A SICK CARRIER.

SCALE $\frac{1}{16}'' = 1 \text{ FOOT}$

FIG. 2.



ORDERLY ROOM IN FRONT



CABINS ON HURRICANE DECK
AFT



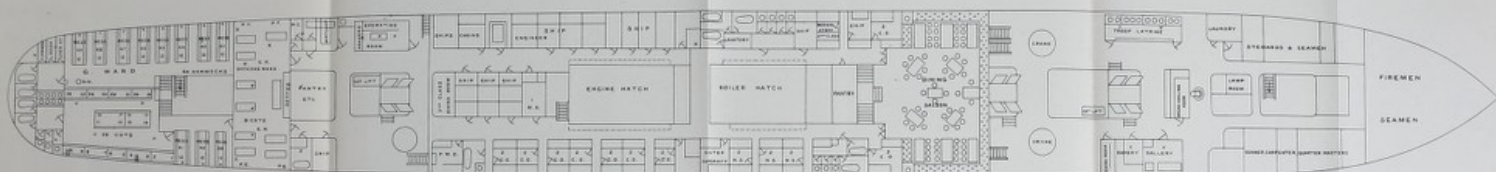
ON HURRICANE DECK
FORWARD

NUMBERS FITTED FOR

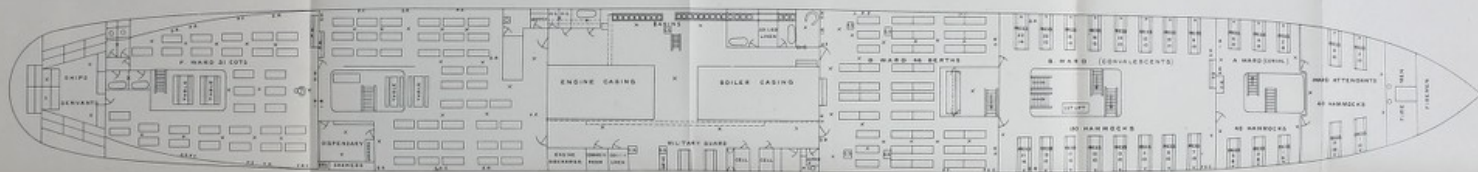
- | | |
|-----|---------------------------|
| 33 | OFFICERS |
| 1 | PRINCIPAL MEDICAL OFFICER |
| 4 | MEDICAL OFFICERS |
| 1 | SISTER SUPERINTENDENT |
| 8 | NURSING SISTERS |
| 400 | COT CASES |
| 200 | CONVALESCENTS (HAMMOCKS) |
| 40 | HARD ATTENDANTS |
| 10 | MILITARY GUARD |

LIST OF ABBREVIATIONS

- P.M.O. PRINCIPAL MEDICAL OFFICER
M.O. MEDICAL OFFICER
C.O. CONVALESCENT OFFICER
N.S. NURSING SISTER
D.M. DRINKING WATER
F.S.C. FIRE SERVICE COOK
S.R. STEAM RADIATOR
E.R. ELECTRIC RADIATOR
P.R. PLATE RACK
V.F. VENTILATING FAN
P.F. PORTABLE FAN
P.L. PORTABLE ELECTRIC LIGHT
E.L. ELECTRIC LIGHT
L.B. LK BOX



PLAN OF UPPER DECK



PLAN OF MAIN DECK



PLAN OF LOWER DECK



PLAN OF MAIN DECK



PLAN OF LOWER DECK



PLAN OF HOLDS



REPORT

UPON THE CONDITIONS OF WORK IN

FLAX AND LINEN MILLS

AS AFFECTING THE HEALTH OF THE OPERATIVES
EMPLOYED THEREIN.

BY

COMMANDER HAMILTON P. SMITH, R.N.,

ONE OF HIS MAJESTY'S SUPERINTENDING INSPECTORS OF FACTORIES.

Presented to both Houses of Parliament by Command of His Majesty.



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1904.

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REPORT

ON THE CONDITION OF THE

FLAX AND LINEN MILLS

AS AFFECTING THE HEALTH OF THE OPERATIVES
EMPLOYED THEREIN.

COMMANDED BY HIS MAJESTY'S COMMISSIONERS OF THE LANCING.

ON THE REPORT OF THE COMMISSIONERS OF THE LANCING.

Printed by the General Printing Office, at the University of London.



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[Price 10s.]

HOME OFFICE,

January, 1904.

SIR,

I BEG to submit the following Report by Commander Hamilton P. Smith, R.N., H.M. Superintending Inspector of Factories, upon the conditions of work in flax and linen mills as affecting the health of the operatives employed in certain processes therein.

I am, Sir,

Your obedient servant,

B. A. Whitelegge,

Chief Inspector of Factories.

The Right Honourable

A. Akers Douglas, M.P.,

His Majesty's Principal Secretary of State
for the Home Department.

REPORT UPON FLAX MILLS,

BY

COMMANDER HAMILTON P. SMITH, R.N.,

H.M. SUPERINTENDING INSPECTOR OF FACTORIES.

HOME OFFICE,

December, 1903.

SIR,

IN 1892 Mr. Osborn presented an exhaustive Report upon the conditions of work in the Belfast Flax Mills and Linen Factories, and on the mortality among textile operatives in the City of Belfast during 1891. A certificate of the Secretary of State published in the *London Gazette* of 3rd January, 1894, declared the processes carried on in flax mills and linen factories to be dangerous within the meaning of Section 8 of the Factory and Workshop Act, 1891, and Special Rules were framed and published by the Home Office on April 18th, 1896. You have from time to time received reports tending to show that although these Rules have done much to secure healthy conditions for the workers, yet in many respects they are capable of considerable improvement without causing serious inconvenience or excessive cost to the manufacturers. You directed me to hold an inquiry, and I have visited a large number of works in the North of Ireland, in Dundee and neighbourhood, and in the South of England. The conclusion I have arrived at is that in the light of our present knowledge and the facilities for utilising that knowledge, it is important that the provisions of the Special Rules should be amended; and that the Rules should be converted into Regulations under Section 79 of the Act of 1901.

I propose to give reasons in detail for the views that I advance, and to submit practical suggestions which may assist in giving effect to the proposed changes. I do not forget that the original Rules were made by predecessors whose ability and judgment will certainly never be questioned, but since they were framed exhaustive and lengthened trials have taken place, new methods have been discovered with the result that greater efficiency can be attained, and improvements may yet be made which will reduce to a minimum conditions which I have no hesitation in saying are seriously, and in some cases dangerously, affecting the health of the persons employed. The views I have expressed will, I believe, be supported by the most influential and most experienced manufacturers. To these gentlemen I am indebted for a large amount of practical and valuable information. I cannot speak too highly of the efforts that have been made by many. They have spent time, thought, and large sums of money, going far beyond any legal requirements that have yet been made. On the other hand, there are manufacturers who, with the best intentions, have not the means to experiment but who would readily adopt measures which had elsewhere been found efficient. With the co-operation of the manufacturers, and I am glad to say that has not been refused me, it may be possible not only to frame new Regulations but also to show how they can be carried out.

VENTILATION.

Turning to the present Rules we find a requirement that in weaving sheds in which artificial humidity is produced an efficient 14 in. extracting fan shall be provided for every 2,500 square feet of floor surface, such ventilation to be arranged to the satisfaction of the Inspector of Factories. In the case of cotton weaving, experience obtained in the working of Section 9 of the Cotton Cloth Factories Act, 1889, which required the delivery of a certain volume of fresh air per head per hour, led to the appointment of a Committee presided over by Sir H. Roscoe. The action taken upon the Report of that Committee, in the Cotton Cloth Factories Act of 1897 and Order of 1898, substituted for the above a chemical standard of purity of the air in terms of the proportion of carbonic acid it contains. The lengthened and exhaustive inquiry recently held by Dr. Haldane and Mr. Osborn supports the view that we must look to the carbonic acid standard as the more scientific and reliable method for ascertaining the condition of the air in factories and workshops. Without possessing the scientific knowledge which led to the conclusions arrived at by the above Committees, I have in practice found the new method to be satisfactory, whereas the old one is unreliable and for practical purposes of administration impossible to carry out. It is difficult to measure with accuracy the amount of air that is passing into a weaving shed, and even when it is approximately known how much air is entering and passing out, it by no means follows that every part of the shed is properly ventilated. While an adequate volume of air may be passing in and out of the shed as a whole, many parts of that shed may be quite or nearly outside the influence of the currents, owing to short circuiting, adverse atmospheric conditions, mis-placed inlets, leakages through doors, windows, crevices or cracks.

Although in the existing Special Rules for Flax Mills it is not laid down that any definite volume of air must enter the shed, the arrangements are based upon calculations to secure that result, and the objections which I have ventured to submit are equally applicable. I therefore recommend that in flax spinning and weaving rooms or sheds the present requirement as to ventilation should be replaced by a standard of purity to be measured (as in the case of humid cotton cloth factories) by the amount of CO_2 in the air of the room in excess of that contained in the outside air, and furthermore that this should apply to all rooms in which persons are employed, whether artificial humidity is produced or not.

In nine weaving sheds and ten spinning rooms I took samples of air. The results of the analyses are as follows :—

Weaving Sheds.

Number.	Locality.	Date.	Hour.	Parts of CO_2 per 10,000 parts of air.
A.	Belfast	June 2, 1903.	12.40 p.m.	10.0
B.	"	" "	"	5.2
C.	"	June 4, 1903.	12.15 p.m.	8.5
D.	"	" "	12.30 p.m.	11.0
F.	"	" "	4.50 p.m.	8.5
E.	Country	June 5, 1903.	3.20 p.m.	7.0
G.	"	June 8, 1903.	11 a.m.	1.7
H.	"	" "	4.10 p.m.	8.0

Spinning Rooms.

No.	Locality.	Date.	Hour.	Parts of CO ₂ per 10,000 parts of air.
A.	Belfast	June 2, 1903.	12.55 p.m.	6.3
B.	Country	" "	3.25 p.m.	4.6
C.	"	" "	4.15 p.m.	4.5
D.	Belfast	" "	5.15 p.m.	10.7
E.	"	June 3, 1903.	11.45 a.m.	8.6
F.	"	" "	12.45 p.m.	6.0
G.	Country	" "	3.15 p.m.	7.2
H.	"	" "	4.15 p.m.	7.5
I.	Belfast	June 4, 1903.	4.15 p.m.	7.3
J.	Country	June 8, 1903.	3.20 p.m.	1.0

I should, however, explain that these tests were taken in exceptionally fine weather, generally speaking with a light breeze and when practically every window was wide open ; and it will be observed that in some of the places which were situated in country spots and at high elevations where probably only fresh air from the sea reached them, the condition of the air in regard to CO₂ was much below what is considered normal even in the most favoured places.

My investigations lead me to believe that no serious difficulty would be found in maintaining a satisfactory standard of purity of air, even when the conditions were less favourable than at the times when my samples of air were taken. Existing mechanical arrangements would, I think, generally suffice, but where they did not, trouble and inconvenience to the manufacturer might be avoided could he be relieved from the requirement of having any particular kind of fan or any particular place in which to fix it. He would have simply to make his arrangements in order to secure the measure of purity. These arrangements when complete should maintain this standard, and he would be relieved from troublesome and sometimes difficult details. I propose that such a standard be established.

I have also given the results of analyses of air taken under favourable conditions, in wet spinning rooms. Under different conditions we would naturally expect more unsatisfactory results. We may, however, I think, conclude that so far as practical manufacturing purposes are concerned there can be no objection to establishing a standard of purity for the air in wet spinning and other rooms in which persons are employed. This would conduce to the health of the workers. I therefore submit that such a standard be established.

HUMIDITY.

Under this heading we find detailed requirements in regard to wet and dry bulb thermometers, which apply to every weaving factory where artificial humidity is produced. Appendices 1, 2 and 3 give the number and situation of flax spinning and weaving works, the number of persons employed in different departments, and a summary of the humidity returns for several years. The existing Special Rules impose the same requirements with respect to humidity in wet spinning rooms as in weaving sheds. Wet spinning rooms are rooms in which the flax rove passes from the bobbins on the frame through a trough of heated water which softens the gummy parts and

allows it to be drawn out without breaking the fibre, before passing to the "flyers" or ring spinners. Steam is given off from the troughs if proper precautions are not taken, and much moisture in the shape of spray from the "flyers." In wet spinning rooms records have, generally speaking, been kept and forwarded, and tabulated in the statistical returns; but doubts have arisen whether the use of hot water in the troughs on the spinning frames, or the use of steam for heating the water, can be regarded as the production of artificial humidity in the sense of the Rules or of s. 96, 1901. These points should, I think, be settled. Looking over the returns it does not appear that any difficulty has been found in maintaining a difference of at least 2 degrees between the wet and dry bulbs, but I was assured that the range at present allowed is necessary for manufacturing purposes, and the opinions from reliable sources generally expressed led me to accept this view. I would therefore propose that the difference between the readings should remain as at present fixed and that the requirement in regard to humidity should apply to all wet spinning rooms. I would further recommend the addition of the following requirement, which is based upon that of section 94, 1901:—

The water used for the purpose of producing humidity or for use in the troughs in wet spinning rooms shall be taken from a public supply of drinking water or other source of pure water, or shall be effectively purified to the satisfaction of the inspector before being introduced in the form of steam, or used in the troughs.

Complaints were made to me during my stay in Belfast to the effect that impure water was used in wet spinning rooms, and serious injury to health was ascribed to this cause.

REMOVAL OF STEAM FROM WET SPINNING ROOMS.

In the rooms under consideration damp floors and a humid atmosphere must be expected, but in a very large number of wet spinning rooms the condition of the floors leaves much room for improvement, and an unnecessary amount of steam from the troughs frequently escapes into the rooms. Dealing first with the steam escaping from the troughs, various methods are found to check this escape. In some works a crude and unsatisfactory system of simply covering the troughs with a wood or metal cover is found, steam escaping largely from the slot extending the length of the trough through which the rove is passed to the drawing rollers. Very frequently this method is improved upon by having what is known as a dip board, or small piece of wood placed at right-angles to the cover on the side where the rove enters the water, and reaching below the surface in the trough. By this means the steam is largely confined and prevented from escaping through the slot. As an example of a better method I may mention that patented by Mr. Kirkpatrick and Mr. Reade, to whom I am indebted for the specification and sketch in Appendix 4, the feature of this invention being that the troughs can be entirely covered, the slot and dip boards dispensed with—the rove passing through tubes of glazed earthenware, or other suitable material, of sufficient length to secure immersion and to prevent escape of steam into the room. On the lower end of the tube there is a projecting lip, well rounded to insure the safe passage of the rove.

In the Annual Report for 1896 (page 78) Mr. Osborn refers to the patent exhaust on the spinning machines which were being fitted at the Forth River Mills of Messrs. Greeves of Belfast. The method then being tried has stood the test of years, and I question whether any better system has yet been found for preventing escape of steam in these rooms than is now to be seen at the works owned by this firm, to whom I am indebted for a description of this, (see Appendix 9) and many other appliances for securing healthy conditions. In the Annual Report for 1899 (page 293) Mr. Osborn says:—"Should Messrs. Greeves' method of enclosing and ventilating the creels, or some similar plan, be more generally adopted, the conditions of wet spinning will be materially ameliorated."

In the exhaustive Report* published in 1902 by Dr. Glibert, Medical Inspector of Factories in Belgium, a reference is made to this system, among others, with an opinion, that whatever the system may be it should be imperative to warm the incoming air in winter.

Mr. Williams, H.M. Inspector of Humid Textile Factories, in his Report † for 1900, states that the conditions under which work is carried on in wet spinning rooms are frequently deplorable, not only on account of excessive heat and humidity of the atmosphere, but also owing to the fact that the garments worn by the workers are saturated by the spray from the rapidly revolving frames. I, too, have noticed this, and have seriously considered whether the present rule provides sufficient safeguards.

It reads as follows :—

Where splash boards are not provided, waterproof overalls or aprons shall be provided by the occupier for all the workers, such overalls or aprons to be sufficient to protect the lower part of the chest, to the satisfaction of the Inspector.

Further, at page 78 of the Annual Report for 1896 Mr. Osborn refers to the dissatisfaction existing in some quarters with the original rule requiring splash boards. It was stated that they could not in all cases be so fitted as to prevent the escape of spray above them, consequently the floors were not kept dry by their use; and that the operatives themselves objected to them as impeding them in their work and thus lessening their earnings. After careful inquiry Mr. Osborn suggested modifications, leaving those who preferred splash boards free to use them, with an alternative in the way of efficient waterproofs. Acting upon this recommendation the Secretary of State approved the rule now in force. During my many visits of enquiry I did not see a single worker wearing any waterproof covering above the waist. Aprons were generally, but not always worn, and consequently where low counts were being spun the clothes on the upper part of the body of the worker were generally saturated. The rule does not even require that the waterproof overalls or aprons provided shall be worn by the worker. During my visits I compared the condition of the floors where splash boards were in use and where they were not found. When in use I found, generally speaking, clean and almost dry floors; where they were not in use and where low counts were being spun, I found small pools or puddles of dirty water, and the clothing of the women in a much more unsatisfactory state than where splash boards were used.

The objections on the part of the operatives to the use of splash boards, alluded to by Mr. Osborn, are probably as strong to-day as at the time when he wrote. The report by Dr. Glibert, before referred to, states that splash boards are not generally used in Belgium, and that at Liège their introduction led to a strike. The Belgian Commissioners state that the workers generally wear aprons of coarse cloth, and consider overalls or aprons made of absorbent material better than waterproofs which allow the water to run down and soak the stockings. In the North of Ireland the operatives usually work in bare feet; but some woollen material of an absorbent nature might be found and made to cover not simply the portion of the body below the waist but also the chest. Seeing that splash boards produce useful results; that they are found in many of the best conducted works in the country; and that by adopting modern methods of construction many of the objections primarily raised can be removed, I am of opinion that they should again be required, but not in all spinning rooms. It is in spinning low counts that moisture in large quantities is given off in the form of spray from the frames, as the rove is much thicker and absorbs more water when passing through the troughs. I propose that where counts of 50 or less are spun that the use of splash boards should be compulsory. Where

* Rapport d'enquête présenté à M. le Ministre de l'Industrie et du Travail par le Dr. D. Glibert, Inspecteur-Médecin du Travail à l'administration centrale (Royaume de Belgique), 1902. (Pages 436, 437.)

† Annual Report for 1900, p. 424.

the counts are higher the requirement might remain as at present, but amended so that where splash boards are not in use overalls and aprons made of water-proof or of some suitable absorbent material should be provided by the occupier and worn by the workers.

By Act of Parliament the standard measure of flax yarn is a cut or lea of 300 yards. One bundle is 60,000 yards, and there are 200 cuts in a bundle. There are 300 yards or 120 threads in a cut.

The rule requiring the floors to be kept in a sound condition so as to prevent retention or accumulation of water, seems to meet present needs; but judging from what I have seen the law should be more strictly observed.

CLOAK ROOMS.

Section 94 (5) of the Act of 1901 requires that in all cotton cloth factories erected after February 2nd, 1898, sufficient and suitable cloak-room accommodation shall be provided for the use of all the persons employed therein, and shall be ventilated and kept at a suitable temperature. The need in the case of flax mills is not less, and I submit that within a reasonable time similar accommodation should be provided for all workers in humidified or wet spinning rooms, it being in my opinion distinctly dangerous for women and young persons to leave hot and damp rooms and walk to their homes, especially in wintry weather, in wet clothes.

PIPES FOR CONVEYING STEAM.

The present rule on this subject runs as follows :—

“Whenever steam is injected into any room, the pipes conveying the same shall be jacketed with non-conducting composition, to the satisfaction of the inspector of factories.”

This rule hardly meets all requirements, and in the regulations now submitted, it is proposed to follow the lines now established as regards humid cotton cloth factories.

DUST.

In roughing, sorting, and machine and hand hackling rooms, and in preparing rooms, the source of danger to health lies chiefly in the fact that large quantities of dust of an injurious nature are generated in the processes of manufacture, and accumulated testimony shows that the workers suffer in health. The raw material after leaving the scutch mill is subjected to the processes of combing, laying parallel, and sorting the fibres of flax. This is done partly by hand and partly by machinery. Taking a rough handful or strick of rough flax, the operative by a swinging motion dashes the fibres on to the vertical needles forming the rougher or hackle. The fibre is drawn through these teeth, separating inferior and short fibres from the better ones and leaving “tow” as the residual. The subsequent processes of hand hackling and sorting are, so far as our purposes are concerned, practically the same. The amount of dust varies according to the condition of the material, but in all, much, of an injurious nature, is given off. Several years ago, under advice from the Home Office, arrangements were made to remove this dust at the point of production by means of exhausts placed behind the hackle pins, the dust being pneumatically drawn through the exhaust pipes by a fan. The methods employed throughout the country vary only slightly, the variation being in the size of the exhaust openings, their distance from the hackling or roughing needles, and the provision or absence of hoods or cowls. I am satisfied that better results are found where hoods are in use: not only is the current of air directed in such a way that its strength is utilised in the required direction, but much dust caused when the worker takes his strick to the hackles is caught by this current and drawn away.

I am indebted to the York Street Spinning and Weaving Co., Belfast, and to Messrs. Greeves of Belfast, for the drawings (Appendices 10 and 11) showing how these hoods are placed; and I may mention that at the York Street Works, in order to avoid inconvenience from loss of light, a pane of glass is placed in the back of the hood. That considerable good has followed the introduction of exhaust ventilation in these rooms will not be questioned by any one. Reports from various Inspectors bear testimony to this fact, and the workers themselves are the first to recognise it. On the other hand, I was sorry to find that plans otherwise sound have, in many cases, been rendered practically useless by defective plant. In many instances the fans were placed at such distances from the exhaust that the current at the far end was inappreciable. In others, the ducts were of wrong size, and no allowance had been made for the difference in area that should be allowed in proportion to the distance from the fan and the entry of branch inlets. In others again, greater efficiency might have been obtained without increased cost by having several fans nearer the exhausts instead of one at a considerable distance. In many of the rooms visited the current of air was practically inappreciable, and means intended to carry away dust were not doing what was required.

In order to secure efficiency it will, I think, be necessary to fix a standard, and I suggest (1) that the sectional area of the exhaust openings shall not be less than 120 square inches*; (2) that the inlet and exhaust ventilating arrangements shall be such as to secure that the velocity of the air passing through each exhaust opening, and measured at that point, shall not be less than 450 feet* per minute, whether the windows be open or closed; and (3) that where necessary to secure reasonable temperature the in-coming air shall be warmed. I append a table of anemometer readings in flax mills (Appendix 5). The standard suggested is based upon results which may be considered fairly satisfactory, and easily attainable, as will be seen from the table (Appendix 6) of results obtained in Sheffield cutlery works, the anemometer being placed close to the exhaust ducts—which approximate very closely in size to the exhausts in roughing and sorting rooms. It will be seen that a speed varying from 905 to 3,210 feet per minute is maintained, but as the dust in flax mills is much lighter than the metallic dust generated in the processes of grinding or glazing in glass polishing, metal polishing, &c., a lower velocity of exhaust should suffice. The nature of the dust is doubtless similar to that referred to in the Belgian Report cited in Appendix 7.

The present Special Rules require that respirators shall be provided for the use of the workers, if children or young persons, and be worn by them at work. In no single instance have I seen, either in hand hackling rooms or in machine hackling rooms, where a similar rule applies, a person at work wearing a respirator. This is an old difficulty not confined to this industry. My own opinion is that if respirators are properly made, much of the prejudice now existing, and the supposed inconvenience would disappear. A dirty respirator means inhalation through a vitiated medium, and is a source not only of discomfort but of danger, but if respiration can be performed with comfort through a clean medium, objections would largely cease. I am of opinion that cloths of open texture, made of fine yarn of woollen material capable of being easily washed, can be worn with advantage and without discomfort. I have also seen in use at the works of Messrs. Armstrong at Elswick, a respirator made of perforated zinc, with a double frame. Between the frames clean cotton material of open texture is placed. A valve allows free expiration, but during inhalation this valve closes, and the air passes readily through the cotton filter, which can easily and readily be changed.

Although in the different departments where dust is generated there were exhausts, I did not see a single worker at Messrs. Armstrong's Elswick Works, Newcastle, without a respirator, and the men to whom I spoke said that they suffered no inconvenience. The returns of sickness have shown a marked decrease

* The figures here named are of course provisional and subject to further consideration in conference with representative bodies and ventilating engineers.

since these precautions were taken. The respirator used is a French appliance made by Bellot of Champieux and known in this country as the "Ever-Trusty." A few years ago the workers at Messrs. Saunderson's wall paper works at Chiswick spoke well of a similar respirator. I called and found that both firms had secured their respirators from the same source and that they were of the same make.

Seeing that it is undesirable to lay down an absolute rule which cannot be enforced, I suggest that the words "to be worn by them at work" be omitted and that the rule should read as follows:—

"Suitable and efficient respirators shall be provided for the use of the persons employed in roughing, sorting, hand or machine hackling, preparing and carding of flax or tow."

The Society of Arts have offered a prize for a dust-arresting respirator, and this offer may lead to the introduction of improved forms.

FANS IN MACHINE HACKLING, PREPARING AND CARD ROOMS.

So far as these rooms are concerned, many methods have failed through want of intelligence in carrying out the spirit of the law. In many instances the letter has been observed, but the spirit entirely forgotten, with very unhappy results. Mr. H. J. Wilson, who then had charge of the East Scotland District, in the Annual Report for 1899 (page 230), after referring to the dust generated in the processes under consideration, says that the rule simply requires fans to be erected on the side of the rooms where the machines are and that inlets should be provided; adding, that the dust is well dispersed in the room before it reaches the fan and that the attendants frequently suffer from clouds of dust. He observes that most of the fans have been installed without the slightest skilled knowledge, being supplied by an agent who was paid by the number sold and who had no direct interest in the results. Mr. Cooke-Taylor, Superintending Inspector for the Scotland and Ireland Division, in the same Report (page 229) says:—"I have seen fans erected quite as required, not simply doing no good, but doing positive harm, drawing the dust right from under the carding machines into the operatives' faces and dispersing it throughout the whole area of the workroom. The law has been complied with, but complied with ignorantly."

These, unhappily, are not over-statements of facts. In machine hackling rooms, card rooms and preparing rooms, I have in many instances seen fans which, as Mr. Cooke-Taylor says, are doing positive harm rather than good. There is one way, and probably only one way, for efficiently removing dust or fumes from workrooms, and that is to draw it away immediately, at, or as near as possible to, the point at which it is produced. Many of the manufacturers, as stated in the early part of my report, have to their credit not only recognised this but have voluntarily installed the necessary plant for carrying it into effect.

I propose that the present rule for roughing, sorting, and hackling rooms be withdrawn, and the following substituted:—

"In every room in which roughing, sorting, hackling, preparing, or carding of flax or tow is carried on efficient exhaust and inlet ventilation shall be provided to secure that dust is drawn away from the workers at or as near as possible to the point at which it is generated.

"The sectional area of the exhaust openings near to each set of hackles shall not be less than 120 square inches, and the arrangements shall be such as to secure that the velocity of the air passing through each exhaust opening and measured at that point shall not at any time be less than 450 linear feet per minute.

"The air inlets shall be so arranged that no direct draught falls upon the persons employed; and the arrangements for inlet ventilation shall as far as practicable be such that the temperature of the incoming air shall not be less than 60° F."

It will doubtless be urged in good faith that practical difficulties will arise in giving effect to this Regulation, but these difficulties are not insurmountable, and I should have hesitated to recommend it had I not, by the courtesy and assistance of various manufacturers, been able to form definite opinions and to suggest means for carrying them out.

Dealing first with machine hackling rooms, where injury to health is a recognised consequence of work, Messrs. Read, Crawford, and McKibbin have patented an automatic screwing for hackling machines. It is claimed that one boy can do the work of four working under the existing system, the health being better, the output increased, the work less exhausting; and that, if the machines are placed so that all the boys are down one side of the room where inlets for fresh air can be provided and fans placed in the windows on the opposite side, the machines will be between the fans and the boys, so that the dust will be drawn away from the boys. The arrangement can be supplied to existing machines without structural alterations. I take it that by suitable suction pipes the dust could be collected close to the source of origin.

The descriptions forwarded by Messrs. Greeves (Appendix 12) show that, notwithstanding the many difficulties that have been found, it is possible practically to prevent the inhalation of dust by workers in machine hackling rooms. Fans placed in the walls in the different parts of the room have utterly failed, simply causing currents of air and distributing the dust. In the Belgian Report before referred to, Dr. Glibert, after exhaustive inquiry in different countries, says (page 400) that there is great difficulty in rendering machine hackling rooms healthy, and that no efficient solution has come to his knowledge. The Belgian Commissioners recommend the use of respirators, to be approved by the medical inspectors, increased air space per person, daily cleansing of the machines and workrooms, humidification of the atmosphere, diminution in the rapidity at which the machines travel, and efficient general local ventilation. The plan adopted by Messrs. Greeves was not, I imagine, perfected at the time that these gentlemen submitted their report. Briefly described, the method adopted is to have suitable exhausts under, and round, the several machines. In this there is nothing new whatever, but where the system has been tried it has generally failed owing to defects in the position of the air inlets and the amount of air admitted. Messrs. Greeves have trunks in the ceiling over each machine, with inlets arranged in such a way that the current of conditioned air is downward. The dust does not rise but is kept down, and the inlets are arranged in such a way that no unpleasant draught is felt by the workers.

Methods closely similar were found at the works of Messrs. Taylor of Carrickfergus. A fan extracting 75,000 cubic feet of air per minute is used for carrying off the dust and ventilating the machine hackling rooms. There are open gratings in connection with ducts on the floor near the machines; in the apex of the gables and running right along them are air inlets, allowing a down current in a diffused form. At the time of my visit practically all the dust was being drawn down and I could see little, if any, in the atmosphere where the persons were at work. The head of the firm, who was good enough to supply me with every information, told me that before this arrangement was made he had the greatest difficulty in getting boys to work in the room, but that since its application there has been no difficulty in securing labour.

Generally speaking, the means adopted for dust extraction from the spread boards, drawing and roving frames are unsatisfactory. The fans generally found in the walls simply cause currents of air laden with dust, frequently drawn into the faces of the workers. In some works, however, better methods prevail, the dust being collected where it is formed, namely, close to the drawing rollers, and pneumatically carried away by exhausts immediately over the rollers. Where this method is adopted the difference in the atmosphere is most marked. I have to thank Messrs. Don Bros., Buist and Co. for the drawings (Appendix 13) showing how this can be done. The system is not new to them but has been in use for years, and was referred to, and described by diagram, in the Annual Report for 1893 (page 208). It is to be regretted that when known remedies exist so little should have been done to give general effect to them. The same

principle is involved in the specification and drawings (Appendix 8) from Messrs. Metcalfe and Morrison. I have seen attempts made to carry off the dust by placing large cowls over two or more machines. These have failed because the suction is too far from the machines for efficient draught. Their use has in some instances aggravated the evil which it was hoped to remedy, by simply drawing the dust up into the faces of the workers.

Amongst the many difficult ventilating problems probably none offer greater difficulties than the efficient removal of dust in card rooms. The Report of the Belgian Commissioners describes and illustrates practically all known systems, whether abroad or in this country. These distinguished authorities, on page 420 of their Report refer to a system designed by M. V. Huglo of Lille which they had seen in operation, and observe that the accepted methods making a single ventilator serve for a series of cards are very inferior to the Huglo system, wherein every card has its own ventilating fan, thus securing much more constant ventilation for each. A characteristic of the system is to separate the waste, rendering it useful for commercial purposes.

The report goes on to describe how this result is produced, by separation of the waste in receptacles under the cards. The system here described varies from many others in the fact that there is a fan for each card, collecting dust at the point of origin and drawing it downwards, but excellent results have been produced by one fan for a series of cards where the power is sufficient and where exhausts have been properly placed. To me it has been a source of unfeigned sympathy when, in visiting some of the best regulated works in the country, I have seen methods which have failed after costing large sums of money. Speaking generally, one may say that the failure is usually due to the fact that the exhaust is not sufficiently strong at the point where it is most wanted, that is, where the women handle the tow and spread it out on the canvas carrier which feeds the machine. A few minutes' observation in practically any carding room will show that notwithstanding the efforts made, the women referred to live during working hours in an atmosphere charged with injurious dust. The Belgian Commissioners, referring to M. Huglo's method, say that the suction appeared to them nearly perfect so far as the interior of the card was concerned. They thought that the little dust which existed in the air came from the spreading table its escape being partly due to the action of the ventilating fan; and it is suggested that this might be remedied by placing at a certain height above the table a screen slightly inclined towards the workers, which would cause the suction from the fan to be felt at the extremity of the table. It is also suggested that the feeding table might be perforated and put in communication with the exhaust tube. M. Huglo has, doubtless, some method in view by which this might be done which I have not had the advantage of seeing. A difficulty, however, presents itself to me in the fact that the raw material would be drawn down and probably close the perforations.

Messrs. Don Bros., Buist and Co. were good enough to send me a drawing (Appendix 14) which shows that by the use of a screen, somewhat as described above, and by the use of the exhaust running horizontally and close to the feeding table, dust can be removed with most excellent results. It is only a question of experimenting to secure perfection in this matter. Other firms have attempted it with more or less success. Where there has been failure it is due, in my opinion, not to the defective system, but to defective workmanship. The drawing and descriptions forwarded by Messrs. Greeves (Appendix 15), indicate another efficient system, which follows the principle described in connection with the ventilation of their machine hackling rooms. The inlet currents are over the heads of the workers feeding the machines, and the dust is drawn downwards. At the time of my visit I suggested certain alterations in the angle at which the down current was then directed, and writing to me on July 9th, 1903, Messrs. Greeves say:—"In the print of the latter (this refers to the card room arrangements) you will see that we have extended the fresh air inlet ducts over the cards, and find the current of fresh air comes to the workers less contaminated with dust than at the time of your visit. We have also increased the capacity of the exhaust fan. The rooms are now much cleaner."

I have seen large hoods placed over the cards, but do not recommend this system. I prefer to see the covers of the cards themselves used as hoods, the suction pipe being actually attached to them. Objections have been raised to this system, it being stated that the current is so strong that not only dust but useful fibres may be carried away, or the work interfered with by the withdrawal of the fibres from the teeth of the machine. Messrs. Morrison and Metcalfe, however, have been good enough to favour me with a drawing (Appendix 16) showing that by raising the cover of the card and placing the suction pipe in a suitable position this difficulty may be overcome.

To summarise, I am disposed to think that so far as our present knowledge carries us the most suitable and efficient ventilation for carding machines is to be found in direct suction applied to the covering of the cards, whether in the shape of separate fans for each card or whether in the shape of one or more adequate fans connected to exhaust pipes directly attached to the covering of the cards. But, in addition to this, I think no method will do what is necessary for the protection of the workers unless there is a pneumatic arrangement fixed close to the feeding table, and in a suitable position, which will draw away the dust generated during the feeding and spreading operations, and will also prevent the escape of dust due to the rotation of the large cylinder in the machine. To render this method effective, great care will, however, have to be paid to the inlet ventilation, and hints can be taken from what has been done by Messrs. Greeves and described in the paper kindly sent by them.

A draft of the regulations which I propose is appended to this report.

The details will doubtless receive further consideration in the light of the observations upon the draft which may be offered by representatives of the trade.

I am, Sir,

Your obedient Servant,

H. P. SMITH,

H.M. Superintending Inspector of Factories.

B. A. Whitelegge, Esq., C.B., M.D.,

H.M. Chief Inspector of Factories.

Draft Regulations.

WORKS IN WHICH THE PREPARING, SPINNING OR WEAVING OF FLAX IS CARRIED ON.

Any approval given by the Chief Inspector of Factories in pursuance of these Regulations shall be given in writing, and may at any time be revoked by notice in writing signed by him.

Duties of Occupiers.

1. The arrangements for ventilation shall be such that during working hours in no room in which persons are employed shall the proportion of carbonic acid in the air at any time exceed the proportion in the air outside by more than [5] volumes of carbonic acid to every 10,000 volumes of air.

Ventilation :
(a) general,
for purity
of air ;
(b) local,
for
removal
of dust.

In every room in which roughing, sorting, backling, preparing or carding of flax or tow is carried on, efficient exhaust and inlet ventilation shall be provided to secure that dust is drawn away from the workers at, or as near as possible to, the point at which it is generated.

The sectional area of the exhaust openings near to each set of hackles shall not be less than 120 square inches, and the arrangements shall be such as to secure that the velocity of the air passing through each exhaust opening and measured at that point shall not at any time be less than 450 linear feet per minute.

The air inlets shall be so arranged that no direct draught falls upon the persons employed ; and the arrangements for inlet ventilation shall, as far as practicable, be such that the temperature of the incoming air shall not be less than 60° F.

Tempera-
ture.

Thermo- meters.	2. In every wet spinning room, and in every room in which artificial humidity of air is produced in aid of manufacture, there shall be provided and maintained in correct working order two sets of standardised wet and dry bulb thermometers. One set shall be fixed in the centre and one at the side of the room, or in such other position as may be directed or sanctioned by the Inspector of the district, so as to be plainly visible to the operatives.
Position	
Readings and record.	Each of the above thermometers shall be read twice in the day, viz., between ten and eleven o'clock in the forenoon, and between three and four o'clock in the afternoon, on every day that any person is employed in the room, and the readings shall be at once recorded on the prescribed form, and the indications of the thermometers at any time, and the entries of them in the record, shall be <i>prima facie</i> evidence of the humidity of the air of the room at that time, and of the temperature.
	The form on which the readings of a set of thermometers are recorded shall be kept hung up near that set, and after being duly filled in, shall be forwarded at the end of each month to the Inspector of the district, and a copy shall be kept at the factory for reference for at least twelve months after the date of the last entry.
Humidity.	3. The amount of moisture in the atmosphere of the room shall not at any time during working hours be such that the difference between the temperatures indicated by the dry and wet bulb thermometers respectively is less than 2° F.
Purity of water.	4. The water used for the purpose of producing humidity, or used in the troughs in wet spinning rooms, shall be taken from a public supply of drinking water or other source of pure water, or shall be effectively purified to the satisfaction of the Inspector of the district before being introduced in the form of steam or used in the troughs.
Steam pipes.	5. The pipes used for the introduction of steam into any room in which the temperature is 70° F. or over, or for heating the water in the troughs in a wet spinning room, shall, so far as they are within the room, be as small in diameter and as limited in length as is reasonably practicable, and shall be effectively covered with non-conducting material, to the satisfaction of the Inspector of the district, so as to minimise the amount of heat thrown off by them into the room.
Splash guards.	6. Efficient splash guards shall be provided and maintained on all wet spinning frames where counts of 50 or less are being spun; and also where higher counts are being spun, unless overalls made of waterproof or of some suitable woollen absorbent material are provided by the occupier and worn by the workers.
Overalls.	
Prevention of escape of steam.	7. Efficient means shall be adopted in every wet spinning room to prevent the escape of steam from the troughs into the room.
Floors.	8. The floor of every wet spinning room shall be kept in sound condition, and drained so as to prevent retention or accumulation of water.
Cloak rooms.	9. On and after January 1st, 1905, sufficient and suitable cloak room accommodation shall be provided for all persons employed in wet spinning rooms and rooms in which artificial humidity of air is produced in aid of manufacture, and shall be ventilated and kept at a suitable temperature.
Respira- tors.	10. Suitable and efficient respirators shall be provided for the use of the persons employed in roughing, sorting, hackling, preparing and carding of flax or tow.

Duties of Persons Employed.

Overalls.	11. The overalls provided under Regulation 6 shall be worn by all persons employed in wet spinning rooms where counts higher than 50 are spun.
Inter- ference with appliances.	12. No person shall in any way interfere, without the concurrence of the occupier or manager, with the means and appliances provided for ventilation, or for the removal of dust, or for the other purposes of these regulations.

APPENDICES.

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1. Table showing the number of Humid Flax Factories in the United Kingdom, July, 1903.
 2. Table showing the number of Persons Employed in Flax Factories in the United Kingdom in 1898-1899.
 3. Summary of the Humidity Returns from Flax Factories in the United Kingdom for the years 1898-1902.
 4. Methods of preventing the escape of steam from wet spinning frames, patented by Mr. Kirkpatrick and Mr. Reade. *With Plate.*
 5. Table of Anemometer readings taken in representative Flax Mills.
 6. Table of Anemometer readings taken in Sheffield Cutlery Works.
 7. Dust in the air of Flax Mills. Extract from the Report of the Medical Inspector of Factories, in the Annual Report for 1902 (page 290).
 8. Improvements in Ventilating, Humidifying and Cleansing of Rooms, Machinery, and Textile Material, patented by Mr. Metcalfe and Mr. Morrison. *With Plate.*
 9. Plan of fans and ducts for Eve's Exhaust Spinning Frame Creels. *Plate.*
 10. Plan for ventilating Roughing and Sorting Shops, adopted by the York Street Spinning and Weaving Co., Belfast. *Plate.*
 11. Plan for ventilating Hackling Shops at the mills of Messrs. J. and T. M. Greeves, Ltd., of Belfast. *Plate.*
 12. Plan for Ventilation of Hackling Machines at the Forth River Mills, Belfast. *Plate.*
 13. Plan for extracting Dust from Flax Preparing Machines adopted by Messrs. Don Bros., Buist and Co., of Dundee. *Plate.*
 14. Method of removing Dust from Flax Tow Cards adopted by Messrs. Don Bros., Buist and Co., of Dundee. *Plate.*
 15. Method of extracting Dust from Carding Machines adopted by Messrs. J. and T. M. Greeves, Ltd., of Belfast. *Plate.*
 16. Method of extracting Dust from Carding Machines adopted by Messrs. Morrison and Metcalfe, of Belfast. *Plate.*
-

APPENDIX 1.

Table showing the Number of Humid Flax Factories, in the United Kingdom, July, 1903.

DISTRICT AND COUNTY.	Number of Rooms under					Persons employed in Rooms under				
	S. 96.			Special Rules.		S. 96.			Special Rules.	
	Pre-paring.	Spin-ning.	Weav-ing.	Spin-ning.	Weav-ing.	Pre-paring.	Spin-ning.	Weav-ing.	Spin-ning.	Weav-ing.
(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)	(9.)	(10.)	(11.)
Manchester ... <i>Lancaster</i> ...	4	—	—	5	—	162	—	—	329	—
Preston ... <i>Cumberland</i>	2	—	—	4	—	29	—	—	103	—
W. Scotland ... <i>Renfrew</i> ...	—	—	—	2	—	—	—	—	124	—
S.W. " ... <i>Ayr</i> ...	—	—	—	5	—	—	—	—	176	—
E. " ... <i>Forfar</i> ...	—	—	—	1	—	—	—	—	72	—
N. " ... <i>Kincardine</i> ...	—	3	—	—	—	—	92	—	—	—
N. Ireland—	35	—	1	144	86	1,636	—	45	12,784	10,851
<i>Antrim</i> ...	29	—	—	96	40	1,396	—	—	9,306	5,691
<i>Armagh</i> ...	—	—	1	14	24	—	—	45	1,004	3,116
<i>Down</i> ...	5	—	—	25	14	140	—	—	1,790	1,419
<i>Londonderry</i>	—	—	—	—	3	—	—	—	—	175
<i>Tyrose</i> ...	1	—	—	9	5	130	—	—	684	450
S. Ireland—	—	—	—	3	6	—	—	—	223	597
<i>Cork</i> ...	—	—	—	3	2	—	—	—	223	94
<i>Dublin</i> ..	—	—	—	—	1	—	—	—	—	100
<i>Louth</i> ...	—	—	—	—	3	—	—	—	—	403
Total... ..	41	3	1	164	92	1,827	92	45	13,811	11,448

At the end of 1902 there were 64 Dry Spinning *Factories* under Flax Special Rules.
viz. :—

Dorset 6.	Edinburgh 1.	Perth 10.
Durham 1.	Fife 13.	Renfrew 2.
Somerset 3.	Forfar 23.	Antrim 1.
York W. Riding (Leeds District) 1.	Kincardine 3.	

APPENDIX 2.

Table showing the Number of Persons Employed in Flax Factories in the United Kingdom in 1898-9.

Process.	Children.		Young Persons.				Adults.		Total.			Total in 1897.
			Between 13 and 14.		Between 14 and 18.							
	M.	F.	M.	F.	M.	F.	M.	F.	M. & F.	M. & F.		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
All Spinning Processes ..	2,673	3,126	761	755	4,155	6,588	11,075	25,195	18,061	35,064	54,328	56,809
<i>With Artificial Humidity</i>	960	1,621	245	549	909	2,601	1,974	7,112	3,188	11,633	14,871	17,614
<i>Without " "</i>	1,713	1,505	516	206	3,246	3,987	10,001	18,083	14,873	23,431	39,457	39,195
All Weaving Processes ..	126	321	160	567	1,742	5,433	9,276	28,732	11,904	35,053	46,357	47,874
<i>With Artificial Humidity</i>	23	39	32	92	359	1,125	1,866	7,465	2,310	8,731	11,041	10,600
<i>Without " "</i>	103	282	128	475	1,383	4,308	7,410	21,267	9,594	26,322	35,316	37,274
Dressing, Finishing, and Miscellaneous Processes.	2	—	7	13	65	80	704	363	778	456	1,234	1,622
Total	2,801	3,447	928	1,335	5,962	12,101	21,055	54,299	30,746	71,173	101,919	106,104

APPENDIX 3.

Summary of the Humidity Returns from Flax Factories in the United Kingdom for the Years 1898-1902.

Year	Total Received.					Estimated Total of Double Readings.					Excessive Readings.				
	Special Rules.		Section 96.			Special Rules.		Section 96.			Special Rules.		Section 96.		
	Spinning.	Weaving.	Preparing.	Spinning.	Weaving.	Spinning.	Weaving.	Preparing.	Spinning.	Weaving.	Spinning.	Weaving.	Preparing.	Spinning.	Weaving.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1898 ..	6,061		—	—	—	277,337		—	—	—	No record.		—	—	—
1899 ..	5,930		—	—	—	271,791		—	—	—			—	—	—
1900 ..	3,971	2,152	—	4	—	182,004	98,633	—	183	—			447	878	—
1901 ..	4,026	2,208	—	47	24	184,535	101,300	—	2,154	1,100	177	794	—	81	2
1902 ..	3986	2,164	282	51	21	182,691	99,183	12,925	2,337	1,100	285	218	36	4	—

APPENDIX 4.

**Method of Preventing the Escape of Steam from Wet Spinning Frames,
Patented by Mr. Kirkpatrick and Mr. Reade.**

Ephraim Kirkpatrick, York Road Mills, Belfast, Mill Manager, Robert Henry Sturrock Reade, Director of the York Street Flax Spinning Company Limited, Belfast, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

This improvement in wet spinning frames relates to what are known as hot water spinning frames for flax and like fibres in which the rove is macerated in hot water before being drawn and the object of this invention is to lessen the amount of moisture passing into the room and yet providing equal facilities to the present for the attendant to pass the rove through the water trough.

The usual arrangement for admitting the rove to the hot water trough is a slot extending the entire length of the trough and through which the rove is passed underneath the "dip board" and rove pipe whence it passes out over the lip of the trough to the drawing rollers (*r*).

This slot is the great outlet for steam into the room and it is for salutary as well as economic reasons that we propose to lessen this escape of moisture by means of this improvement which is illustrated in the drawing annexed. The same figures and letters of reference always apply to the same or like parts.

Fig : 1 being a section of a trough and so much of the adjacent parts of a wet spinning frame as is necessary to show the connections and

Figs : 2, 3 and 4 are enlarged and detached sections of the tube which is the main feature of this invention which consists of taper tubes (*a*) one to each spindle (*b*) each tube has a bell mouth and collar at its largest and upper end (*a*¹) and on its outer surface immediately below the collar is a projection or key (*a*²). The smaller and lower end of the taper tube has a projecting lip (*a*³) on the same side and in line with the key (*a*²) under the collar (*a*¹). This projecting lip (*a*³) is well rounded on the inside for the safe passage of the rove (*d*).

These taper tubes (*a*) are carried by the back cover (*c*¹) of the hot water trough (*c*) by suitable holes therein. The collar (*a*¹) covering the joint and the key (*a*²) forms a guide for the projecting lip (*a*³) and ensures its being in its proper position for the outward passage of the rove (*d*) which is guided into the centre of the tube (*a*) by rods (*e*) with pins (*e*¹) or other suitable guides (*e*²) thereon.

The tubes (*a*) are made of glazed earthenware porcelain glass or other suitable material.

The tubes (*a*) can be readily attached to existing troughs and are made of a suitable length to ensure the immersion of the rove (*d*) and by the use of these tubes (*a*) the rove rod in the trough (*c*) and the "dip boards" are dispensed with the steam pipe (*f*) remaining as hitherto.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed we declare that what we claim is :—

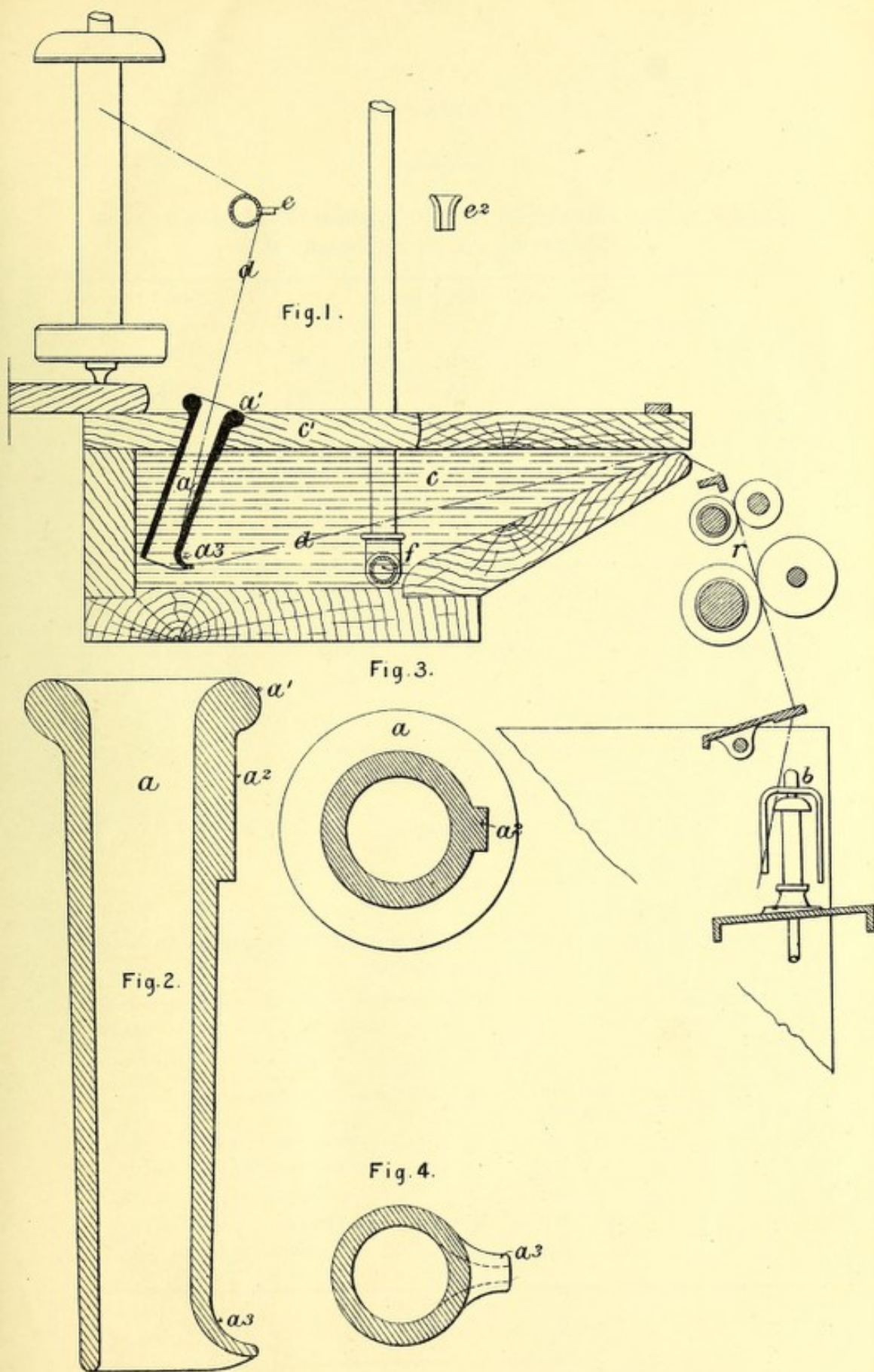
In wet spinning frames the use of porcelain or like tubes of the form and for the purpose set forth herein.

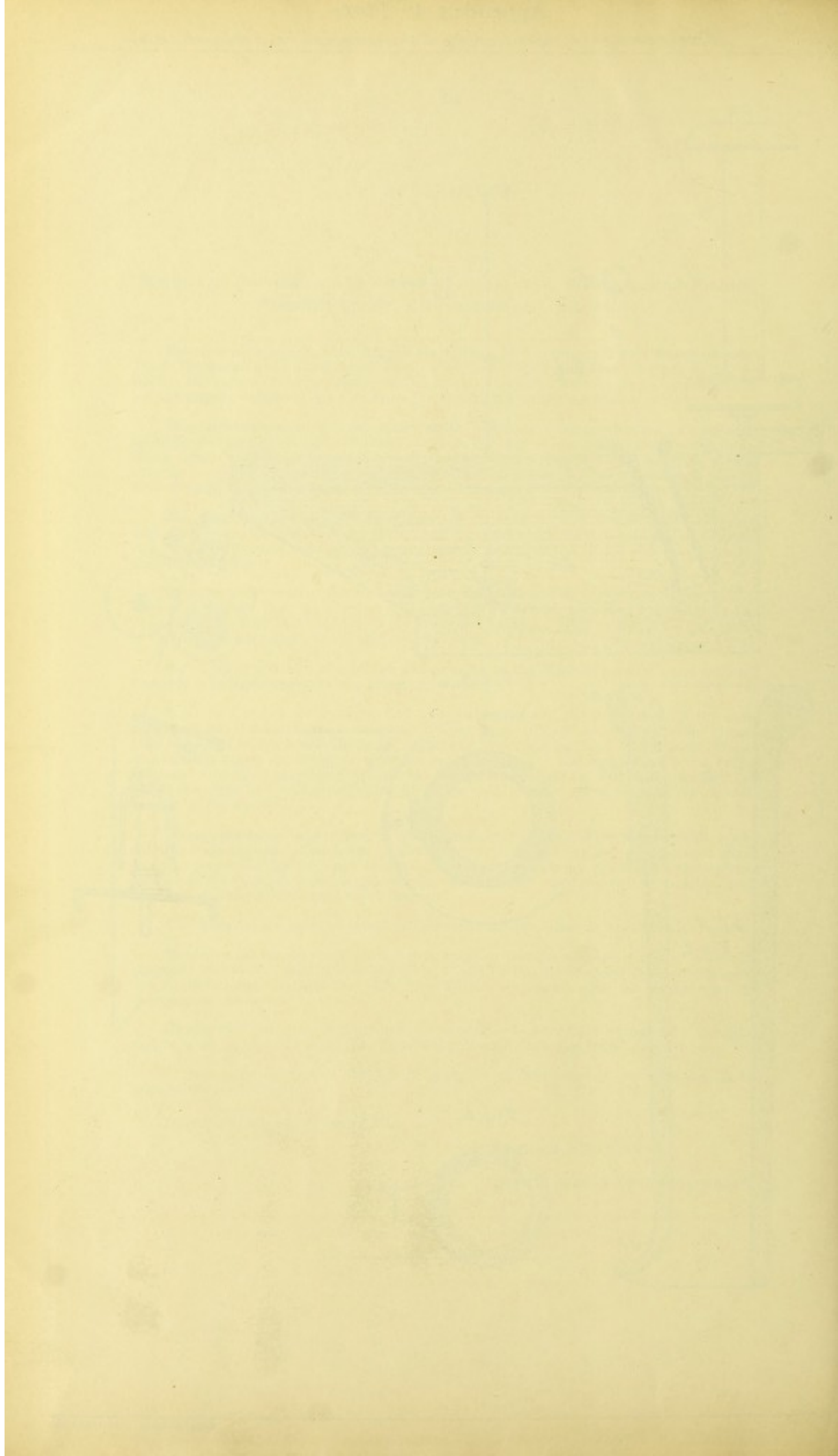
Dated this 19th day of July 1902.

EPHRAIM KIRKPATRICK.

ROBERT HENRY STURROCK READE.

[This Drawing is a reproduction of the Original on a reduced scale]





APPENDIX 5.

Table of Anemometer readings taken in Representative Flax Mills by
Mr. Snape, Mr. Butler, and myself.

Factory.			Velocity of Draught in Feet per Minute.					
A	...	...	210	276	315	320		
B	...	...	238	281	365			
C	...	...	161	350				
D	...	...	351	261	254			
E	...	...	190	228				
F	...	...	576	410	285	56	135	586
G	...	...	236	514	509	381	550	387

This table is simply intended to show the ordinary air speed now existing, but the tests were made under different conditions. In some cases the exhausts are close to the fans, in others far removed. The size of the exhausts vary and efficiency seems to depend more upon chance than upon method. The proposals that I have made are intended to remove this anomaly.

APPENDIX 6.

Table of Anemometer readings taken in Sheffield Cutlery Works on
25th June, 1903.

Factory.	Process.				Velocity of Draught in Feet per Minute.
A	Grinding pocket knife handles	...	...	...	With one duct closed, 1,520. With all ducts open, 1,272.
B	Dry grinding of scissors	...	...	...	2,280.
C	Dry grinding of brace bits	...	...	...	3,210.
D	Grinding of pocket knives	...	...	...	2,300.
E	Grinding table knife handles	...	...	...	1,700.
F	Grinding of razors	...	...	...	830.

APPENDIX 7.

Dust in the air of Flax Mills.

[Extract from the Report of the Medical Inspector of Factories, in the Annual Report for 1902, page 290.]

Dust in the various workrooms.—The following method was adopted by Dr. van Mierden, of the Pathological Laboratory of Louvain, for determining the number of particles of dust and moulds present in the rooms.

Three litres of air were aspirated into a vessel containing sterile water, and after brisk shaking one centimeter was mixed with gelatine and spread out on a Petri dish. The air was taken about 5 feet from the ground and at the ordinary working place.

Numerous analyses are given which may be summarised as follows :—

Process.	Dust.		Total.
	Vegetable.	Mineral.	
	Average per cubic metre.	Average per cubic metre.	Average per cubic metre.
Hand heckling	94,828	16,932,421	17,027,249
Machine heckling	74,821	17,420,228	17,495,049
Preparing	171,866	17,074,070	17,245,936
Carding	381,451	23,376,579	23,758,030
Rag-picking	—	—	21,125,495

Micro-organisms.	
	Per cubic metre.
Hand heckling	1,055,249
Machine heckling	351,476
Preparing	199,100
Carding	746,033
Spinning	102,166
Reeling	42,285
Rag-picking	5,433,999

In the open air and in the rooms of the laboratory the number of particles of mineral dust never exceeded 6,000,000 per cubic metre, and the micro-organisms did not exceed 26,000.

The dusty processes therefore are (1) carding, (2) machine heckling, (3) preparing, and (4) hand heckling.

Those containing the largest number of micro-organisms are (1) hand heckling, (2) carding, (3) machine heckling, (4) preparing, (5) spinning, and (6) reeling.

The cause of the injurious nature of the flax dust is ascribed to (1) the considerable proportion of silica which it contains, and (2) to the retting of the flax in water containing a great number of micro-organisms, and (3) the debris of sharp-pointed cellular matter adhering to it when it arrives at the factories.

The heckling rooms both hand and machine are described as very dusty. Their condition explains the ill-health of the workers and the rapid elimination of the workers which takes place. As an additional cause reference is made (with quotations from the writings of the late Dr. C. D. Purdon, of Belfast, and Dr. Arlidge) to the arduous nature of the work in the machine heckling rooms—the nature of the work not admitting of a moment's relaxation on the part of the boys employed.

The carding rooms are described as so dusty that the workers appear to work constantly in a mist. It is held to be the most unhealthy occupation from which results a rapid elimination of workers, only those of strong constitution being able to continue at it. Despite this the unhealthy nature of the work leads to illness frequently, and causes others to abandon the work. The average duration of employment is the shortest, and yet the sickness among the workers is the greatest. As possibly causing the dust of the carding rooms to be more injurious than that of any other reference is made to the metal particles which must be present in the air from the wearing away by friction of the numerous teeth on the carding machines.

Work in the preparing rooms is not considered to be comparable as regards injury to health with those described, and it is pointed out that the figures as to the amount of dust and of micro-organisms present in the air are to some extent vitiated by the fact that carding and preparing are sometimes carried out in the same room.

Reeling is not an injurious occupation; what injury to health there is arises from the humidity of the atmosphere. As a subsidiary cause of ill-health in these rooms is the fact that some of the machines are only capable of being kept in motion by the foot being pressed continually on a bar underneath the machine. This necessitates continuous strain on the muscular system.

APPENDIX 8.

Improvements in Ventilating, Humidifying and Cleansing of Rooms, Machinery and Textile Material.

(Patented by Mr. A. W. Metcalfe and Mr. J. B. Morrison.)

We, ARTHUR WILSON METCALFE and JOHN BARBOUR MORRISON, both of Grove Mill, Belfast, in County Down, Flax Spinners, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to means for humidifying textile material and removing dust and dirt from hackling, preparing, combing, spinning and weaving machinery for textile fibres and for cleaning and purifying the air and removing the dust and dirt in rooms where such machinery is working.

The manner in which these operations are performed is illustrated by reference to the drawings herewith.

Fig. 1 represents the end view of a hackling machine in sectional elevation. The material is shewn suspended between the sheets of pins which hackle it downwards. Immediately below where the two sheets diverge is the usual dust board of inverted V shape for conducting the dropping fibres and dust on to the revolving brushes. The under side of this dust board is formed into a duct *a* coupled to an exhaust pipe *b*. The two sides of the duct *a* are perforated so as to admit the dust laden air from the machine, whilst they are also so arranged as to be in contact with the revolving brushes whereby they are cleared of the fibre and kept operative.

Fig. 2, represents a section of part of a roving or gill spinning frame.

Figs. 4 and 5, represent in like manner a drawing frame in section and front sectional elevation respectively.

In these figures the ducts *a a* connected to exhaust pipe *b b* are shewn in various positions where they may be placed for drawing off the dust given off by the material in its passage through the gills *g, g*.

Slits or holes or nozzles in the ducts may be provided, continuously or at intervals such as shewn in Fig. 5, where nozzles are shewn in some cases opposite each gill *g, g*, or say between pairs of gills.

The heavier dust and droppings fall into the space *e e* beneath the gills and in the case of Fig. 2 a certain amount is thrown off by the spindles into the space *f f* beneath the frame. This dust and dirt and dropped fibre as also that about the machinery and rooms generally is removed by means of a flexible hose pipe connected to an exhaust pipe. The nozzle of this hose pipe is directed by the operator to any part about the machinery or room and the dust is sucked up and carried away thereby.

Connections may be provided at various intervals about the rooms to the exhaust pipe, to which the hose may be attached.

In Fig. 5, a cap *d* on end of exhaust duct *a a* is made capable of removal whereby a volume of air is admitted to flush the duct of any lodgment of dust.

In order to supply fresh or humidified air to the material on its passage through the machines, ducts as at *c c* in Figs. 2, 4 and 5 may be so disposed beneath or near the machines as to cause a current to pass through or near the material on its way to the exhaust ducts *a a*.

Fig. 3 represents a section of a loom.

Here the humidified air or steam is supplied by the duct *c* through slits or perforations, against the warp, whilst an exhaust duct placed above carries away the surplus moistened air.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

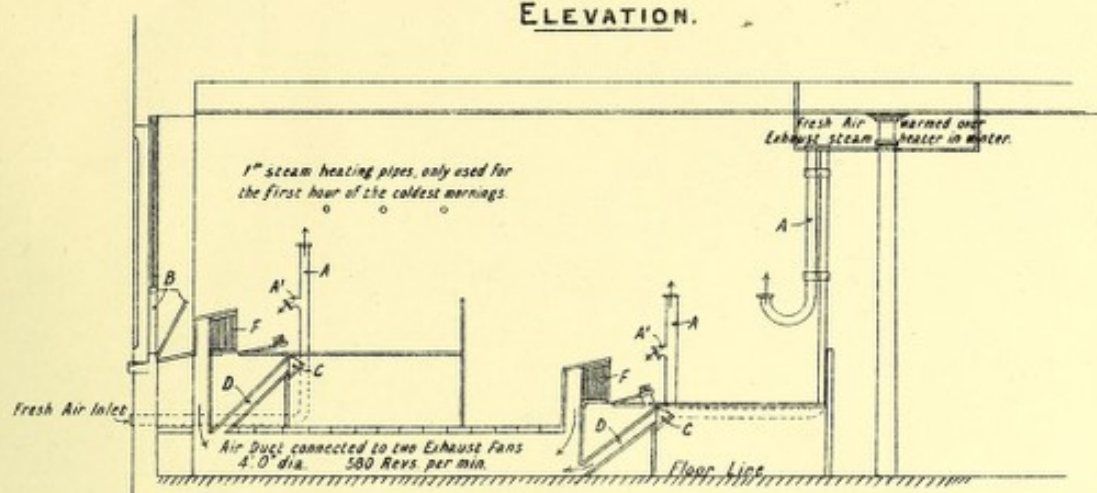
- 1.) The method of ventilating hackling machines substantially as described and illustrated by Fig. 1.
- 2.) The method of ventilating drawing roving and gill spinning frames substantially as described and illustrated by the ducts *a a* in Figs. 2, 4 and 5.
- 3.) The method of humidifying and ventilation applied to drawing, roving and gill spinning frames substantially as described and illustrated by Figs. 2, 4 and 5.
- 4.) The method of humidifying and ventilation applied to looms substantially as described and illustrated by Fig. 3.
- 5.) The system of cleansing machinery and rooms of dust and the like by means of hose pipes attached at any desired position in the room to an exhaust pipe, and operated by hand substantially as described.

Dated this 6th day of May 1899.

ARTHUR W. METCALFE,
JOHN B. MORRISON.

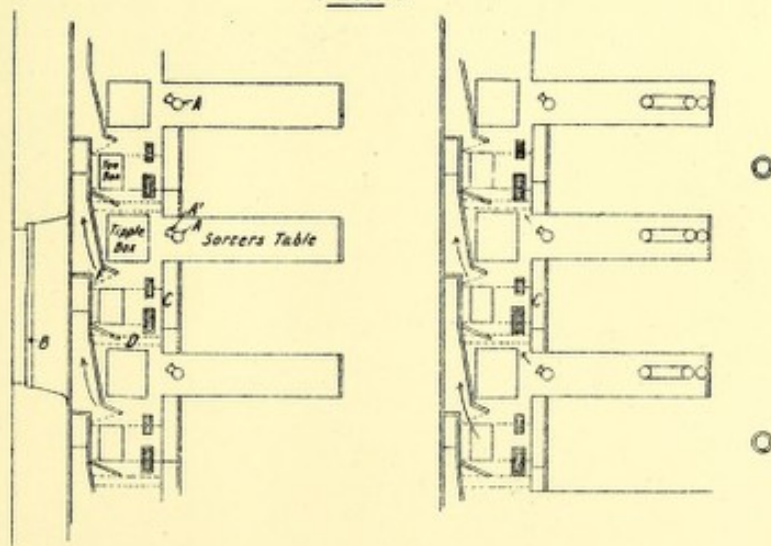
PLAN FOR VENTILATING HACKLING SHOP AT THE MILLS OF MESSRS. J. & T. M. GREEVES LTD., BELFAST.

ELEVATION.



- A. Inlet tubes on Tobin's principle distributing fresh air over the ceiling from which it falls so gradually that no draught is felt. This fresh air as it falls prevents the dust rising to the hacklers face.
 A'. Is a branch tube the current from which carries dust at once over to grid F.
 B. Inlet in windows only used in very warm weather.
 C. Open trough to catch dust falling from hackles and connected to duct D size 4" x 3 1/2" a similar velocity of current as at F gives 1/3 cubic feet exhaust for each hackler with windows closed, and 2/3 cubic feet with window inlets open.
 F. Exhaust grids opposite each hackler size 12" x 16 1/2" diminished by 13 rods 1/4" dia. clear effective area = 116 sq. inches. A current ranging from 250 to 300 lineal feet per min. is obtainable with all windows shut, which gives 3/5 cubic feet per min per hackler. These latter figures rise to 2/3 cubic feet with window inlets open, the lineal feet rising from 550 to 650.
 Minimum Exhaust per Hackler = $250 \times 25 = 275$ cubic feet per min.

PLAN.



THE UNIVERSITY OF CHICAGO PRESS

CHICAGO, ILLINOIS, U.S.A.

Appendix 8. - Plate

[This Drawing is a reproduction of the Original on a reduced scale]

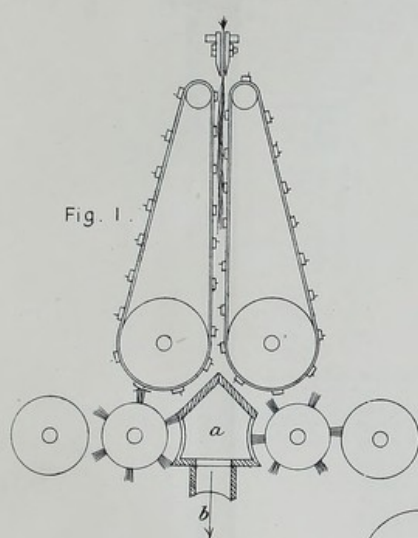


Fig. 2.

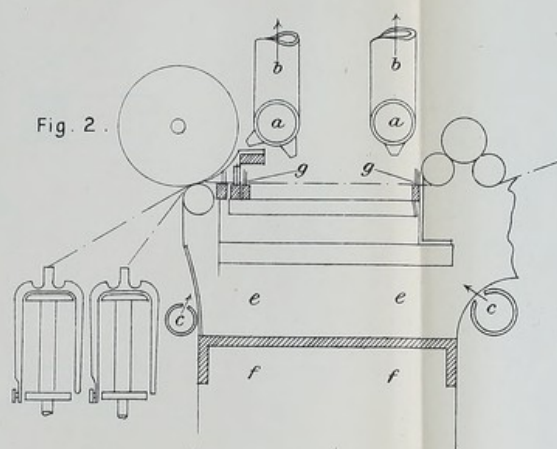


Fig. 3.

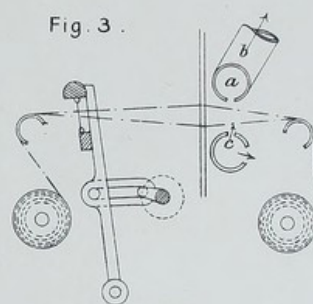


Fig. 4.

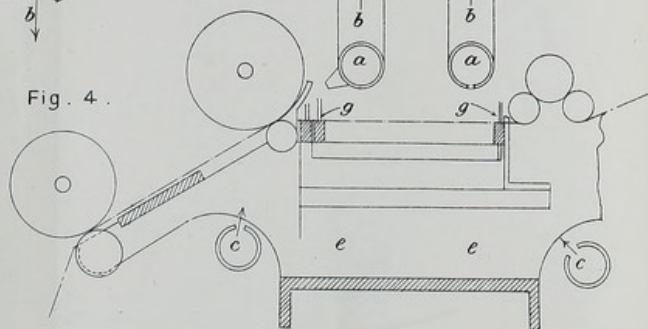
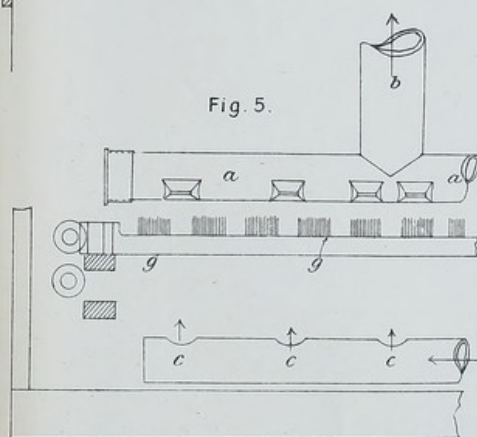
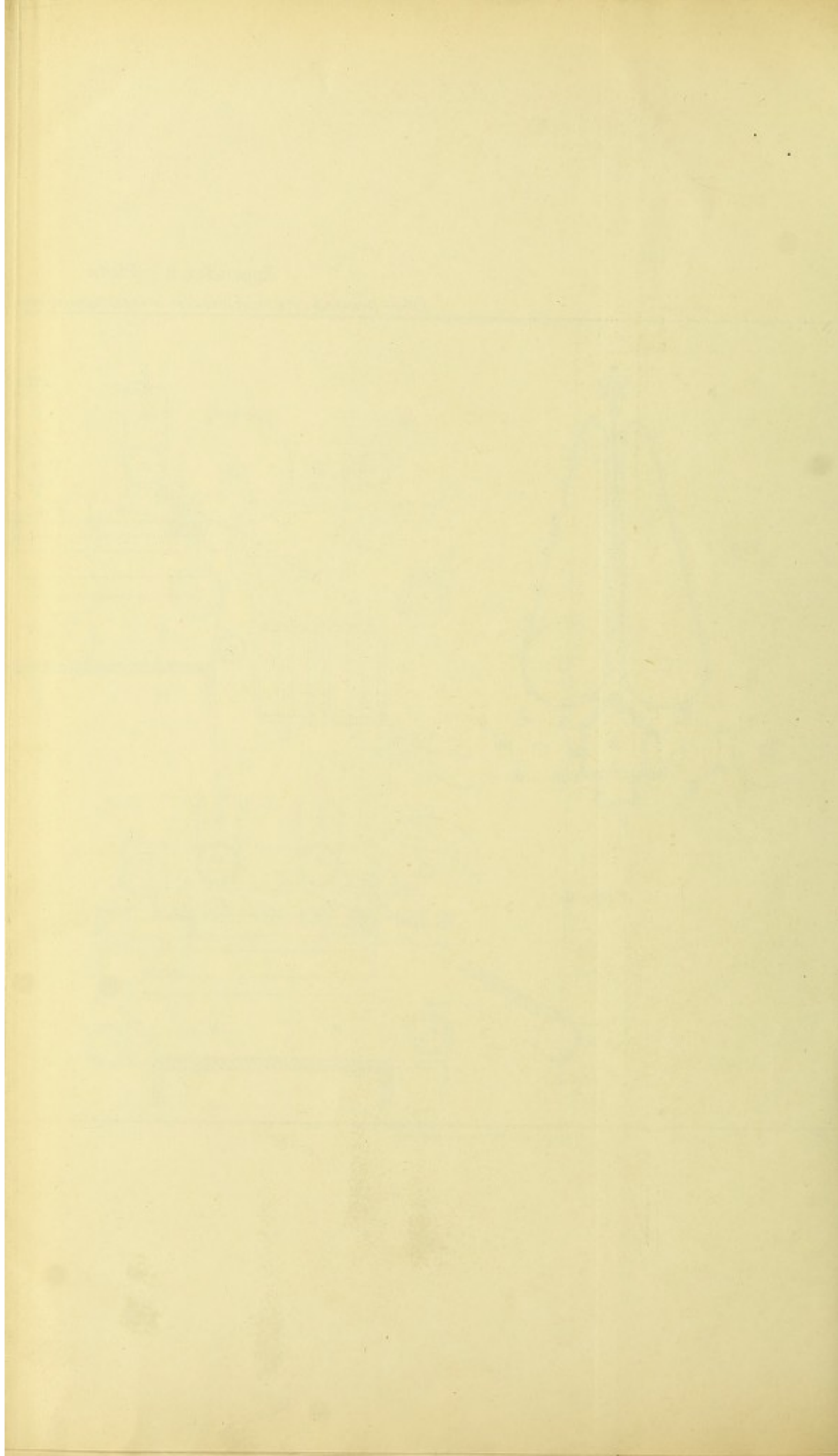


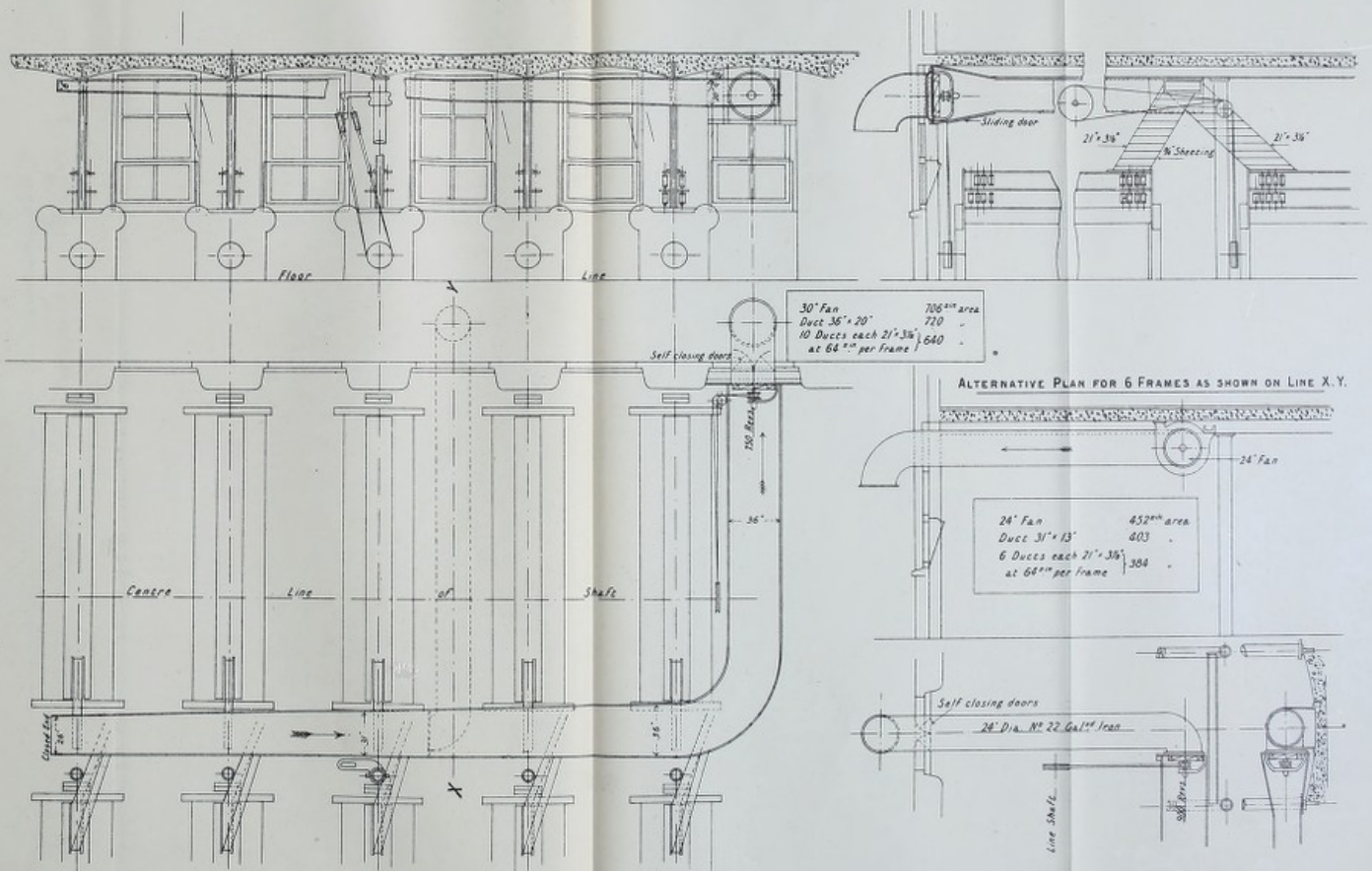
Fig. 5.





Appendix 9.

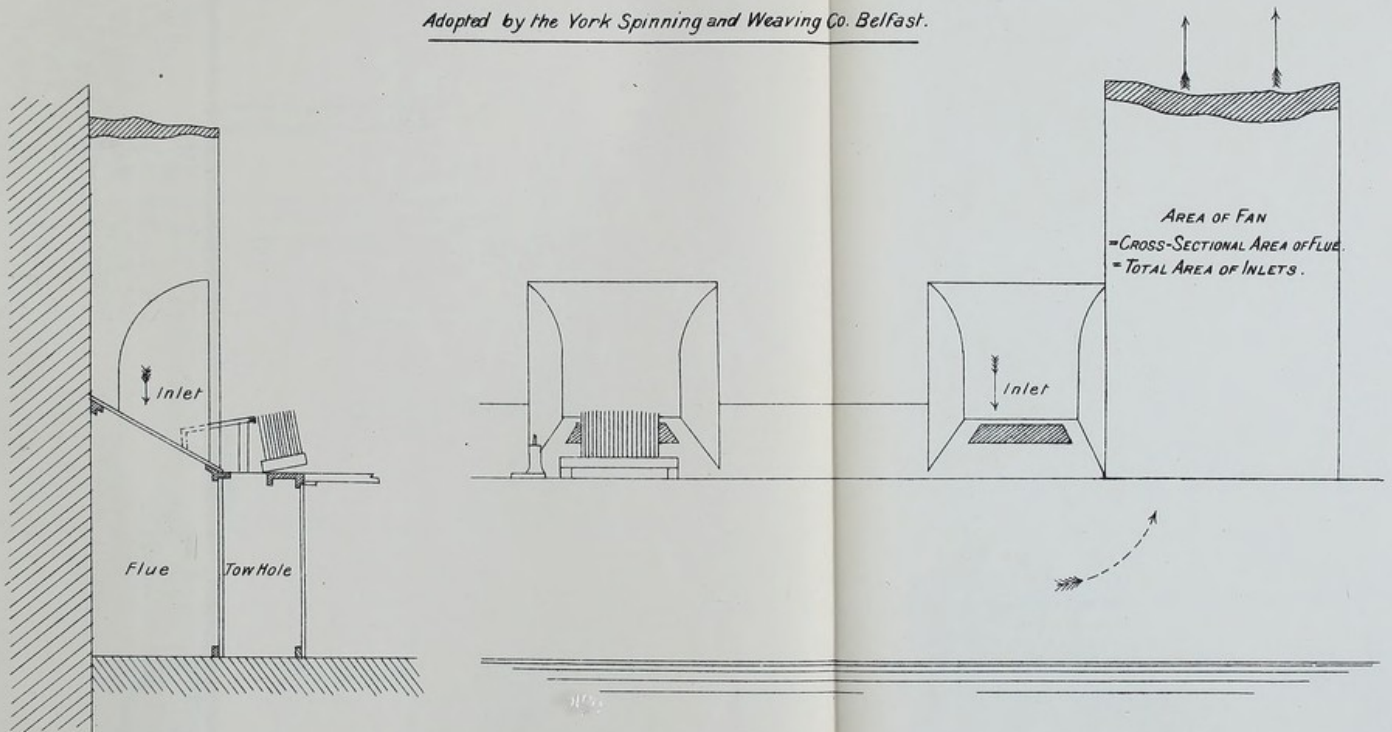
PLAN OF FANS AND DUCTS FOR EVE'S EXHAUST SPINNING FRAME CREELS.



Appendix 10.

PLAN FOR VENTILATING ROUGHING & SORTING SHOPS.

Adopted by the York Spinning and Weaving Co. Belfast.



Presented to

THE NEW YORK HISTORICAL SOCIETY

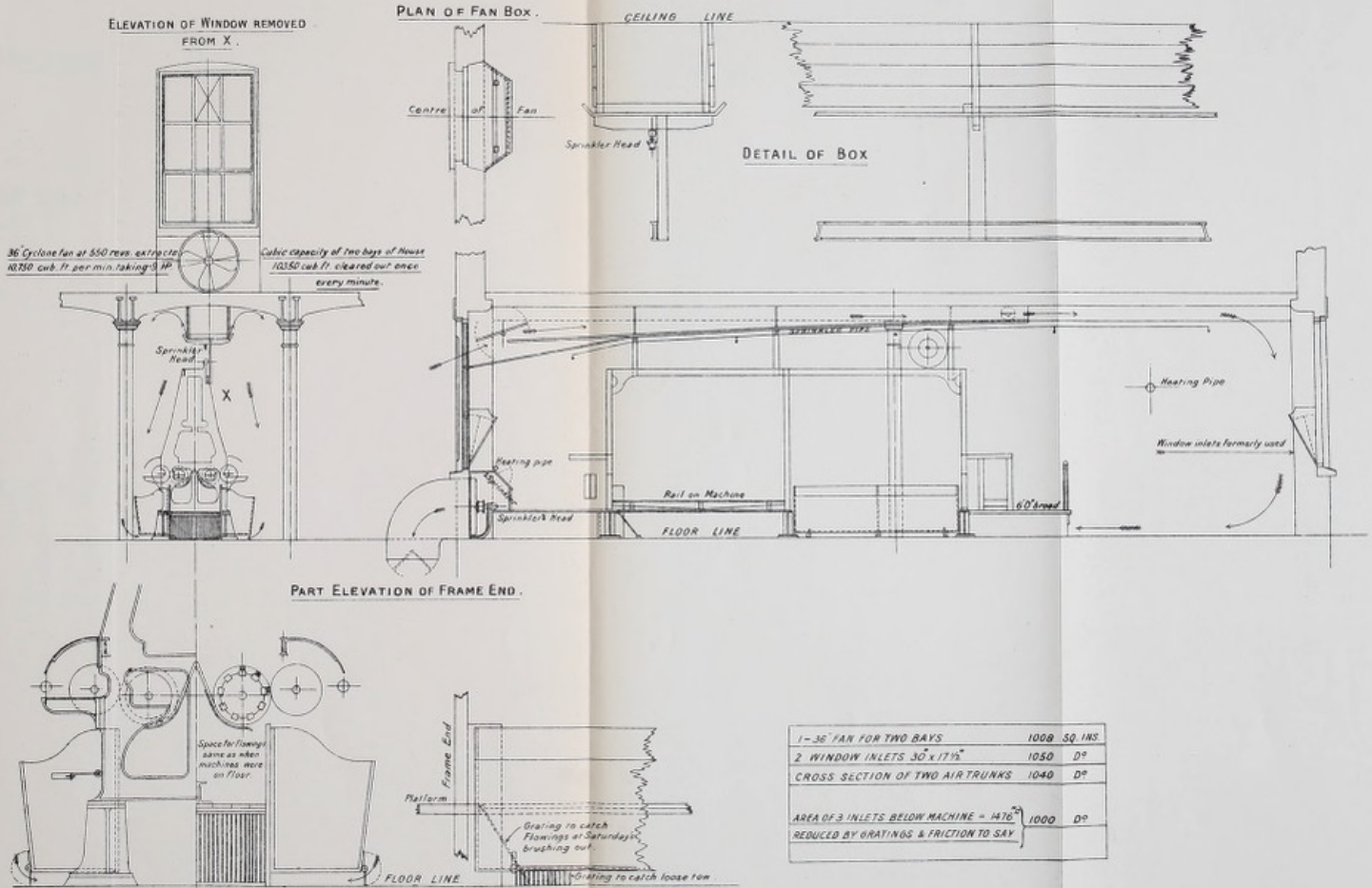
BY THE NEW YORK HISTORICAL SOCIETY

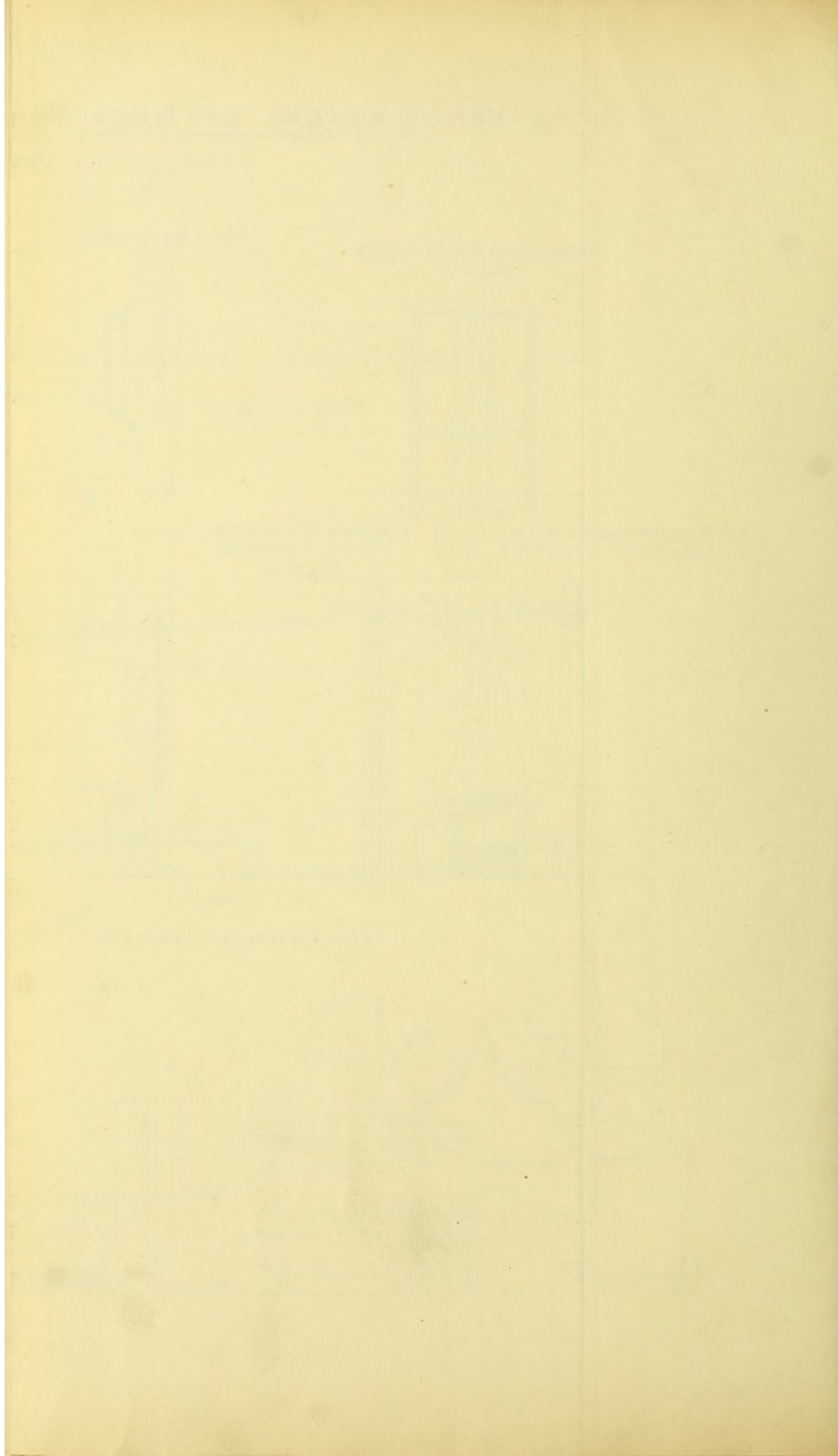
Appendix 12.

VENTILATION OF HACKLING MACHINES AT FORTH RIVER MILLS.

DESIGNED BY J. V. EVES.

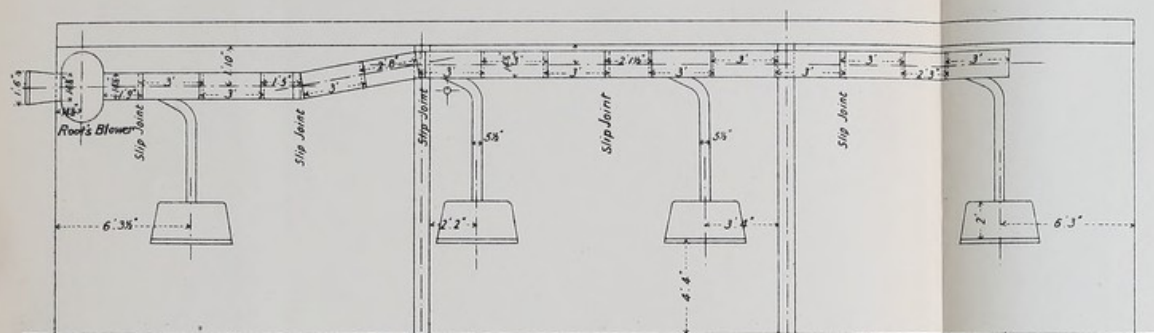
FEB. 1898.



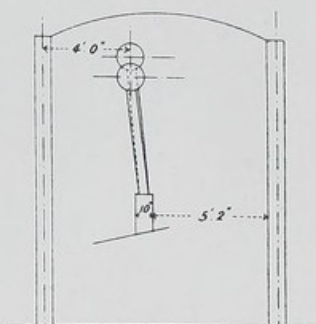


Appendix 13.

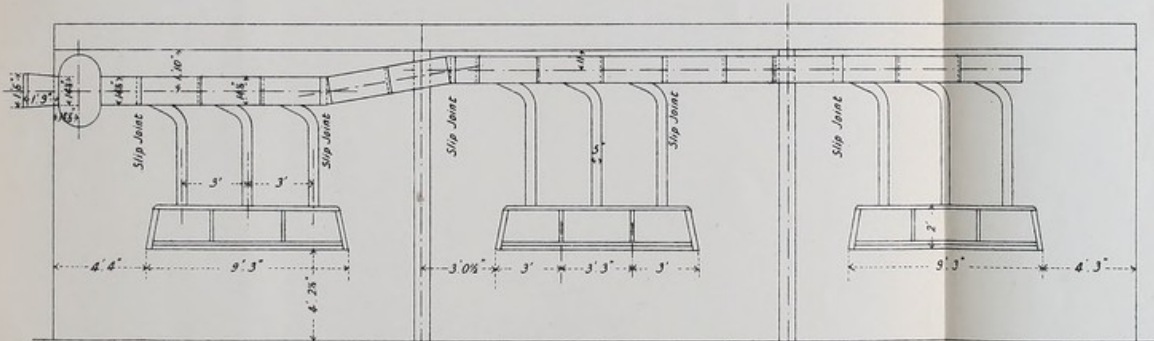
ROOT'S BLOWER WITH ARRANGEMENT OF PIPES FOR EXTRACTING DUST FROM FLAX PREPARING MACHINES,
ADOPTED BY MESSRS. DON BROS. BUIST & CO., WARD MILLS, DUNDEE.



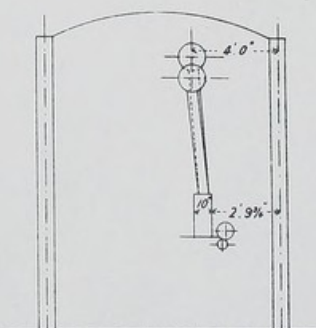
SPREADINGS. ELEVATION.



END ELEVATION.



DRAWINGS. ELEVATION.



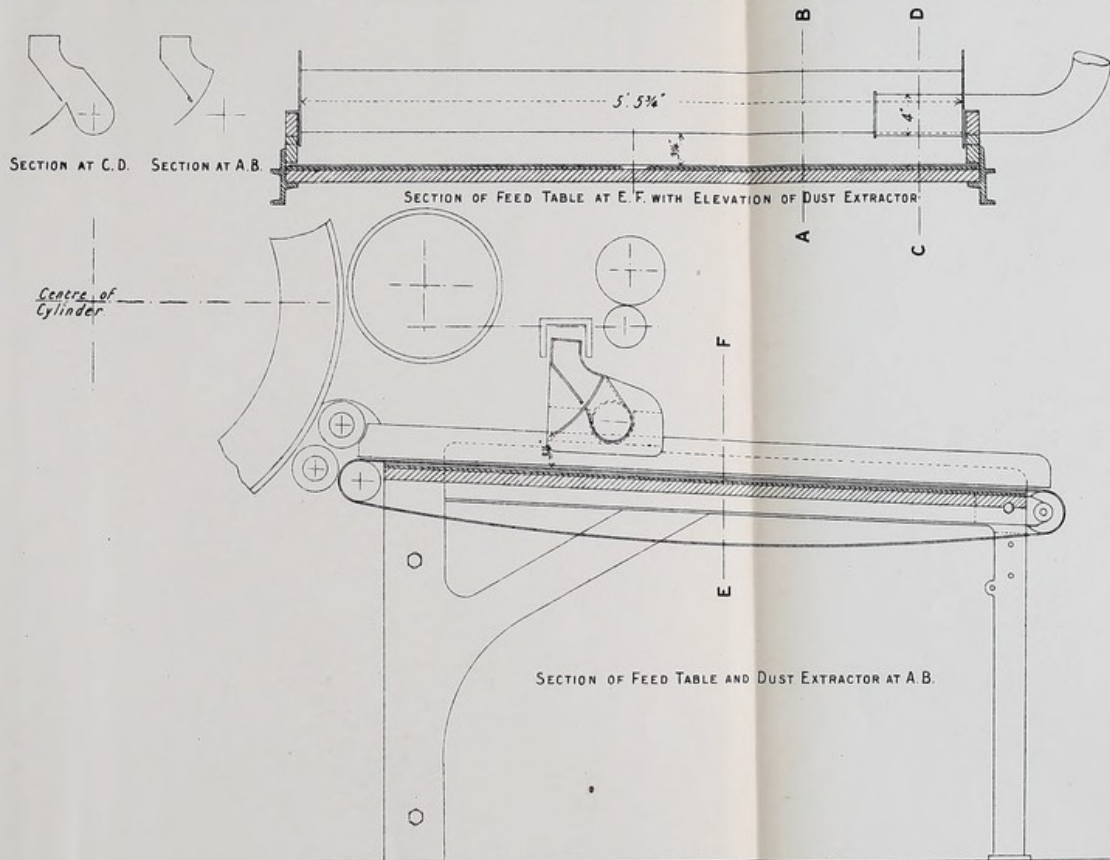
END ELEVATION.

Appendix A

Roots of the equation $x^2 - 1 = 0$ are ± 1 .
Roots of the equation $x^2 - 4 = 0$ are ± 2 .
Roots of the equation $x^2 - 9 = 0$ are ± 3 .
Roots of the equation $x^2 - 16 = 0$ are ± 4 .
Roots of the equation $x^2 - 25 = 0$ are ± 5 .
Roots of the equation $x^2 - 36 = 0$ are ± 6 .
Roots of the equation $x^2 - 49 = 0$ are ± 7 .
Roots of the equation $x^2 - 64 = 0$ are ± 8 .
Roots of the equation $x^2 - 81 = 0$ are ± 9 .
Roots of the equation $x^2 - 100 = 0$ are ± 10 .

Appendix 14.

METHOD OF REMOVING DUST FROM FLAX TOW CARD.
ADOPTED BY MESSRS. DON BROS. BUIST & CO., WARD MILLS, DUNDEE.



THE

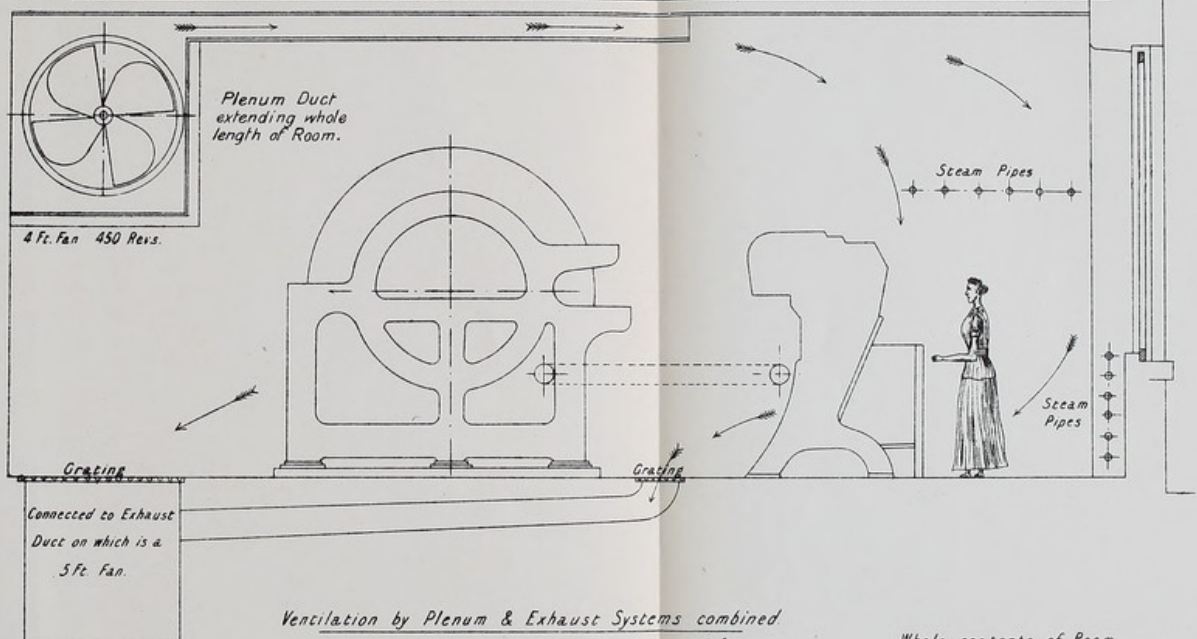
WITCHAMPTON

WITCHAMPTON

Appendix 15.

METHOD OF EXTRACTING DUST FROM CARDING MACHINE,
ADOPTED BY MESSRS. J. & T. M. GREEVES, LTD., BELFAST.

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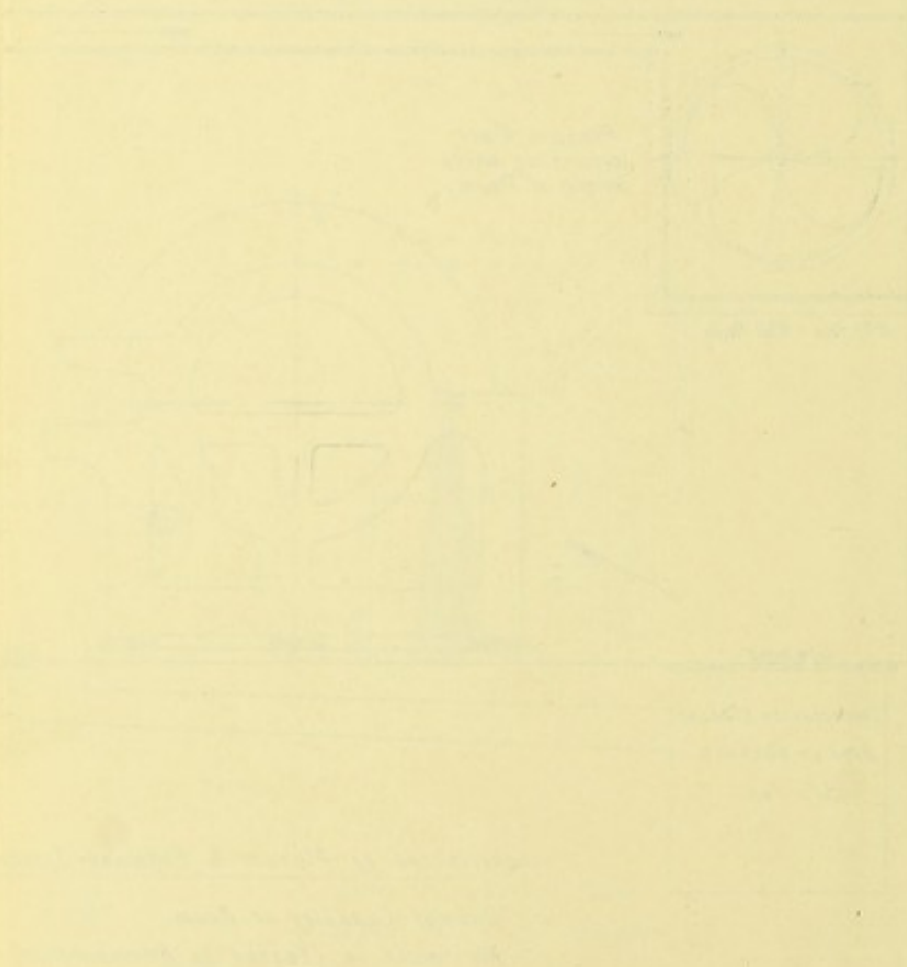
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METHOD OF EXTRACTING OYSTERS

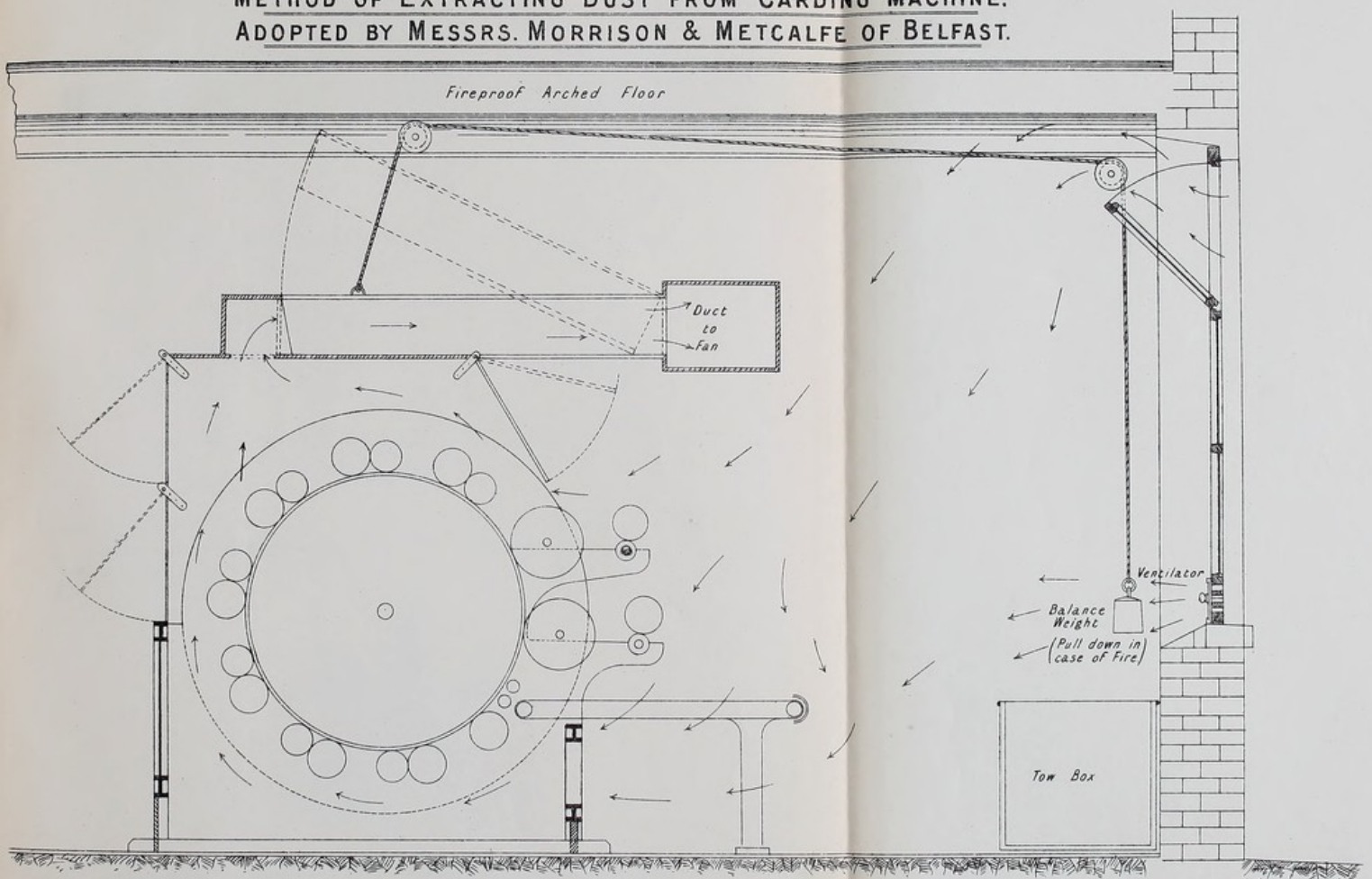
ADAPTED BY HENRY J. LAM

Translated from the French of J. B. LAM



Appendix 16.

**METHOD OF EXTRACTING DUST FROM CARDING MACHINE.
ADOPTED BY MESSRS. MORRISON & METCALFE OF BELFAST.**



REPORT ON THE
METHOD OF EXTRACTING OIL FROM SEEDS
REPORTED BY MISS M. M. M. M. M.



R E P O R T

TO

THE SECRETARY OF STATE FOR THE
HOME DEPARTMENT

ON THE

HEALTH OF CORNISH MINERS.

BY

J. S. HALDANE, M.D., F.R.S.,

FELLOW OF NEW COLLEGE, OXFORD ;

JOSEPH S. MARTIN,

H.M. INSPECTOR OF MINES FOR THE SOUTH-WESTERN DISTRICT ;

AND

R. ARTHUR THOMAS,

MANAGER OF DOLCOATH MINE.

Presented to both Houses of Parliament by Command of His Majesty.



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REPORT

THE SECRETARY OF STATE FOR THE
HOME DEPARTMENT

ON THE

HEALTH OF CORNISH MINERS.

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TERMS OF REFERENCE.

"To enquire into and report upon the health of the miners employed in mines in Cornwall, with special reference to the injurious effects alleged to be produced by the state of ventilation in the mines, the dust arising from the use of rock-drills, and the introduction of impurities into the working-places through the use of compressed air."

The enquiry was begun by Mr. Martin and Dr. Haldane in October, 1902. It having been discovered at the outset that ankylostomiasis (worm disease) was prevalent among miners in the Camborne district, a report to the Secretary of State dealing with this subject was prepared by Dr. Haldane, and published as a Parliamentary Paper in December, 1902. In a letter dated February 14th, 1903, Mr. Thomas was requested by the Secretary of State to co-operate in the inquiry.

TERMS OF REFERENCE

To enquire into and report upon the health of the miners employed in mines in Cornwall, with special reference to the injurious effects alleged to be produced by the state of ventilation in the mines, the dust arising from the use of rock-drills, and the introduction of impurities into the working places through the use of compressed air.

Enacted in 1892

1892

The enquiry was carried out by Mr. Martin and Mr. Halliday in 1892. It having been discovered at the time that the ventilation in Cornish mines was generally so bad, and that the dust arising from the use of rock-drills was so injurious, the Government decided to have a special enquiry into the health of the miners employed in the Cornish mines. The enquiry was carried out by Mr. Martin and Mr. Halliday, and their report was published in 1892. The report was very valuable, and it led to the passing of the Cornish Mines Act, 1892, which provided for the improvement of the ventilation in the Cornish mines, and for the regulation of the use of rock-drills.

The Cornish Mines Act, 1892, was a very important piece of legislation, and it was the first time that the Government had taken any steps to improve the health of the miners in Cornwall. The Act provided for the improvement of the ventilation in the Cornish mines, and for the regulation of the use of rock-drills. It also provided for the appointment of a special commission to enquire into the health of the miners in Cornwall, and to report upon the results of their enquiry. The commission was appointed in 1892, and it was headed by Mr. Martin and Mr. Halliday. Their report was published in 1892, and it was very valuable. It led to the passing of the Cornish Mines Act, 1892, which provided for the improvement of the ventilation in the Cornish mines, and for the regulation of the use of rock-drills.

REPORT

TO

THE SECRETARY OF STATE FOR THE HOME DEPARTMENT

ON THE

HEALTH OF CORNISH MINERS.

SIR,

WE have the honour to submit to you the following Report, dealing with the health of Cornish miners, and with conditions underground which are prejudicial to health.

The Cornish mines are at present devoted chiefly to the production of tin, although copper, arsenic, wolfram, silver, and other minerals are also obtained. According to the recent Census Returns there were in 1901 6,059 tin miners in Cornwall. According to returns supplied by employers to the Inspector of Mines, 3,678 men were actually employed underground, and 2,690 males and 357 females above ground.

DEATH-RATE OF CORNISH MINERS.

It has been known for long that the health of tin, lead, and copper miners is unsatisfactory, as compared with that of men employed in other industries.

The following table, compiled from the evidence submitted by Dr. Farr to the Royal Commission which reported in 1864 on the health of metalliferous miners, shows the mortality as it existed 40 or 50 years ago in the chief mining districts of Cornwall and in other mines of England :—

TABLE 1.
Annual Deaths per 1,000 living.

		Ages.					
		15-25.	25-35.	35-45.	45-55.	55-65.	65-75.
Cornish miners...	1849-53	8.9	9.0	14.3	33.5	63.2	111.2
	1860-62	9.4	9.6	15.1	29.7	63.2	110.5
Males in Cornish mining districts, excluding miners ...	1849-53	7.1	8.8	10.0	14.8	24.1	58.6
	1860-62	7.5	8.3	10.1	12.5	20.0	53.3
All males (England and Wales)	1849-53	8.1	10.1	13.0	19.0	34.8	65.9
Staffordshire miners (coal)	1849-53	13.6	14.9	17.6	27.6	50.0	104.8
Durham miners (coal)...	1849-53	8.5	8.5	10.1	16.8	24.4	65.2
South Wales miners (coal)	1849-53	20.7	20.4	23.8	34.3	57.4	138.9

The death-rates among tin miners, coal miners, and ironstone miners for the years 1890-91-92, and among Cornish miners for 1900-02, are shown in Table II., which is compiled from the figures given in Part II. of the Decennial Supplement (1897) to Vol. 55 of the Registrar-General's Reports, and from returns (*see* Appendix I.) specially furnished at your request for the years 1900-02 by the Registrar-General for the purposes of this inquiry.

TABLE 2.

		Ages.					
		15-20.	20-25.	25-35.	35-45.	45-55.	55-65.
Occupied males (England and Wales)	1890-92	2.55	5.1	7.3	12.4	20.7	36.7
All males (England and Wales)	... 1890-92	4.14	5.55	7.7	13.0	21.4	39.0
Tin miners (Cornwall)	... { 1890-92	3.0	7.0	8.1	14.3	33.2	66.1
	... { 1900-02	1.55	5.8	13.4	27.9	39.85	68.8
All miners (Cornwall)*	... 1900-02	1.7	5.8	20.9	39.0	44.6	70.5
Coal miners	... 1890-92	3.8	5.6	6.3	9.6	19.4	43.8
Ironstone miners	... 1890-92	3.4	4.6	5.9	8.2	17.0	33.3

* Including gold miners, &c., who had worked abroad.

On comparing these figures it will be seen that up to 1890-92 the death-rate among Cornish miners was more or less abnormally high, but that only above the age of about 40 was the excess extremely marked. In 1900-02, on the other hand, the excess among tin miners, and still more among miners of all kinds living in Cornwall, was very greatly increased between the ages of about 25 and 50. Between these ages the death-rate among miners in Cornwall was from three to four times that among colliers and ironstone miners.

It is also evident that while there has been during the last 50 years a very great decrease in the death-rate among coal miners below the age of about 50, the death-rate among Cornish miners has diminished only at ages below 25.

The following tables show the causes of death producing the excess :—

TABLE 3.

Annual Deaths per 1,000 living.

			Ages.					
			15-25.	25-35.	35-45.	45-55.	55-65.	65-75.
Cornish miners...	{ 1849-53	{ Lung diseases ...	3.05	4.4	8.5	24.3	44.5	55.9
		{ Other causes ...	5.85	4.6	5.8	9.2	18.7	55.3
	{ 1860-62	{ Lung diseases ...	3.8	4.15	7.9	19.75	43.3	45.0
		{ Other causes ...	5.6	5.4	7.2	10.0	19.9	65.5
Males (exclusive of miners in same districts)	{ 1860-62	{ Lung diseases ...	3.3	3.8	4.2	4.3	5.2	10.5
		{ Other causes ...	4.2	4.5	5.8	8.2	14.8	42.8

TABLE 3—continued.

Annual Deaths per 1,000 living—continued.

				Ages.					
				15-25.	25-35.	35-45.	45-55.	55-65.	65-75.
Cornish miners (tin and copper)	1849-53	Accidents ...		2.0	2.1	1.9	2.4	1.5	2.1
		Lung diseases ...		3.05	4.4	8.5	24.3	44.5	55.9
		All other causes		3.85	2.45	3.9	6.8	17.2	53.2
Staffordshire miners (coal)	1849-53	Accidents ...		7.5	7.7	8.2	8.8	6.8	6.8
		Lung diseases ...		1.8	2.7	3.3	7.9	20.2	35.2
		All other causes		4.3	4.5	6.1	10.9	23.2	62.7
South Wales miners (coal)	1849-53	Accidents ...		7.05	6.1	7.2	8.1	7.3	6.1
		Lung diseases ...		5.7	4.5	5.9	9.8	21.9	56.5
		All other causes		8.0	9.8	10.7	16.3	28.2	76.3
Durham miners (coal)	1849-53	Accidents ...		2.4	2.2	3.3	3.7	3.75	2.9
		Lung diseases ...		2.9	2.15	1.8	3.5	6.8	13.9
		All other causes		3.2	4.15	5.0	9.6	13.9	48.4
England and Wales (males)	1849-53	Accidents ...		0.9	1.0	1.15	1.4	1.6	1.8
		Lung diseases ...		3.6	4.8	5.3	6.8	9.6	14.5
		All other causes		3.6	4.3	6.35	10.7	20.6	49.6

TABLE 4.

Annual Deaths from Lung Diseases per 1,000 living.

				Ages.					
				15-20.	20-25.	25-35.	35-45.	45-55.	55-65.
Occupied males (England and Wales)	1890-92			0.95	2.7	3.7	5.9	8.6	13.0
Tin miners (Cornwall)	1890-92	...	...	1.3	3.7	3.9	9.5	23.0	40.7
	1900-02	...	...	0.5	2.6	10.5	23.2	29.6	42.8
All miners (Cornwall)	1900-02	...	...	0.7	2.7	17.3	33.2	32.2	42.6
Coal miners	1890-92	...	...	0.9	2.0	2.1	3.5	7.8	18.7
Ironstone miners	1890-92	...	...	1.6	1.5	2.1	3.2	6.5	13.0

TABLE 5.

Annual Deaths from Accident per 1,000 living.

				Ages.					
				15-20.	20-25.	25-35.	35-45.	45-55.	55-65.
Occupied males (England and Wales)	1890-92			0.5	0.6	0.7	0.9	1.1	1.4
Tin miners (Cornwall)	1890-92	...	...	1.0	2.1	0.9	0.3	0.3	4.4
	1900-02			0.5	1.8	0.9	0.6	1.4	0.0
All miners (Cornwall)	1900-02			0.5	1.7	0.8	0.55	1.25	0.5
Coal miners	1890-92	...	...	1.5	1.5	1.8	2.25	2.9	3.1
Ironstone miners	1890-92	...	...	0.9	1.1	1.2	1.3	1.7	1.9

TABLE 6.

Annual Deaths from Other Causes besides Lung Disease and Accident per 1,000 living.

				Ages.					
				15-20.	20-25.	25-35.	35-45.	45-55.	55-65.
Occupied males (England and Wales)	1890-92			1.1	1.8	2.9	5.6	11.8	19.3
Tin miners (Cornwall)	1890-92	...	...	0.7	1.2	3.3	4.5	9.9	21.0
	1900-02			0.5	1.4	2.0	4.2	8.9	26.0
All miners (Cornwall)...	1900-02	...	...	0.5	1.4	2.8	5.25	11.15	27.4
Coal miners	1890-92	...	...	1.4	2.1	2.4	4.3	8.7	22.0
Ironstone miners	1890-92	...	...	0.9	2.0	2.6	3.7	8.9	18.4

On a comparison of these tables two points stand out clearly.

1. The excessive mortality among miners in Cornwall, as compared with that among occupied males generally, and particularly among coal and ironstone miners, is due entirely to lung diseases. Apart from the tendency to lung diseases, Cornish mining is, on the whole, an exceptionally healthy and fairly safe occupation, and as regards men up to the age of 45 shows marked improvement during the last 50 years, in accordance with the improvement among the population generally.

2. The excessive mortality from lung diseases had, up till 1892, only seriously affected men of over 40. During the last few years, however, there has been an enormous increase in the death-rate from lung diseases, particularly among younger men from about 25 to 45, with the result that the total death-rate at all ages from 25 to 55 is now far greater than at any previous period during the last 50 years. Between the ages of 25 and 45 the death-rate from lung diseases among miners living in Cornwall has recently been from eight to ten times the corresponding death-rate among coal miners or ironstone miners.

In connection with the death-rates for tin miners in the above tables it should be remarked that under "tin miners" are included a large number of men (probably about a third of the whole) partly or wholly employed above ground. For those employed underground only the death-rates would probably be higher. On the other hand, as will be shown later, the recent rise in the death-rate is mostly due to the effects of work in mines in South Africa.

Before endeavouring to indicate the exact causes of the excessive mortality, we must give some account of the conditions met with underground in Cornish mines.

Conditions of Work in Cornish Mines.

The Cornish mines are all metalliferous, by far the most important mineral now extracted being tin ore. This occurs in lodes, which traverse the "killas" (an argillaceous schist) and granite. The workings follow the lode, which is extracted wherever it is rich enough to repay the expense, and left where this is not the case. The general method of working is shown in Plate I., which represents a longitudinal section of the main lode at Dolcoath Mine. It will be seen that copper ore occurred in the upper part of the lode, and was formerly extensively mined. The present workings are mostly at a depth of over 2,000 feet, and have reached nearly 3,000 feet. Only tin ore is now obtained.

The ore is wound up through the shafts in iron boxes known as "skips," which run on wheels wherever the shaft is not vertical. Somewhat similar iron boxes known as "gigs" are used for the conveyance of men to and from their work. There are also ladder-ways at the sides of the shafts, and at many points throughout the workings, to enable the men to pass from level to level. In working the lode the shafts are first sunk to a sufficient depth, and levels driven horizontally from them. The levels are then connected at intervals with the levels above and below by intermediate shafts ("winzes" or "rises"), by which means ventilation of the levels is secured. These connections are known as "winzes" when they are made by sinking from a higher to a lower level, and as "rises" when made from a lower to a higher level. The process of removing the portions of lode thus blocked out is known as "stoping," and the working places as "stopes"—"underhand" when the lode is worked from a higher to a lower level, and overhand when from a lower to a higher level. The ore is usually shot down into the level below and removed to the shaft on small wagons running on rails and ordinarily pushed by hand. In driving the levels, sinking winzes, and "rising," rock-drills driven by compressed air are commonly used for boring the holes which receive the explosive. On the stopes hand-drills are nearly always used in Cornwall. The space left after the lode has been worked out is known as a "gunnis," and may extend upwards or downwards for hundreds of feet. When the roadway of a level crosses a "gunnis" it is supported by timber.

The general ventilation of a Cornish mine is produced, almost invariably, by "natural" means only. Large fans or furnaces, as in coal mines, are not employed, since in deep metalliferous mines, if proper means are taken to enable the air to circulate, adequate general ventilation can usually be obtained without them; nor would it be possible to employ them advantageously unless the shafts were closed laterally so as to prevent short-circuiting between downcast and upcast shafts. The air currents in the down cast and upcast shafts depend on the fact that, unless the mine is very shallow, the temperature below is much higher than on the surface, and that, even when in warm weather the difference of temperature would not by itself suffice to produce a current, the temperature in any shaft or part of the mine which has been previously acting as a downcast will always be lower, at the same levels, than in the corresponding upcast shaft. The general course of the air-currents in Dolcoath Mine, together with the quantities of air passing upwards by each upcast, the temperature, and the deficiency of oxygen and excess of carbonic acid, as recently

determined by us, is indicated by the arrows on the section. It will be seen that roughly speaking the air passes down by the shafts at each end of the section of lode worked, and passes up by the shafts in the middle. The temperature is consequently a good deal lower in the eastern and western (Stray Park) shafts than in the middle shafts.*

The course of the air through the levels, stopes and winzes of a metalliferous mine is very complicated and irregular, as it is usually allowed to pass upwards or downwards according to local differences in the temperature at different points; but generally the distribution is fairly good, except in ends and rises, where there is, of course, no through current unless artificially induced.

The work of the men employed underground is of several kinds. The ore is nearly all obtained by means of explosives, so that the majority of men are chiefly employed in drilling holes to receive the charge, which usually consists of blasting gelatine, dynamite, gelignite, or some other high explosive, although compressed gunpowder is also used to some extent. On the stopes the drilling is at present almost all done by hand, one or two men striking the drill while another man holds and rotates it (see Figure 2), but occasionally single-handed drilling is practised. The work of boring the holes in driving levels, making "rises," and sinking shafts or winzes, is commonly now done by boring machines (rock-drills), two men being employed at a time for working each machine (see Figure 1). The ore or rock detached by each blast is (except in ends, or in sinking), shot down to the level below, and loaded into trucks (see Figure 4), in which it is conveyed to the shaft, and either tipped into the skip directly or into the plat or ore-bin first. Besides the men engaged in driving, stoping, and tramming, a considerable number are occupied in "pit-work," i.e., repairing shafts, pumps, &c., or as timbermen in timbering or executing repairs.

The fact that the excessive mortality among tin miners is confined exclusively to "phthisis" and other diseases of the respiratory system, points at once to vitiation of the air as the probable cause. It is, however, necessary to refer to other suggested causes.

One cause which has frequently been referred to is the excessive strain produced by climbing ladders. We cannot, however, find any definite evidence that this by itself has at any time had a marked effect on health. In the first place the statistics published in the Registrar-General's Decennial Supplements show no evidence of excessive mortality among tin miners from diseases of the circulatory system, such as would naturally result from over-exertion. And secondly, the amount of climbing to and from work in tin mines is now very greatly reduced, as the men nearly always ascend or descend the shaft in a "gig." Yet the excessive mortality remains as in former times, when there was far more climbing. The work of climbing must, however, have been severely felt by men already affected by pulmonary disease.

Another suggested cause is the sudden fall of temperature to which the men are exposed on returning to the surface, often with wet or insufficient clothing. In this respect, however, Cornish miners are better off than colliers, since at Cornish mines special rooms, heated by steam-pipes, are now provided for the men to wash and change their clothes in and hang them up to dry. The climate is also much milder in Cornwall than in the colliery districts. Yet colliers and ironstone miners, who have usually to go to and from their homes in their underground clothes, are extraordinarily free from the respiratory diseases which affect metalliferous miners. It would seem, therefore, that exposure to cold is, at any rate, not a primary cause of the excessive mortality among metalliferous miners, although such exposure may probably aggravate lung disease produced by other causes.

* The measurements were made before Williams' Shaft, shown in Plate II., was connected with the workings by the cross-cut at the 220-fathom level. Since then the air supply has considerably increased, and all the shafts between Stray Park and South Valley Shafts are now upcasts.

Metallic poisoning also suggests itself as a possible cause; but so far as metalliferous mining in Great Britain is concerned there is no evidence whatever in support of this theory. Even among lead miners there is no appreciable mortality from lead-poisoning.

Another cause which must be discussed is the absence of daylight during work underground. Colliers and ironstone miners work also in the absence of daylight, and apart from accidents are exceptionally healthy. We may therefore conclude that if absence of daylight is prejudicial to health, the work of a miner is in other respects usually so much more healthy than most other kinds of work that the prejudicial effects of the darkness are more than counterbalanced.

The comparatively high temperatures met with underground do not appear to be injurious, since colliers are, on an average, exposed to about as high temperatures as tin miners.

The air of tin mines might be injurious, either from the gaseous or particulate impurities; and the possible influence of the former may be first discussed.

In order to obtain some idea of the gaseous impurities in Cornish tin mines we have examined the air in various parts of several Cornish mines. The results of the analyses are given in Appendix III.

For the sake of comparison we visited two typical ironstone mines, in the Cleveland district, where the miners are extremely healthy. The analyses showed that the air of these mines contained, on the whole, more carbonic acid and less oxygen than the air of Cornish mines. The amount of smoke in the air from blasting (powder being the explosive used) appeared also to be greater in the ironstone mines. In coal mines, to judge from the return air, the gaseous impurities are also more abundant than in Cornish mines. (Appendix III.) It is thus evident that the ordinary gaseous impurities found in the Cornish mines cannot be responsible in any degree for the relative unhealthiness of tin mining. Indeed, it is extremely improbable that the small excess of CO_2 , or deficiency of O_2 , ordinarily met with in mines could have any influence on health. Nor have they, as a rule, the same indirect significance as excess of CO_2 , or deficiency of O_2 , in the air of inhabited rooms, since they are only to a very slight extent produced by respiration or burning of lights, &c., and are due almost entirely to processes of slow oxidation of minerals, and probably also of the timber (see Appendix III.). Except in "ends" immediately after blasting we were unable to detect in the air of Cornish mines any carbonic oxide or other poisonous constituent, and such traces of poisonous gases as were doubtless present owing to blasting were in far too small proportions to have any influence on health. Moreover, in the ironstone mines which we visited, gunpowder smoke appeared to be present in greater quantity than smoke from explosives in tin mines, and yet caused no appreciable harm to the men. In the air of close ends appreciable quantities of poisonous gases, such as carbon monoxide, nitric peroxide, and sulphuretted hydrogen are undoubtedly present after a blast, but we could obtain no evidence of permanent ill effects attributable to these gases; and where ordinary care is exercised in allowing the smoke from a blast to dissipate no trouble from this cause should arise. (See Appendix III.)

In accordance with the terms of reference of our enquiry we have carefully investigated the composition of the compressed air which is supplied to the rock-drills, and escapes through the drills into the ends, rises, &c., where the drills are at work. The result of our investigation (Appendix III.) was to show that this air, in the case of the compressors investigated in Cornwall, was for all practical purposes perfectly free from gaseous impurities. We would also point out that the amount of air supplied in this way is very considerable. The consumption of air by different drills varies greatly, but our measurements showed that an ordinary drill while at work consumes about 20 to 30 feet of compressed air at about 70 lbs. pressure per square inch, or 110 to 160 feet of air at atmospheric pressure per minute. This being fresh air delivered directly

to the working place, is a fair supply for two or three men, even allowing for the drill only being at work about half or a third of the time during which the men are present, although it may be quite insufficient for the general ventilation of the level or rise. The occasional escape of a spray of oil in the air from the drill appears to be due chiefly to oiling the drill by the extraordinary method of pouring large quantities of oil into the pipe supplying compressed air to the drill. Apart from this source of contamination, for which the men using the drills are responsible, we have never observed any sign of the air from a drill being impure. Assuming that, as is probable, the compressed air is saturated at the temperature of the mine, it is evident that the air issuing from the drill will, when it reaches the mine temperature again, be very dry (only 20 per cent. saturated if the pressure is 60 lb. per square inch). This dry air is not only very cold as it issues, but has a great additional cooling effect in virtue of its dryness. It is thus greatly superior in a hot "end" or "rise" to an equivalent volume of the ordinary mine air. As regards gaseous impurities the air of an "end" with a drill at work may contain purer air than any other part of a mine. A striking instance of this is quoted in Appendix III. (p. 85).

The particulate impurities met with in the air of mines consist chiefly of dust arising from blasting, drilling, and handling the material mined. In Cornish mines the dust arises from working the hard stone (containing usually about 1 to 4 per cent. of "black tin" (binoxide of tin)), of which the lodes consist, and from the containing rock, consisting of granite or "killas." The extent to which different classes of miners are exposed to dust varies considerably, and its effects on the men doubtless depend largely on the hardness and other qualities of the rock.

The men working machine-drills, under present conditions, are greatly exposed to dust, as while the drill is at work, particularly on dry rock, a very large amount of fine dust is given off from holes bored horizontally or upwards, and this remains for some time in suspension in the air, so that the men in charge of the drill are constantly inhaling it. Anyone standing in an "end" or "rise" with a drill at work boring dry holes becomes quickly covered with dust, and the grit is quickly noticeable, even in the mouth. In the case of holes bored in a downward direction no dust is produced, as the men pour in water in order to clear the holes and to keep the point of the drill from heating and so becoming blunt sooner than would otherwise be the case. Estimations of the amount of dust present in the air of ends and rises with drills at work and boring dry holes were made by the method described in Appendix III., and showed that there is commonly as much as .5 milligrammes of stone dust per litre or 14 milligrammes per cubic foot in the air breathed by the men when boring a hole upwards. In a "rise" all the holes are bored upwards, but in the "end" of a level most of the holes are downwards. Since it is probable that during work a man would breathe at least half a cubic foot a minute, it is evident that the amount of dust inhaled must be considerable. It should be noted that the drills used in Cornwall are all on the percussion principle, and worked by compressed air. Percussion drills must not, of course, be confused with the rotary hand or electric drills, so extensively used in boring soft ground, for instance, in ironstone mining.

A very thick cloud of fine dust is also produced by blasting, especially with large charges of high explosives; and if a man returns before this has had time to subside, he may inhale a large amount of dust. The greater part of the dust will be arrested in the nose and air passages, but some must penetrate to the air cells of the lungs.

The men engaged in drilling by hand are much less exposed to dust than the rock-drill men. In Cornwall most of the work in driving ends or rises is now done by machine-drills, so that the proportion of men working in close places and drilling holes by hand in an upward direction is much less than in former times. In the stopes, which are mostly "underhand," the holes are usually drilled in a downward direction, and kept constantly wet with water. With "overhand" stoping, however, the holes cannot be drilled downwards. In moving and breaking up the

detached ore, a good deal of dust is produced. Dust is also thrown into the air in very large quantities at every blast when the rock is dry; and the men are apt to breathe a good deal on returning afterwards. The trammers are also exposed to dust at the ore-shoots, and in shovelling the ore from the ends. It is thus evident that in one way or another the ordinary men employed in getting the mineral and transporting it to the shaft are considerably exposed to dust.

The "pitmen" or men engaged in repairing the shafts, pumps, &c., and in setting timber, are very much less exposed to dust than the men already referred to. It must, however, be remembered that the men frequently change from stoping to rock-drill work or pit work, and *vice versa*.

INVESTIGATIONS AS TO THE DEATHS OF MINERS IN THE REDRUTH DISTRICT.

In order to investigate the influence on health of the different kinds of work just referred to and of work in mines abroad, we asked the Superintendent-Registrar (Mr. T. C. Peter) and Sub-Registrars for the Redruth District (comprising Camborne, Redruth, Illogan, Phillack, and Gwennap), and containing 4,102 out of the 6,059 men returned as at present employed in mining operations in Cornwall, to make personal enquiries as to the work on which each of the miners who had died within the district during the years 1900-01-02 had been employed since boyhood, together with the age and cause of death. The detailed results of the enquiries made by the Sub-Registrars for each sub-district are printed in Appendix II., and we are much indebted to those gentlemen (Messrs. J. C. Burrow, W. Phillips, T. Curnow, C. Hosking, and C. Bawden) for the thoroughness with which the work was carried out. The main results are shown in the following tables:—

TABLE 7.

Causes of Death among Men who at any time had worked machine-drills.

Cause of death.	Number.	Average age at death.
Lung diseases	133	} 37.2
Other causes	9	
Total	142	

Of these men 63 had worked in mines abroad only; 41 both in Cornwall and abroad; and only 38 in Cornwall only.

TABLE 8.

Causes of Death among Men who had never worked machine-drills.

Cause of death.	Number.	Average age at death.
Lung diseases	120	} 53.0
Other causes	59	
Total	179	

From these figures it is evident at once that the mortality from lung diseases among men working machine-drills, and therefore most exposed to dust, is enormously greater in proportion than among men not working machine-drills. The proportion of deaths from lung diseases to deaths

from other causes was 15 to 1 among the machinemen, whereas Tables 4, 5 and 6 show that on an average the proportion is almost exactly 1 to 1 between the ages of 20 and 45 among occupied males, and 5 to 1 among colliers. Assuming that, as shown by Tables 5 and 6 to have been the case among Cornish miners generally in 1890-92 and 1900-02, the mortality among machinemen from other causes than lung disease was about normal, *the death-rate among machinemen from respiratory diseases was about fifteen times and their total death-rate about eight times that for average occupied males in this country.* Or to make another comparison, *the death-rate among machinemen from respiratory diseases was about 30 times, and the total death-rate about 10 times as great as that among colliers or ironstone miners of the same age.*

In the case of men who had not worked machine-drills the deaths from lung diseases were almost exactly double the deaths from all other causes. At the average age at which these men died the proportion among occupied males in England and Wales in 1890-92 was about one death from respiratory diseases to 1.5 from all other causes. As the latter death-rate was about normal, as shown in Tables 5 and 6, it follows that *the proportion of deaths from lung diseases among Cornish miners who had not worked rock-drills was about three times the normal, and the total death-rate about 1.8 times the normal, at the age in question.* Table 15, given below, shows that the actual death-rate between the ages of about 45 and 65 corresponds closely to this estimate.

The following tables show the ages at which the deaths occurred, both for machine-drill men and ordinary miners; also the death-rate for miners in the Redruth District, including 15 deaths of mine labourers, &c., who had never worked underground, and excluding 13 deaths of men who had worked as miners (chiefly as rock-drill men), but whose deaths were registered under other occupations. The latter corrections were made in order to make the deaths correspond with the census return of occupations, and also to make the table comparable with those in the Decennial Supplements to the Registrar-General's Annual Reports.

TABLE 9.

Deaths of Men who had worked Machine-drills, Redruth District, 1900-02.

	Ages.							Total.
	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	Over 65.	
Lung diseases...	—	3	51	54	22	3	—	133
Accident ...	—	—	—	—	—	—	—	—
Other causes ...	—	2	4	1	2	—	—	9

TABLE 10.

Deaths of Miners employed underground, and who had not worked Machine-drills 1900-1902.

	Ages.								
	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65-75.	75-85.	Total.
Lung diseases	1	1	8	19	23	36	25	2	115
Accident	1	4	1	1	2	1	—	—	10
Other causes	1	2	1	6	10	15	13	5	53

TABLE 11.

*Deaths certified as of Miners and Mine Labourers of all kinds,
Redruth District, 1900-02.*

	Ages.								
	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65-75.	75-85.	Total.
Lung diseases	1	4	54	71	46	39	25	2	232
All other causes	2	8	6	10	15	18	16	8	83

TABLE 12.

*Annual Death-rates among Men returned as Miners and Mine Labourers
in Redruth District, 1900-02, per 1,000 living, calculated on Census
Return of Mining Population (Males), 1901.*

	Ages.						
	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65-75.
Lung diseases	0.4	2.25	18.6	33.8	35.5	44.4	65.6
All other causes	0.8	4.4	2.1	4.8	11.5	20.4	41.9
Total death-rate	1.15	6.65	20.7	38.6	47.0	64.8	107.6
Number of miners (1901)	841	591	948	700	433	293	127

TABLE 13.

*Annual Death-rate per 1,000 occupied Males, England and Wales,
1890-91-92.*

	Ages.					
	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.
Lung diseases	0.95	2.6	3.8	5.9	8.5	13.0
All other causes	1.6	2.5	3.4	6.5	12.2	23.7
Total	2.55	5.1	7.3	12.4	21.5	33.7

TABLE 14.

Annual Death-rate among Men returned as Miners in Cornwall outside Redruth District, per 1,000 living, 1900-1902.

	Ages.					
	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.
Lung diseases	1.3	3.4	16.0	33.7	29.2	41.1
All other causes	1.3	0.9	5.2	5.8	13.1	34.1
Total	2.6	4.3	21.2	39.5	42.3	75.2

TABLE 15.

Calculated Table of Deaths, apart from rock-drill work, Redruth District, 1900-02.

			Ages.							
			15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65-75.	
Deaths from ...	{	Lung diseases ...	...	1	3	12	21	27	36	25
		All other causes	...	2	8	6	10	15	18	16
Death-rates per 1,000 from	{	Lung diseases...	...	0.4	1.7	4.2	10.0	20.8	40.9	65.6
		Other causes ...	...	0.8	4.5	2.1	4.8	11.5	20.5	42.0
Total	1.15	6.2	6.3	14.8	32.3	61.4	107.6

It is evident at a glance that the great increase in the death-rate among Cornish miners for 1900-02 is chiefly due to deaths from lung disease of machine-drill men. In order, however, to see whether the increase is due solely to this influence, Table 15 has been constructed, showing the death-rate which would have existed if the proportion of deaths from lung disease to total deaths had been the same among the machine-drill men as for Cornish miners of the same ages in 1890-92. It will be seen that the death-rates thus obtained are slightly lower than those for Cornish miners in any previous decade, so that it seems probable that apart from the effects of rock-drill work in Cornwall and abroad, there has been, on the whole, some improvement in Cornish mines, as regards the health and safety of the men. The accident rate is now very low considering the nature of the work. The table shows that the increase in the death-rate for 1900-02 is due solely to the great mortality among the machinememen.

Out of the 142 deaths of rock-drill men, 120 were certified as from various forms of phthisis, or "miners' disease," and 13 from other respiratory diseases; whereas among the other miners, out of 178 deaths, 68 were ascribed to phthisis and 48 to bronchitis and other respiratory diseases. The difference in the proportions indicates clearly enough that the

disease which attacks the machine-drill men resembles ordinary tubercular phthisis much more closely on an average than does the more chronic affection which so frequently attacks the ordinary tin miner.

Of the rock-drill men the majority had worked rock-drills in other countries. The following table shows where the work had been done and the causes of death:—

TABLE 16.

—	Phthisis.	Other lung diseases.	All other causes.	Total.	Average age at death.
1. Cornwall only	27	7	4	38	37·5
2. Cornwall and Transvaal ...	25	—	3	28	36·4
3. Cornwall and India	3	—	—	3	37
4. Cornwall and America	1	—	—	1	32
5. Cornwall and West Africa ...	1	—	—	1	35
6. Cornwall, India, and Transvaal.	4	—	—	4	35·7
7. Cornwall, Transvaal, and America.	4	—	—	4	36·5
8. Transvaal only	46	2	1	49	36·3
9. America only	4	2	1	7	43·9
10. India only	2	—	—	2	41·5
11. America and Transvaal ...	4	—	—	4	39·7
12. Transvaal and Brazil	1	—	—	1	40
Total	122	11	9	142	—

It will be seen that 63, or nearly half, of the men who died had never worked machine-drills in Cornwall, while only 38, or little over a fourth, had worked in Cornwall only. The remaining 41 had worked partly in Cornwall and partly abroad. Of the 104 who had worked abroad 90 had been employed in the Transvaal. It would probably be unfair to attribute more than about 58, at most, of the deaths, or 50, allowing for the existence of an ordinary death-rate, to the effects of rock-drill work in Cornwall; but even when allowance is made for this there is evidently a considerable recent increase in the death-rate among miners working in Cornwall.

From information kindly supplied to us by the managers of all the Cornish mines in which rock-drills are used it appears that at present only about 320 men are employed in rock-drill work, and that their average age is about 29. 58 deaths in three years among 320 men would give an annual death-rate of 60 per 1,000, or about eight times the normal death-rate among occupied males of about the same age. As, however, men frequently change from work with rock-drills to other kinds of work, or come and go from abroad and *vice versa*, it is impossible to calculate accurately what is the actual death-rate among the men employed solely on rock-drill work in Cornwall. The matter is also complicated by the fact that many men go abroad after they have learnt to manage a rock-drill, and that the use of rock-drills has rapidly extended during the last

few years. A large number of the men have for these reasons only been employed for a very short time. On the other hand, an unusual proportion of men who have returned from the Transvaal have been employed in Cornish mines during the last four years, and this has doubtless increased the death-rate.

The following table shows the average duration of rock-drill work in the cases as to which information could be obtained, and where death was due to lung diseases:—

TABLE 17.

	Number of cases.	Average number of years of rock-drill employment.
Men who had worked in Cornwall only ...	17	8.4
Men who had worked in Transvaal only ...	47	4.7
Men who had worked in Cornwall and Transvaal.	18	11.6

These figures, combined with the fact that of men who had worked only in the Transvaal all but one died of lung disease, and that the age at which Cornish miners begin rock-drill work in the Transvaal is certainly greater than in Cornwall, confirm the general opinion among miners that the conditions under which rock-drill work has hitherto been carried out have been far more detrimental to health in Transvaal than in Cornish mines. From the reports for 1901 and 1902 of the Government Mining Engineer of the Transvaal, it appears that enquiries made by the Inspectors of Mines in the Johannesburg, Germiston and Krugersdorp districts showed that out of 1,377 machinemen employed before the war 225 were known to have died between October, 1899, and January, 1902. The annual death-rate thus appears to have been at least 73 per 1,000, even during a period when the great majority of the men were not actually employed in rock-drill work. Of the deaths in the Redruth District during 1900-02, 60 were returned as of "gold miners," or "retired gold miners," between the ages of 25 and 55. The table in Appendix I., showing the mining population, gives only 79 persons at these ages under the heading "Miners in other minerals or undefined," who would include all the "gold miners." These two figures are sufficiently significant.

NATURE AND CAUSE OF MINERS' PHTHISIS.

With regard to the nature of the lung disease from which Cornish miners suffer, we are, unfortunately, still to a large extent in the dark. In spite of many efforts it has not been possible to obtain permission for a post-mortem examination of the lungs of any of the numerous miners who have died during the course of the enquiry. The existing prejudice in Cornwall against post-mortem examinations, combined with the absence of any local hospital in which cases of miners' phthisis could be carefully observed, has seriously handicapped the efforts which have been made towards the prevention and treatment of lung disease among the miners.

Clinically speaking, the cases of lung disease present physical signs which vary between those of very chronic bronchitis and extremely acute phthisis or broncho-pneumonia. In most cases, however, there is far more marked shortness of breath than in ordinary bronchitis and phthisis. Shortness of breath appears to be almost always the first prominent symptom, and is frequently accompanied by palpitations or other signs

of circulatory disturbance. Usually there is also more or less wasting and other signs of impaired health. Consequently Cornish miners are frequently prematurely aged, and unfit for hard work at a period of life when men in other occupations are at their best. For this reason many men are unable to work underground after the age of 40 or 45, and seek some lighter employment above ground. The knowledge and experience which they have gained is thus lost, both to themselves and the community.

Where definite symptoms of bronchitis appear these may or may not be accompanied by signs of consolidation or cavity-formations in the lungs, or of pleurisy. Probably many of the cases described as "miners' phthisis," "miners' disease," or "miners' decline," or "fibroid phthisis," in Cornwall, would be classified under the heading of "bronchitis" in other parts of the country; and for this reason we have preferred to classify all the cases of lung disease together under one heading.

Cases of lung disease among machine-drill men are usually far more rapid and acute than among ordinary miners. Shortness of breath and wasting seem to be usually the first symptoms. Definite signs of consolidation in the lungs are often absent until the disease is well advanced, and a doctor unfamiliar with miners' phthisis would probably fail to recognise the gravity of such cases. In other cases, however, there are signs of consolidation, cavity formation, or pleurisy and pleuritic effusion as in ordinary phthisis; and it appears that the first signs of consolidation are commonly met with at the bases of the lungs instead of at the apices, as in ordinary tubercular phthisis. This has, at any rate, been the experience of Drs. Hichens and Permewan, of Redruth, and Drs. Telfer Thomas, and Tonking, of Camborne, who have had very large experience in connection with cases of phthisis among rock-drill men. Up to the end the most marked and distressing symptom is the shortness of breath; and cases of phthisis in rock-drill men can often be at once distinguished by the prominence of this symptom. Rise of temperature, though present, seems to be less marked than in ordinary phthisis.

The comparative suddenness with which the disease often begins to show itself in machine-drill men is somewhat surprising. A man who appears to be in the best of health may rapidly fall a victim; and in many cases men have suddenly developed the disease many months after retiring in apparently excellent health from rock-drill work in the Transvaal to some other occupation above ground at home. This relatively sudden onset seems to suggest strongly that, although dust inhalation is the great predisposing cause of the disease, yet tubercular, or possibly other infection, also plays an essential part. The sputa from a number of cases of miners' phthisis were examined during the last few months by Dr. Ritchie, Reader in Pathology in the University, Oxford, who is at present investigating (in connection with the work of the Home Office Departmental Committee on Factory Ventilation) lung diseases caused by inhalation of dust. The patients (comprising men who had worked abroad, as well as in Cornwall) from whom the sputa were obtained were nearly all examined by him and Dr. Haldane, in conjunction with the doctor in attendance, and we are much indebted to several of the doctors in Camborne and Redruth for their co-operation. The following is the report of his examination:—

"During February, March, and April, 1903, the cases of 23 miners, living at the time in Cornwall, were investigated. The men all lived in one district, and probably the group of cases included most of the miners suffering from very serious lung trouble at that time in the area examined. In every case the sputum was examined microscopically, in 14 out of the 23 with the result that tubercle bacilli were found. In 21 cases the microscopic examination was supplemented by the intraperitoneal inoculation of guinea-pigs with the sputum (the animals used were of the laboratory stock, among which no cases of spontaneous tuberculosis have occurred

during seven years). Out of the 21 animals inoculated 15 contracted tuberculosis, as was demonstrated by post-mortem examination. In the case of the two sputa not subjected to the inoculation test, bacilli were found microscopically, and we thus have, as the gross result of the investigation, that, out of the 23 cases, 17 were definitely shown to be tubercular. Further analysis of the cases shows that in 12 cases a history of the men having worked machine drills was obtained, and of these eight were tubercular. In six cases where the men had never worked such drills all were tubercular. Again, nine of the men examined had worked in the Transvaal, and of these six were tubercular; one of these six tubercular cases had not worked in any mine except in the Transvaal. An opportunity was afforded of examining most of the cases clinically. To speak generally, the signs in the lungs were pretty much those of phthisis as ordinarily seen; but perhaps on the whole there was a greater tendency than usual for the signs in the lungs to be basal in character, though this feature was not very marked. Sometimes great dyspnoea was present, with sucking in of the intercostal spaces during inspiration. In an extreme case of this condition, where the accompaniments present were only of the nature of general rhonchi without definite signs of consolidation, tubercle bacilli were, nevertheless, abundant in the sputum. Another clinical point which was especially to be noted in the Transvaal cases was that the men had come home from Africa and had continued in apparent health for, in some cases, several years, and then had comparatively suddenly manifested lung symptoms. The general conclusion to be drawn from the cases investigated is that probably at least two-thirds of the cases of lung trouble amongst these miners (including all the cases of so-called "miner's phthisis") are to be looked on as in reality of a tubercular nature. Whether there exist certain cases of a true non-tubercular fibroid phthisis, which may ultimately cause death by acute, or chronic, bronchitis is a question, but there is no doubt that in the majority of cases similar to those which were made the subject of the present examination death is due to tubercle. The history of certain cases might favour the idea that the vitality of the lung is lowered by a fibroid process on which a tubercular condition is superimposed. In favour of a further enquiry into the possibility of the existence of a non-tubercular condition is the fact that among the six cases where no evidence of tubercle was obtained were two, where a second unsuccessful inoculation experiment was performed with a sample of sputum obtained some weeks after that which gave the first negative result. The cases alluded to where extreme dyspnoea existed without any specially localised signs in the lungs emphasises the necessity for a thorough investigation of the sputum even in what appear to be the most typical examples of simple fibroid phthisis."

The results of these observations coincide with those of previous unpublished observations by Dr. Tonking, of Camborne, who informed us that he had frequently examined the sputum from cases of phthisis in miners, and had nearly always succeeded in finding tubercle bacilli when the disease was at an advanced stage, although sometimes repeated examinations of the sputum was needed in order to find the bacilli. In some early cases—too few to draw any certain conclusions from—none could be found.

As there is no hospital in Cornwall where cases of miner's phthisis are treated, so that all the affected men remain in their homes, it is evident that they must tend to spread tubercular infection in the community. To what extent there is evidence of such spread we have not enquired. The very low death rate from lung diseases among Cornish miners under the age of 25 seems, however, to exclude the idea that tubercular infection in the families of miners has been widespread hitherto.

Owing to the absence of post-mortem evidence we are unable to draw any conclusions as to the "fibroid" changes in the lungs in cases of phthisis, bronchitis, or "asthma" in Cornish miners; but we have little doubt that

these changes would be found to be similar in nature to what has already been observed in cases of lung disease produced by inhalation of stone-dust. We would refer in particular to the very thorough and careful report by Dr. Andrews on the lungs of two miners who had died from lung disease induced by inhaling ganister-dust.* In both these cases there was evidence of extensive fibroid change complicated by tubercle. The subject was recently discussed at the meeting of the British Medical Association, 1903, by Dr. Oliver, Professor Hamilton, and others. Dr. Oliver's conclusions are similar on the whole to our own, except that he attributes little importance to tubercle in connection with the disease. Professor Hamilton, on the other hand, lays stress on the tubercular complication in cases of lung disease among men exposed to inhalation of stone-dust. Some confusion has, we think, arisen through the attempt to bring under the one heading of "pneumokoniosis" the various forms of wasting disease and alterations in the lungs observed to be associated with the inhalation of dust of whatever kind. The changes always found in the lungs of colliers and ironstone miners for instance are very different from those present in the lungs of men suffering from the effects of inhaling stone-dust. The coal-dust and ironstone-dust appears to do very little harm, while the stone-dust from hard stone induces the wasting diseases so well-known among tin-miners, lead-miners, gold-miners, ganister-miners, stone-masons in certain districts, potters, &c.

So far as the Cornish miners are concerned it seems evident enough that the stone-dust which they inhale produces permanent injury of the lungs—gradually in the case of ordinary miners, and rapidly in the case of machine-drill men—and that this injury, while it is apparently capable of gradually producing by itself great impairment of the respiratory functions, and indirectly of the general health, also pre-disposes enormously to tuberculosis of the lungs, so that a large proportion of miners die from tubercular phthisis.

That the primary injury to the lungs is due solely to inhalation of stone-dust would seem to be practically certain. As already shown, the other causes to which the prevalence of lung disease among Cornish miners has been attributed do not explain the facts, while the stone-dust theory receives the strongest confirmation from the fact that the machine-drill men, who are far more exposed to stone-dust than any other class of miner, are also far more liable to lung disease. The stone-dust theory also receives the strongest support from what is known as to the prevalence of lung disease in other occupations where men are similarly exposed. Table 18 (*see* p. 22), compiled from Dr. Tatham's last decennial supplement to the Registrar-General's Annual Reports, shows the mortality in certain trades where a considerable number of the men are exposed to stone-dust: various kinds of hard stone-dust in the case of lead-miners and those classed as quarrymen (doubtless embracing stone-dressers); powdered flint in the case of potters; and grind-stone dust (containing also steel) in the case of grinders of steel implements.

It will be seen that in the case of tin and lead miners, cutlers, potters, and "quarry-men," who are all in various degrees exposed to stone-dust, the death-rate from respiratory diseases shows an undue rise after the age of about 35. As might be expected, however, the rise is much less marked in the case of quarry-men, who work usually in the open air, than in men who work underground or under cover. It is only in the case of rock-drill men that a great rise in the death-rate begins at the age of 25.

For purposes of comparison we have included in the table the statistics for occupied males generally, and for coal-miners, printers, and agricultural labourers. Coal-miners are probably far more exposed to the inhalation of coal-dust than are metalliferous miners to inhalation of stone-dust. Yet the coal-dust is relatively harmless. Various other kinds of dust,

* Annual Report of the Chief Inspector of Factories, 1900, p. 487.

TABLE 18.

Occupations.	Ages.											
	15-20.		20-25.		25-35.		35-45.		45-55.		55-65.	
	Lung diseases.	All other causes.	Lung diseases.	All other causes.	Lung diseases.	All other causes.	Lung diseases.	All other causes.	Lung diseases.	All other causes.	Lung diseases.	All other causes.
Occupied males	0.95	1.6	2.6	2.5	3.8	3.4	5.9	6.5	8.5	12.2	13.0	23.7
Tin-miners	1.3	1.7	3.7	4.3	3.9	4.2	9.5	4.8	23.0	10.2	40.7	25.4
Lead-miners	2.0	1.0	3.3	3.1	5.1	4.2	8.7	4.8	13.2	10.7	32.0	34.6
Cutlers, scissors makers, &c.	1.5	0.9	4.1	1.3	4.7	3.8	12.8	8.1	20.8	14.8	36.2	24.0
Potters	1.1	1.7	3.0	2.4	4.7	3.5	12.3	7.3	26.1	16.9	41.0	34.1
Quarry-men	1.1	2.3	1.8	3.8	4.0	3.4	7.6	6.9	12.7	12.6	23.2	28.4
Coal-miners	0.9	2.9	2.0	3.6	2.1	4.2	3.5	6.1	7.8	11.6	18.7	25.1
Printers	1.6	1.6	4.6	2.0	6.0	3.1	8.3	6.1	9.4	12.2	16.4	27.0
Farm labourers	0.5	1.2	1.9	2.0	2.5	2.7	3.7	4.6	4.8	8.0	7.6	14.0
Tin-miners (Cornwall, 1900-02).	0.5	1.0	2.6	3.7	10.5	2.9	23.2	4.9	29.6	10.1	42.8	26.0
All miners living in Cornwall (1900-02).	0.7	1.0	2.7	3.1	17.3	3.6	33.2	5.8	32.2	12.4	42.6	27.9
All miners living in Redruth District* (1900-02).	0.4	0.8	2.25	4.4	18.6	2.1	33.8	4.8	35.5	11.5	44.4	20.4

* Including gold miners, &c., who had worked abroad.

e.g., cement dust, &c., would seem to be equally so. Probably the special harmfulness of dust produced by the mechanical disintegration of hard stone or other hard material is due to the physical characters of the dust thus produced. Investigations on this point are being carried out at present by the Home Office Committee on Factory Ventilation. Printers are very little exposed to dust, but their occupation is sedentary, and they very commonly work in badly ventilated close rooms. It will be seen that their death-rate from lung disease is high between the ages of about 20 and 45, but not afterwards. This high death-rate is due solely to tubercular phthisis, and not to the gradual damage produced in the lungs by dust. Their death-rate from lung diseases other than phthisis is relatively low at all periods of life, and is thus in marked contrast with the corresponding death-rates after the age of 35 of men who are exposed to stone-dust inhalation.

Since the above was written we have received the very important report by the Commissioners appointed to enquire into Miners' Phthisis in the Transvaal. Their general conclusions with regard to the essential causes and the prevalence of miners' phthisis agree closely with our own. Their evidence shows that among Transvaal miners the disease is very common, but practically confined to rock-drill men; and they conclude that dust inhalation is the cause. They quote in full a most valuable report by the Committee of the Transvaal Medical Society on Miners' Phthisis. As this report is not very readily accessible, we reproduce from it the following specially important passages.

I. STATISTICAL.

The life histories of a large number of miners at present living on the Rand, or of miners who have died of chest disease within the knowledge of our informants, were obtained by the efforts of several members of the Committee. The results elicited may be stated thus:—

1. Miners' phthisis is not peculiar to machine miners, for, although it is most typically and commonly seen in them, it frequently develops also in course of time

amongst miners who have never used rock drills at all. Most cases of this sort, however, have been mining for long periods, *e.g.*, over 30 years, and it may be taken that the ordinary miner has a considerable advantage in length of life over the rock drill miner.

2. The disease undoubtedly falls most heavily on rock drill miners. Out of the living rock drill miners whose cases we have investigated, the majority of those who have been working rock drills for over five years were found to be suffering more or less from chest symptoms; the average time that those who were admittedly so affected had been employed on rock drill work was from seven to nine years (ranging from six to 15) out of a mining life of 18 years.

3. Of the rock drill miners who have died from chest disease the average age at death was under 35 years, and the average number of years which they had worked machines was seven to nine years.

4. The conclusions strongly suggested by the above results are that the use of rock drills over a prolonged period greatly increases and accelerates the incidence of chest disease amongst miners, and that the working efficiency of any rock drill miner, working under the present conditions, will on the average be impaired or even exhausted after seven to nine years' work.

This shows the serious and urgent nature of the question, as many of those men die in the prime of life often leaving widows and children behind them, few of whom are provided for. Thus out of 30 men with regard to whom this matter was particularly investigated 19 left widows with 48 children.

It is true that men may be found who have worked for 10 years or more with rock drills and whose health is not perceptibly impaired; on the other hand others have become affected under the average time. Probably in this respect a great deal depends on the class and type of mining engaged in, and its locality. "Wet" mines have a much better reputation than "dry" mines. The quartzite of the goldbearing beds of the Witwatersrand is admittedly very hard, and the mines are practically all "dry." There is also no doubt that persons who inherit chest weakness are more liable to be attacked by disease of this nature, but, while this fact may explain some individual variations, it does not explain the enormous incidence of chest disease on miners as a class. The same observation may be made with regard to personal habits of intemperance and mode of living.

5. All the statistical evidence goes to show that developing, *i.e.*, "raising" and "driving," is more dangerous to health than working in stopes. The most striking case in point which the statistics furnish is that of two brothers, who worked rock drills for four years only, doing nothing but "raising" all the time, and who died thereafter of chest disease at the age of 28 and 29 respectively.

II. CLINICAL.

Clinical investigation and examination show that the disease is an extremely insidious one, of very gradual development, having in its earlier stage little or no obvious effect on the general health, so that by the time the working efficiency of the miner becomes seriously impaired the disease is, as a rule, already well advanced.

1. The usual symptoms in a typical case are in the earlier stages recurrent and obstinate bronchial "colds," which may attract little attention, for the patient being for a long time quite able to work is apt to regard his earlier symptoms as of little moment.

Gradually as the disease progresses shortness of breath on exertion, cough and spit, a more frequent liability to contract colds and a greater difficulty in throwing them off, and sometimes flitting pleuritic pains, are the symptoms which usually first attract serious notice.

Gradual loss of weight and strength, and more urgent breathlessness, which may be of an asthmatic type, follow, as an increasing area of breathing space becomes disabled. Expectoration may or may not be a prominent symptom; haemoptysis is exceptional and when present is usually slight; night sweats are not as a rule noticeable, and pyrexia may be altogether absent throughout. Three of the characteristic signs of tubercular phthisis are thus frequently absent.

Finally towards the end the patient rapidly loses ground in all directions.

The most striking feature brought out by *physical examination* in a typical case is the diminished expansion of the chest, which in many cases is very striking, and is accompanied by rigidity of the chest wall, so that the breathing becomes mainly abdominal. The lungs are not, however, emphysematous in the sense that their area of resonance is increased; often indeed it is noticeably diminished. Hollowing of the supra-clavicular, suprascapular, and intercostal spaces, together with general emaciation, is noticeable in the more advanced cases.

Percussion and auscultation often give very indefinite results, owing no doubt to the diffuse nature of the disease. The dyspnoea seems frequently quite out of proportion to the evident organic changes. In the more advanced cases there is definite evidence of consolidation, and even in some cases of cavity formation, but in many, some impairment of percussion, here and there, perhaps more frequently at the bases than at the apices, with harsh, interrupted or bronchovesicular breathing, and sometimes crepitation and pleuritic friction are the most that can be made out. The disease is bilateral, but one lung is frequently affected to a greater degree than the other.

2. It is not common to find the typical physical signs of tubercular phthisis present, and this observation, together with the confirmatory fact, that, out of a series of over 30 sputa from cases of disease of the lung of miners examined by a member of your committee only two or three were found to contain tubercle bacilli, leads us to conclude that, while in some cases a true tubercular phthisis may co-exist or may be superadded, the conjunction is only seen in a minority of cases. Where tuberculosis does co-exist or become superadded the disease assumes more of the typical tubercular character with pyrexia, sweating, hectic symptoms, and the characteristic expectoration. The type becomes more of a "moist" one. The disease is primarily a local one, and is at first confined to the respiratory organs; secondary disorders of the heart, liver, stomach, and kidneys are late accompaniments. The heart is not as a rule dilated, but the pulse rate may be accelerated.

3. In the more chronic forms, seen perhaps more typically in the miners of many years' standing, who as a rule are not rock drill workers, chronic bronchitic and asthmatic symptoms are perhaps more prominent, and in them dilatation of the heart and accelerated pulse rate are more common.

We may therefore perhaps usefully distinguish from a clinical standpoint three types of "Miners' Phthisis."

1. The pure fibroid non-tubercular type, the commonest and most characteristic form of the disease.

2. The mixed fibroid and tubercular type, where the two processes co-exist.

The very chronic type seen in miners of many years' standing, where the fibroid change in the lungs, although more chronic is less extreme, and where secondary changes in the heart and kidneys are more prominent.

On certain subsidiary points the conclusions we have arrived at differ somewhat from those of the Transvaal Commissioners and Medical Society. Thus, in view of the undoubted presence of tubercle bacilli in the great majority of samples of sputum examined for us by Dr. Ritchie, and in view also of the clinical phenomena—particularly the marked wasting, and the frequent rapid onset of the disease in men not at the time exposed to dust, we are inclined to attribute great importance to tubercular (or possibly other bacterial) infection as an element in the disease. The fact that miners' phthisis usually differs in some respects from ordinary tubercular phthisis does not seem to us to exclude the hypothesis that the disease is due to tubercular infection of lungs previously injured by dust inhalation. On the other hand, it is possible that the cases observed in Cornwall differ greatly from most of those seen in the Transvaal.

The Transvaal Commissioners appear to incline to the view that gaseous impurities in the air play an important part in predisposing miners to miners' phthisis; and in an appendix to the report a number of analyses are quoted showing considerable quantities of carbonic oxide and other impurities in the general air of the mines, and in the air from the compressors. Except for a little carbonic oxide in the air of "ends" just after blasting, we have never obtained any similar results; and it can hardly be doubted that, as was, indeed, hinted by Mr. Pakes in his evidence before the Commission, very serious errors have crept into many of the air analyses quoted in the Transvaal report. For example, the six analyses of "normal mine air under ordinary working conditions" show an average excess of .08 per cent. of carbonic acid along with .133 per cent. of carbonic oxide, and .73 per cent. of hydrogen. Neither gases from explosives nor any other known source of impurity could produce air of this composition: moreover, the percentage of carbonic oxide is so high that work could not possibly be carried on in such an atmosphere. A similar criticism applies to the analyses of air from the compressors. The methods of analysis by which the results in question were obtained, are not stated. It cannot be too clearly understood that analyses of mine air, to be of any

real use, must be carried out by processes which are sufficiently accurate for the purpose in view, and that as a rule great accuracy is needed, so that the methods usually employed in technical gas-analysis are not applicable.

PREVENTION OF DUST-INHALATION.

The preceding portion of our investigation has led to the conclusion that the excessive mortality from lung disease among Cornish miners, and particularly among rock-drill men, is, practically speaking, entirely due to the breathing of air containing stone-dust in suspension. It remains to consider what measures are practicable for reducing to a minimum this source of danger.

Work with Machine-drills.—The most urgent problem is that presented by the very dangerous conditions under which the machine-men have hitherto been working. Even if all deaths fairly attributable to work abroad be left out of consideration, it appears, from the statistics for Redruth District, not only that the rate of mortality is very excessive among the comparatively small number of rock-drill men in Cornish mines, but that of the total excess of deaths among miners between the ages of 25 and 65 working in Cornwall, fully half of those attributable to the effects of work in Cornwall occur among rock-drill men, although the number employed on rock-drill work is less than a tenth of the total employed underground. These deaths are also nearly all among picked men in the prime of life, whereas in the case of other men employed underground the extra mortality is chiefly among much older men. We have, therefore, directed special attention to measures for dealing with the unhealthy conditions under which machine-drill men work.

As already remarked, the machine-drill men are specially exposed to dust in two ways—firstly, during the drilling of holes in an upward direction, where no water can be poured into the holes; and secondly, in returning to the working face after blasting before the air has cleared of dust. In Cornish mines, where development work is not usually carried out under great pressure, the men, as a rule, allow considerable time to elapse before returning after blasting, so that the air in ends and rises has sufficient time to become fairly clear of dust and noxious gases. In the Transvaal mines this precaution seems to have been commonly neglected; and the ill-effects produced in both white men and Kaffirs by rock-drill work in these mines are probably due, in considerable measure, to the custom of returning at once after blasting. There is little doubt that it is during the actual drilling of dry holes that the rock-drill men in Cornwall inhale most of the dust which injures their lungs.

One method of endeavouring to prevent the inhalation of this dust is by the use of respirators, designed to filter off the dust. Some of the rock-drill men use sponges for this purpose, and we have also examined other kinds of respirators. The protection thus afforded is, however, very imperfect. Air containing dust commonly leaks in round the edges of a respirator, particularly after the filtering material has become wet from moisture condensed from the expired air. It is common enough to find that after the whole of the filtering opening has been plugged with wax or clay respiration is practically as easy as before. Respirators are also hot and uncomfortable, particularly when the air is as warm as is very commonly the case in ends and rises. The space inside the respirator is filled with expired air at the end of each respiration, and as this expired air contains about six per cent. of carbonic acid it necessitates increased depth of respiration. Inconvenience also arises from men not being able to communicate with one another when respirators are worn. It is thus difficult to persuade or compel men to use them regularly.

They can thus hardly be regarded as more than a very partial preventive against dust-inhalation, unless great care is taken in their use. A respirator ought, however, to be used whenever, in case of need, a miner has to go temporarily into a dusty atmosphere.

Increased ventilation is also a remedy which must be considered. An air-current, such as appears to be quite impracticable in ends and rises, would, however, be needed to dilute the dust to a sufficient extent; and it has been shown above that even quarrymen employed in dressing stone or slate in the open air appear to be liable to some extent to lung disease caused by stone-dust. Stone-masons working in open sheds are also liable.

We made a number of experiments as to the practicability of surrounding the mouth of the hole by a wetted canvas bag, through an opening in which the drill passes, the bag itself being fixed to a metal ring pressed by means of an adjustable rod against the rock round the hole, and luted round with clay. We found that this arrangement was very effective in stopping dust. It did not, however, appear to be practicable, as it was often impossible to fix the ring securely, particularly when the surface was very irregular, and the rock crumbly.

A completely effective remedy for the dust produced by rock-drills is, however, afforded by a jet or spray of water passing into the hole. When machine-drills first came into use water-jets were used in connection with each drill. Both Mr. Doering and Colonel Beaumont, who were largely instrumental in introducing rock-drills, insisted on the importance of using a jet, although at that time the disastrous effects on the men of the dust produced in dry boring were not realised.* The jets employed seem, however, to have caused considerable inconvenience from the amount of water used, although the cooling effect of the water saved the cutting edge of the boring tool, and so increased the rate of boring. In any case jets for many years have fallen completely out of use in Cornwall with ordinary machine drills.

We have carried out a number of experiments with water-jets and sprays, and find that only a small quantity of water is needed in order

* The following statement by Mr. W. Negus gives a very clear description of the rock-drill as first used in Cornish mines. The method employed for producing a jet of water is of special interest :—

The boring machine was first introduced into the Tincroft Mine in the year 1865 by Mr. Doering and drove 20 fathoms in an end at the 180-fathom level Martin's East Shaft. A small air compressor was driven by a belt from a portable engine (such as used to work thrashing machines), the pressure of air being 18 lbs. per square inch and the boring machine working at 80 strokes per minute. The explosives used were gun cotton and dynamite, a galvanic battery being used to blast with.

Two years later the boring machine was first introduced into the Dolcoath Mine, and was employed to drive at the 238- and 266-fathom levels West of Old Sump and at the 238-fathom level East of New East. The air-pressure was now 50 lbs. per square inch, and the boring machine worked at 250 strokes per minute. The explosive used was chiefly gun cotton.

At that time the boring machine was on an upright bar, the bar being fixed to a four-wheel carriage. When the machine was at work the wheels of the carriage were blocked, and wedges were driven between the top of the bar and the roof.

Attached to the carriage were two cisterns, containing about four gallons each. One cistern was used to receive the water, which then passed into the other; this cistern was connected to the main air-pipe by a half-inch pipe in order to admit air pressure. Connected to the cistern was a half-inch hose, which could be attached to the cradle of the boring machine, so that it would be in line with the machine and drill, and would allow a small jet of water to be injected into the hole while drilling.

At that time they used to drill only four or five holes at a time; the carriage and machine were then run back and the holes blasted, consequently fewer holes were required then than now to drill the end over.

JOHN NEGUS.

to completely prevent the issue of dust capable of floating in the air. With a small jet a certain amount of steam is formed, owing to the heat produced in drilling through hard rock. This steam may at first be mistaken for fine dust, but on aspirating the air through a plug of cotton-wool, it will be found that no visible deposit of dust can be obtained, whereas without the water-jet the surface of the plug is rapidly stained if the hole is in dry and hard rock. When the hole becomes deep the water ceases to reach the cutting edge of the boring tool, but continues to effectually stop the dust by converting it into a thin mud nearer the mouth of the hole.

In drilling a hole "bits" of diminishing diameter are used as the hole increases in depth. If a fine jet of water is directed up the hole as far as possible, it not infrequently happens, particularly in soft rock, that a ring of somewhat tenacious mud is formed in the hole two or three feet up. Although this does not impede the working of the drill, it leads to difficulty and delay in removing the bit, as the expanded cutting edge catches in the ring. For this reason we have found that in soft ground it is preferable to use a spray, which does not carry water more than a short distance into the hole; or if a jet is used to direct it obliquely. By these means the hole is only kept wet for a few inches in, but the passage of fine dust into the air is effectually prevented, although a little of the coarse dust may fall outwards in a more or less dry state.

For producing a jet a nozzle with an opening of about one-twentieth of an inch in diameter is amply sufficient; and a spray with an opening of about the same diameter, answers well. The water can be taken from an iron pipe carried into the end or rise from the pumping shaft, or any other available source of supply. Sometimes, however, a water-pipe would entail undue expense, and to meet such cases we adopted the following arrangement (see figures 1 and 3):—A steel cylinder, holding about 12 gallons, is placed at some convenient position out of the way of blasting, but not far from the drill. This cylinder, as shown in figures 1 and 3, has three openings, of which one is for filling with water, one for connection with the compressed air-pipe, and one for carrying water to the jet or spray. On closing the filling tap and opening the compressed air tap the water is driven through the hose to the jet. The pressure is that of the compressed air (about 60 or 70 lbs. per square inch), and will suffice to drive the water to a point 15 or 20 fathoms above the cylinder if the drill is in a rise. To obviate the risk of the cylinders bursting, or being injured by rough usage, they were stoutly made and tested to a pressure of 600 lbs. per square inch.

The water used for filling the cylinder must be clean, and may be obtained from any available point, and conveyed to a large vessel beside the cylinder. The cylinder can then be filled from this vessel before the commencement of work. One filling usually lasts for a whole shift in a "rise."

To obviate inconvenience from the jet or spray becoming accidentally blocked, it is advisable to have a filter of fine copper gauze inside the nozzle.

The spray-nozzle which we have employed is of a kind in common use for garden syringes, &c., and is so arranged that a rotary movement is imparted to the water before it issues through the opening of the nozzle. What would otherwise be a plain jet is by this device converted into a spray. The pattern used was the nozzle supplied with the "Mackenzie Spray Disinfectant,"* but slightly modified so as to diminish the scattering of the water.

* This is an appliance designed by Dr. Leslie Mackenzie for rapidly spraying with a disinfectant solution the inside of a room.

The spray can be conveniently used for wetting the surface of the rock in a warm end or rise. By this means the temperature is sensibly reduced, as the dry air issuing from the drill causes rapid evaporation, and consequent cooling of the rock.

The sprays and jet just described have now been in use, attached to water-pipes, where these were available, and to steel cylinders elsewhere, for several months in Dolcoath Mine. They were at first willingly used by the men, but after a time objections were raised on account of the splashing of water and mud from the holes, and great difficulty has been met with in inducing the men to use them. The same difficulty has been met with at East-Pool Mine.

After practical trials had been made of them for some weeks at Dolcoath, the managers, or other representatives, from all the Cornish mines were invited to see them in action in July last, and afterwards to discuss the whole subject. Representatives from nearly all the mines attended, and there was an animated discussion, at the end of which it was moved by Mr. Richards, Manager of East-Pool Mine, seconded by Mr. Nancarrow, Carn Brea and Tincroft Mines, and carried unanimously, "that we undertake to further, to the best of our ability, the introduction into Cornish mines, as soon as possible, of water-jets or other means for the prevention of dust in rock-drilling."

After careful consideration of the subject we are strongly of opinion that the use of percussion rock-drills in hard stone without water-jets or other efficient means of stopping the dust from being given off should be prohibited in all underground workings, whether in metalliferous mines or coal-mines. The facts adduced above show that the need for such a provision is urgent, and we would point out that it is very difficult for the management of any single mine to insist upon the use of proper precautions, as the men who object may at once obtain employment at another mine where similar precautions are not insisted upon. We have no doubt, however, that the great majority of the miners would strongly support legislative interference in the direction we have indicated, and we believe that the objections raised by miners on account of the splashing of water from the drills would be overcome at once if boring dry holes were made definitely illegal.

Besides the dust raised in drilling dry holes we have given careful consideration to that produced by blasting. The firing of a shot anywhere in a mine produces a great cloud of dust unless the substance of the rock is thoroughly wet. In ends or rises, or other confined spaces, the air just after a blast is so loaded with fine dust that it is impossible to see a candle a foot away. If this air is breathed for a few moments the nostrils become loaded with dust. As the dust in many Cornish mines has a characteristic red colour, the smoke after a blast is also red by reflected light; and this has sometimes been mistaken for nitrous fumes. It takes a considerable time (about half an hour or more) for the dust from a blast to subside; and as a rule the men arrange for their shots to be fired at such times that they do not require to return till after the dust has more or less subsided, and the gases have been greatly diluted.

In some cases, however, it is necessary to return as soon as possible, in order to fire other holes; and it is, therefore, important to have some means of rapidly clearing an "end" or "rise" from the dust and gases formed by a blast. One method of doing this is to withdraw the dust by means of a ventilating pipe and jet of compressed air in the manner described in Appendix 3. This plan, however, has the disadvantage that the dust is discharged into the air-current, which may be breathed by men beyond. Besides this the air-pipe cannot be carried into the end itself, as it would be injured by the blast.

We find that the following plan, devised by Mr. William James, Underground Agent at Dolcoath, is very effective in quickly laying the

dust and diluting the gases. At the mouth of the level a piece of 6-inch iron-pipe, or a small cylinder, provided with a side tap, is let into the ordinary 2-inch iron-pipe for carrying the compressed air for the drill. (Fig. 5.) Before the blast this is filled with water through the side tap from a cistern after the compressed air has been turned off. Immediately after the blast the compressed air is suddenly turned full on. The water is thus driven along the pipe with great velocity, and a mixture of finely divided water and air is discharged from the open end, which is directed towards the face which has just been blasted. By this means the dust is entirely cleared from the last thirty or forty feet back from the blast, the air leaving quite clear immediately after. If a ventilating pipe is carried forward about as far as the compressed air-pipe, any dust which has been driven out beyond the reach of the jet can be rapidly carried off. This plan has the great merit that it implies scarcely any trouble, and no extra apparatus except the piece of 6-inch pipe and tap for filling it. The rock blasted is also thoroughly wetted, so that no dust is produced in shovelling it. The water partially washes out from the air any nitrous fumes which may be present, but, of course, not carbonic oxide; and for this reason, if no other, a ventilating pipe (*see* Appendix 3) is desirable in cases where the level or rise has been driven more than a few fathoms beyond the air-current.

In levels and rises dust is not merely produced by rock-drilling and blasting, but also in moving the ore, if the latter be dry. We would, therefore, point out the desirability of wetting any dry material before it is handled. Where water jets are used it is easy to keep the ore damp.

Work on Stopes.—Although men working on the stopes, or driving by hand, are not so much exposed to dust as rock-drillers, yet as shown above, they do suffer very considerably, after the age of about 40, from the effects of dust, which is chiefly produced by blasting and by shovelling dry ore or stone. It seems to be impossible to prevent the dust formed in blasting—particularly with high explosives—from spreading in the air of a stope. By good ventilation, however, and by so arranging the times for shot firing that the men can remain in pure air until the dust has cleared away, much can be done to prevent the inhalation of this dust; and we would emphasise the importance of taking all available means to prevent the dust being inhaled.

The dust produced in shovelling the ore, and at ore-shoots, &c., can be avoided by keeping the ore damp. If, however, the air of the mine is dry, it is very difficult to keep the ore and stone constantly damp. This brings us to a point on which there is apt to be some difference of opinion, but which we think it is of great importance to discuss fully. If the ventilation of a deep metalliferous mine is very ample, the air usually carries off moisture from the stopes very rapidly, with the result that everything is dry, and dust is produced. This is a natural result of the fact that the temperature is higher in the workings below ground than on the surface, or in the downcast shaft, so that air, even though it is saturated with moisture on the surface or in the downcast shaft, will take up a great deal of moisture in passing through the workings; air saturated at 60° Fahrenheit is, for instance, capable of taking up twice as much moisture when raised to 80° Fahrenheit. Thus, the good effect produced by the air current carrying off the impurities in the air may be more than neutralised by the bad effect due to drying, and a consequent greater tendency to dust formation. If the air is saturated it is also somewhat misty, as is the case to a much more marked extent in an upcast shaft, where, owing to expansion and consequent cooling, mist is formed. The mistiness is, however, no measure at all of the impurity of air. Any air, however pure, is apt to become misty as it rises upwards in the stopes and winzes of a metalliferous mine; and such air may be in reality far more wholesome than dry air which, owing to its drying effect in the workings, becomes charged with dust during every mining operation. As a matter of fact the formation of mist in the air seems to greatly

aid the deposition of particles present. Of the easily applied tests for finely divided particulate matter in air by far the most delicate is the one afforded by the "aerokonoscope," an instrument recently devised by Mr. John Aitken, F.R.S. On testing the warm and misty air in the upcast shafts at Dolcoath with the aerokonoscope we found that it gave no indication whatever of the presence of particulate impurities, although the air outside gave abundant indications, the weather at the time being stormy, and the air probably charged with fine spray from the sea, which was only a few miles distant. It would thus seem that the air had actually been purified from particulate matter by passing through the mine.

A further point of importance is the drainage of the stopes. If the drainage is too complete the stopes will, except in the bottom levels, be dry, and dust-formation will thus be favoured. We think that in arranging the drainage regard should be had to the great importance of preventing dust-formation on the stopes by keeping them wet. Where other means of keeping the stopes moist fail, a hose may be used to advantage.

The report of the Transvaal Medical Society Committee contains the following recommendation in italics:—"*Dry mining should, as far as possible, be converted into wet mining.*" With this we concur, as regards metalliferous mining in hard rock, though we are well aware that precautions against ankylostomiasis are doubly necessary in the case of wet mining. It is probable, for instance, that ankylostomiasis would have been very prevalent in the Transvaal mines had they been wet instead of dry.

We think it very desirable that at every metalliferous mine special rules suited to the circumstances of the mine should be established for the prevention of dust inhalation.

In arranging the ventilation of a metalliferous mine, it is, we think, of great importance to endeavour to obtain all the good effect of ventilation in carrying off dust and other impurities without at the same time drying up the workings, and so favouring the formation of dust. With this object in view it seems desirable, as far as possible, to so arrange the ventilation that a plentiful supply of fresh air is carried straight to the bottom levels, where it becomes warmed and saturated with moisture, and afterwards rises upwards through the workings without taking up much, if any, further moisture. To secure this object the downcast shaft or shafts must be isolated from the workings, and doors or curtains provided at the levels where necessary. Arrangements should also be made, in connection with winzes, &c., for distributing the air where it is most needed to keep down the temperature and carry off dust from blasting, &c., without exposing men working higher up to dusty air. In any particular mine it may be quite impossible to arrange for an ideal system of ventilation; but as a rule a great deal may be done by keeping in mind the main objects and principles of ventilation, and particularly the desirability of so utilising it as to reduce to a minimum the temperature and the inhalation of dust by the men. Other impurities than dust are, as shown in Appendix III., of comparatively trifling importance, except in confined spaces. It is, however, of great importance from the economic standpoint to keep the temperature of the workings from rising to an uncomfortable extent. A man cannot, and in any case will not, do a full day's work in air which is both very warm and very moist; and, where possible, temperatures above 75° or 80° Fahrenheit should not be exceeded. The conditions on which the high temperature met with in some mines depends, and the standards of air-supply required to keep down the temperature to a reasonable extent, are discussed in Appendix III. The same Appendix contains a discussion of the ventilation of ends and rises. We have not included these discussions in the text of our report, because, important though they are from the economic standpoint, we scarcely consider them to be of primary importance in relation to the unsatisfactory health conditions in Cornish mines.

PREVENTION OF ANKYLOSTOMIASIS.

As the presence of ankylostomiasis in Dolcoath and other mines in the Camborne district has been dealt with in a special report by Dr. Haldane, we do not propose to add much here as to this disease,* excepting with regard to practical recommendations. There is no evidence that ankylostomiasis has appreciably raised the death-rate among Cornish miners, though it has prevailed, unrecognised, for some eight years in the Camborne district. On the other hand it has caused considerable loss, inconvenience, and hardship to both miners and mining companies; and this report would be incomplete without some reference to it.

The number of men infected with the *Ankylostoma duodenale* is probably about as great at the present date as was the case a year ago, although the men who are visibly affected in health by the worm can now be effectually treated, and so far as we know no bad cases are left, even the very chronic cases known to exist a year ago having been cured. Continuous efforts have been made at Dolcoath by the management, by providing sanitary buckets for use underground,† by posting notices, and in other ways, to prevent the pollution of the mines by fæces. Unfortunately these efforts have met with only partial success. Some of the miners still continue to pollute the mine; and as a consequence of their dirty habits, several fresh cases of anaemia have been observed lately. It is very difficult for the management of individual mines to deal effectively with such cases, and we think that the time has now come for dealing with the matter by legislation or special rules, applicable to metalliferous mines. We also think that it should be made illegal to employ underground any miner who has evident symptoms of ankylostomiasis, unless he undergoes treatment, or is found to be free of the disease.

We are well aware that the recommendations which we have made above, with a view to the prevention of dust, will, if carried out, render metalliferous mines still more favourable than they have been to the propagation of ankylostomiasis. Of the two evils, however, dust is by far the more serious; and there seems to be no reason whatever why the pollution of the ground, which is the cause of ankylostomiasis, should not be dealt with as successfully as has been the case with other dangers to miners.

As so many Cornish miners have died, and are dying, from the effects of work in the Transvaal mines, it seems scarcely out of place for us to call renewed attention to the report of the Transvaal Miners' Phthisis Commission, and to urge here the importance of dealing drastically and without delay with the dangerous conditions which have hitherto prevailed in these mines.

In conclusion we venture to express our conviction that there is no reason why work underground, in whatever kind of mine, should not be a perfectly healthy employment; the work itself is thoroughly wholesome both to body and mind, and the special dangers, whether to health or to life and limb, associated with different varieties of mining, are such as, if recognised and faced, can be avoided, provided that both employers and employed will co-operate in bringing this end about.

SUMMARY.

1. The death-rate among miners living in Cornwall, which has always been very high in the case of men over about 40, has very greatly increased during the last few years among men of from 25 to 45.

* Further information on Ankylostomiasis in Cornish mines is contained in Dr. Boycott's recent Report to the Home Secretary on the Diagnosis of Ankylostoma Infection, and in two papers by Drs. Boycott and Haldane in the Journal of Hygiene, Vol. III., p. 95, and Vol. IV., p. 73.

† Fig. 6 showed the galvanised iron pails which are in use at Dolcoath.

2. The excessive death-rate is shown by the statistics to be due entirely to phthisis and other lung diseases.

3. The recent increase in the death-rate is also shown to be due to the deaths of men who have worked rock-drills. The great majority of these deaths are attributable to the effects of rock-drill work in the Transvaal or elsewhere abroad; but a considerable number are attributable to work in Cornwall.

4. Nearly the whole of the deaths of rock-drill men were due to "phthisis," and of the cases examined at least 74 per cent. were tubercular.

5. The predisposing cause of the present excessive mortality among metalliferous miners from lung diseases is evidently the inhalation of stone-dust.

6. The dust is produced in the drilling of dry holes by rock-drills, in blasting, in handling the ore, and in other ways.

7. The dust produced by rock-drills can easily be prevented by even a very small water jet. The dust from blasting in close ends can be laid by a powerful jet of water and air; and can in any case be avoided by the men. The inhalation of dust produced in blasting on the stopes can also be to a large extent avoided; while the dust produced in handling the ore can be mostly prevented by keeping the workings damp.

RECOMMENDATIONS.

1. That the use of percussion rock-drills in hard stone without satisfactory precautions for preventing the dust being inhaled by the men be prohibited in all mines.

2. That Special Rules be established under the Metalliferous Mines Regulation Act by the management of every metalliferous mine, subject to the approval of the Secretary of State, for the carrying on of the work in such a manner as to reduce to a minimum the inhalation of dust by the various classes of men employed in the mine.

3. That Special Rules be also established under the same Act, rendering it obligatory on the part of owners of metalliferous mines to provide and maintain in a suitable and cleanly condition a reasonable number of sanitary receptacles for the use of the men in case of necessity underground, and also on the surface; and rendering it a contravention of the Act to unnecessarily pollute any part of a mine with human faeces.

We wish to record our very cordial thanks for the help which we have received on all hands during the course of the enquiry. From the management of all the Cornish mines which we visited or communicated with, and of Lumpsey and Eston ironstone mines, we have received every possible assistance. To the Directors of Dolcoath we are specially indebted for the liberality with which they have placed the resources of the mine at our disposal in connection with various experiments; and we owe much to members of the staff who have cordially co-operated, especially to Mr. W. James and to Mr. H. V. Thomas, Surveyor. Mr. A. L. Stevenson and Mr. Donald Bain helped us greatly in connection with our visits to ironstone mines. We are also much indebted to the medical men, and to the Superintendent Registrar and Sub-Registrars, of the Cambourne and Redruth districts.

The invaluable statistics contained in Appendix I. were prepared under the direction of Dr. Tatham and Mr. Waters, of the General Register Office, who have spared no trouble in obtaining information for our guidance. To Dr. Ritchie, Reader in Pathology at Oxford, and Mr. P. J. Kirkby, New College, Oxford, we owe two valuable contributions, which are embodied respectively in our Report and in Appendix III.

We are,

Sir,

Your obedient Servants,

J. S. HALDANE.

JOSEPH S. MARTIN.

R. ARTHUR THOMAS.

To the Right Honourable A. Akers-Douglas, M.P.

APPENDIX No. 1.

STATISTICS FURNISHED BY THE REGISTRAR-GENERAL FOR THE
PURPOSES OF THE ENQUIRY.

The Miners whose mortality is shown in the accompanying table were classified as follows in the Census Report :—

Occupation.	Total, 15 years and upwards.	Ages.						
		15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65 and upwards.
Ironstone miner	24	3	3	6	5	5	1	1
Copper miner	120	10	9	29	19	16	13	18
Tin miner	6,333	1,288	914	1,467	1,122	711	499	332
Lead miner	38	1	1	4	2	5	9	16
Miner in other minerals (and undefined).*	615	36	40	131	161	101	83	63
Mine—owner, agent, manager ...	94	1	1	8	16	22	19	27
Other mine service	59	13	11	12	8	6	4	5

* Includes gold, silver, arsenic, etc., miners, who were not tabulated separately.

Mortality of Miners (including retired) in the Registration County of Cornwall in the
three years 1900-02.

Cause of Death.	Total, 15 years and upwards.	Ages.						
		15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65 and upwards.
Phthisis	334	2	6	80	114	66	43	23
Other Respiratory Diseases ...	143	1	2	6	19	18	38	59*
Accident	17	2	5	4	2	3	1	—
All other causes	256	2	4	14	21	29	52	134
TOTAL (All causes) ...	750	7	17	104	156	116	134	216
Years of Life (Census Population \times 3).	21,849	4,056	2,937	4,971	3,999	2,598	1,902	1,386
Mean annual death-rate per 1,000.	34.3	1.7	5.8	20.9	39.0	44.6	70.5	155.8

* This includes one case of Miners' Bronchitis, age 66.

MEMORANDUM.

Mine Engineers were classified partly among "Civil Engineers" and partly among "Engine Drivers" in the Census Report: their number cannot therefore be ascertained and their deaths have accordingly been excluded from the Mortality Table.

Gold Miners were not separately classified in the Census Report, but were merged in the heading "Miners in other Minerals." They are included in both Tables, but cannot be shown separately.

General Register Office,
Somerset House,
London, W.C.

Mortality of Tin Miners in the Registration County of Cornwall in the three years 1900-02.

Cause of Death.	Total, 15 years and upwards.	Ages.						
		15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65 and upwards.
Pulmonary Tuberculosis ...	30	—	2	6	10	8	3	1
Phthisis	123	1	3	26	31	27	21	14
Miners' phthisis	23	—	—	7	7	5	3	1
Miners' disease, miners' decline	8	—	—	1	6	—	—	1
Hæmoptysis	5	—	—	—	—	2	1	2
Fibroid phthisis, fibroid disease of lung, cirrhosis of lung.	30	—	—	3	12	6	8	1
Bronchitis	66	—	—	2	3	8	20	33
Pneumonia	19	1	2	1	2	5	4	4
Pleurisy	4	—	—	—	—	1	1	2
Emphysema, asthma	8	—	—	—	2	1	3	2
Other diseases of lungs	6	—	—	—	5	—	—	1
Principal epidemic diseases ...	3	2	—	1	—	—	—	—
Influenza	4	—	—	—	1	—	3	—
Erysipelas	2	—	—	—	—	1	—	1
Rheumatism, rheumatic arthritis	8	—	2	—	1	1	—	4
Malignant disease	16	—	—	—	2	3	6	5
Diabetes	2	—	—	—	—	1	—	1
Diseases of nervous system ...	8	—	—	—	3	1	1	3
Diseases of heart	54	—	—	5	3	5	11	30
Apoplexy, hemiplegia	16	—	—	—	—	3	7	6
Liver diseases	4	—	—	—	1	—	1	2
Other diseases, digestive system	6	—	—	—	1	1	2	2
Bright's disease	11	—	—	—	—	2	5	4
Disease of bladder or prostate, calculus.	9	—	—	1	1	—	1	6
Old age	29	—	—	—	—	—	—	29
Other diseases	8	—	2	2	1	1	1	1
Accidents :—								
Stated to be in mines ...	10	1	3	2	2	2	—	—
Other accidents	6	1	2	2	—	1	—	—
Suicides	1	—	—	—	—	—	1	—
TOTAL (All causes)...	519	6	16	59	94	85	100	156
Years of life at risk (Census population of 1901 × 3).	18,999	3,861	2,742	4,401	3,366	2,133	1,497	996
Annual rates of mortality per 1,000.	27.32	1.55	5.84	13.41	27.93	39.85	68.80	156.63

Redruth Registration District.

Occupations.	Ages, 10 years and upwards.										
	Total.	10-14.	14-15.	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65-75.	75 and upwards.
Tin miners	3,769	27	99	821	573	898	653	377	239	72	10
" " (retired)	105	—	—	—	—	6	6	15	25	33	20
Copper miners	12	—	—	3	—	1	3	2	—	3	—
" " (retired)	10	—	—	—	—	—	—	1	4	3	2
Miners in other minerals, or un- defined.	79	—	—	2	6	27	23	15	3	3	—
" " " (retired)	36	—	—	1	1	2	4	8	15	1	6
Mine-owner, agent, manager ...	25	—	—	1	1	4	4	7	8	—	—
" " " (retired)	17	—	—	—	—	—	2	3	—	8	4
Other mine service	46	—	1	13	10	10	5	5	1	1	—
" " " (retired)	3	—	—	—	—	—	—	—	—	3	—
TOTAL	3,931	27	100	840	590	940	688	406	251	79	10
	171	—	—	1	1	8	12	27	42	48	32
TOTAL (including retired)	4,102	27	100	841	591	948	700	433	293	127	42

Camborne Registration Sub-District.

Occupations.	Ages, 10 years and upwards.										
	Total.	10-14.	14-15.	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65-75.	75 and upwards.
Tin miners	1,629	11	44	355	238	395	296	158	90	30	3
" " (retired)	41	—	—	—	—	2	2	9	9	12	7
Copper miners	1	—	—	—	—	1	—	—	—	—	—
" " (retired)	1	—	—	—	—	—	—	—	—	—	1
Miners in other minerals, or un- defined.	22	—	—	1	—	6	9	6	—	—	—
" " " (retired)	11	—	—	1	1	—	1	1	3	—	4
Mine-owner, agent, manager ...	9	—	—	1	—	2	2	1	3	—	—
" " " (retired)	9	—	—	—	—	—	1	1	—	4	3
Other mine service	44	—	1	12	10	9	5	5	1	1	—
" " " (retired)	3	—	—	—	—	—	—	—	—	3	—
TOTAL	1,705	11	45	369	248	413	312	170	103	31	3
	65	—	—	1	1	2	4	11	12	19	15
TOTAL (including retired)	1,770	11	45	370	249	415	316	181	115	50	18

NOTE.—Mine-labourers are included with tin-miners.

APPENDIX

APPENDIX No. II.

RESULTS of ENQUIRIES by the SUB-REGISTRARS of REDRUTH DISTRICT into
the PREVIOUS HISTORY of the MINERS who DIED within the DISTRICT during the
YEARS 1900, 1901, and 1902.

APPENDIX

RESULTS of ENQUIRIES by the SUB-REGISTRARS of REDRUTH DISTRICT into
the YEARS 1900,I.—*Camborne Sub-District*

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
1	36	Phthisis pulmonalis	Tin miner	Cooks Kitchen, 3 years Dolcoath, 12 years American mines, 2 years
2	66	Chronic bronchitis	Tin miner	Cooks Kitchen, 40 years West Seton, 3 years Tolcarn, 2 years
3	24	Pneumonia	Tin miner	Dolcoath, 3 years South Africa, 9 months Dolcoath, short time
4	60	Fibroid phthisis, asphyxia ...	Tin miner	South Francis, some years Basset Mine, some years
5	43	Miners' phthisis, asphyxia ...	Tin miner	Dolcoath, 4 years Dolcoath, 6 years
6	21	Phthisis	Tin miner	Wheal Grenville, 3 years
7	47	Influenza, broncho-pneumonia	Gold miner	Dolcoath, short time Lake Superior, some years Colorado, 10 years Utah, 2 years
8	52	Pneumonia	Mine labourer ...	—
9	58	Phthisis	Mine carpenter, formerly a miner.	Wheal Venture, some years St. Ives Consols, 2 years Nova Scotia, 2 years Wheal Sisters, 2 years
10	46	Miners' phthisis	Tin miner	Wheal Grenville, short time Dolcoath, 26 years
11	54	Apoplexy 15 months	Tin miner	Tincroft, some years Dolcoath, 12 years
12	40	Miners' phthisis, tuberculosis...	Gold miner	Wheal Johnny, some years Cooks Kitchen, 3 years Dolcoath, 2 years South Africa, 8 years Brazil, some years
13	30	Heart disease	Tin miner	South Crofty, 9 years Wheal Agar, 3 years Dolcoath, 1 year New Shaft, 1 year
14	35	Acute pulmonary tuberculosis	Tin miner	Wheal Agar, 5 years Dolcoath, 6 years South Africa, 6 years Dolcoath, short time
15	38	Miners' disease, cardiac failure	Tin miner	East Pool, 7 years Mysore, 6 years South Africa, 2 years South Africa, 2 years Dolcoath, 6 months

No. II.

the PREVIOUS HISTORY of the MINERS who DIED within the DISTRICT during 1901, and 1902

(Mr. J. C. Burrow, Sub-Registrar).

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes	Yes	No	No	No	—	Drank a little.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Tributer	No	No	No	Mine "dry" keeper for 3 years.	Moderate drinker.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	No	No	No	Mine labourer up to 20 years of age. Caught cold; home one week and died.	Moderate drinker.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No	Home some years working on a bit of ground.	Moderate drinker.
Yes	Yes	No	No	No		
No	No	No	Assistant with boring machines.		Tin dresser before he went with boring machines underground.	Drank freely up to last 4 years.
No	No	No	Yes	Yes		
Trammer 2½ years.			Yes for last 6 months of his life.	Yes for last 6 months of his life.	Worked on tin streams until about 19 years old.	Total abstainer.
Yes	Yes	No	No	No	Did no mining for 12 years before he died. Kept public house during that time.	Moderate drinker.
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
Never worked underground.						
Yes	Yes	No	No	No	For the last 17 years a mine carpenter.	Total abstainer.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	No	No	No	—	Moderate drinker.
Yes	Yes	No	No	No		
No	No	No	Yes	Yes	After Dolcoath worked a horse and cart with a boy as guide.	
Blinded in Dolcoath by a hole going off about him.						
Yes	Yes	No	No	No	Worked boring machines abroad nearly all the time. Had fever in Africa.	Moderate drinker.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
Yes	Yes	No	Yes	Yes 3 years.	Sold fish last 3 months of his life.	Moderate drinker.
No	No	No	Yes	Yes		
Yes	Yes	No	Part of the time.	Yes		
Yes	Yes	—	Yes	Yes	Boring machines almost all the time.	Drank whisky freely.
—	—	—	Yes	Yes		
Yes	Yes	—	—	—		
Yes	Yes	No	Yes	Yes	Worked boring machines for 20 years. Wore respirator when rising with machines in East Pool.	Moderate drinker. Spat up much black stuff before he died.
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
16	42	Acute congestion of lungs, hæmoptysis.	Tin miner ...	Wheal Grenville, some years... Formerly South Condurrow ...
17	37	Miners' disease ...	Gold miner ...	Dolcoath very young, and worked there many years. South Africa, 6 years ...
18	52	Phthisis, left lung ...	Tin miner ...	West Basset, 3 years ... Dolcoath, 2 years ... Lakes, America, 6 years ... West Francis, 12 years ...
19	54	Mitral cardiac disease ...	Tin stream foreman	—
20	82	Inflammation of lungs, 3 days	Tin miner ...	Wheal Alfred, many years ... Stray Parks, many years ... Cooks Kitchen, many years ...
21	51	Fibroid phthisis, hæmoptysis...	Silver miner ...	Dolcoath, some years ... California, 10½ years ... Pittsburg, U.S., 6 years ... Butte, 10 years ...
22	56	Phthisis pulmonalis ...	Tin miner ...	Wheal Grenville, 30 years ... Dolcoath, 5 years ... South Condurrow, short time ... Basset, short time ...
23	20	Accidentally killed through falling from a skip.	Tin miner ...	—
24	38	Phthisis ...	Gold miner ...	Tincroft, 3 years ... Mysore, 3 years... South Africa, 3½ years ... South Africa, 6 months ... South Africa, 1½ years ...
25	70	Cardiac disease ...	Tin miner ...	West Seton, many years ... Dolcoath, 26 years ...
26	34	Miners' phthisis, asphyxia ...	Gold miner ...	Tincroft, 5 years ... Colorado, 4 years ... South Africa, 5 years ... Home, 1 year ... South Africa, 6 months ...
27	35	Fibroid phthisis, hæmoptysis...	Tin miner ...	Cooks Kitchen ... } Dolcoath ... } 15 years { Tregartha Downs South Africa, 3 years ...
28	36	Pulmonary phthisis, 2 years ...	Tin miner ...	Dolcoath, 11 years ...
29	72	Chronic mitral valve disease, cardiac failure.	Gold miner ...	West Wheal, Seton, some years ... Peru, Chili, some years ... Australia, 19 years ... California, 3 years ... Mexico, 4 years...
30	35	Fibroid phthisis, asthenia ...	Gold miner ...	Michigan, some years... South Africa, 5 years ...
31	65	Heart disease ...	Formerly tin miner, tin dresser.	North Pool, 6 years ... West Basset, 4 years ... Carn Brea, 2 years ...
32	34	Injuries accidentally received by a fall of ground at North Roskear Mine.	Tin miner ...	—

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes	Yes	No	No	No	No	Moderate drinker.
Yes	Yes	No	No	No	No	
Yes	Yes	Sometimes	Yes	Yes	No	Never complained of work in Dolcoath, but considered African work very inferior. (Abstainer at home; drank a little in Africa).
—	—	—	Yes All the	Yes time.		
Yes	No	—	—	—	Blacksmith up to a young man. America as a copper miner. Last 6 years coal carrier.	Total abstainer.
—	—	No	No	No		
Yes	Yes	Pitman	—	—		
Sinking shaft.		—	—	—		
Never worked underground.						
Yes	Yes	Yes	No	No	Worked for 6 years on a farm.	Heavy drinker; often over the bay.
No	No	Yes	No	No		
No	No	Yes	No	No		
Yes	Yes	No	No	No	Some time as tin dresser before he went underground.	Moderate drinker.
Yes	Yes	—	No	No		
Yes	Yes	—	No	No		
—	—	—	Yes	Yes		
Yes	Yes	No	No	No	For the last 10 years of his life he worked a mine engine at Wheal Grenville.	Moderate drinker.
Yes	Yes	No	No	No		
Tributer		—	—	—		
Tributer		—	—	—		
—	—	—	—	—	—	Coroner's certificate.
Yes	Yes	No	Yes	Yes	Boring machines all the time except for 2 years; ceased work 1 year and died.	Moderate drinker.
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
Yes	Yes	No	No	No	Always a miner. Home 3 years before he died.	Very moderate drinker.
No	No	Yes	No	No		
Yes	Yes	No	No	No	—	Moderate drinker.
Yes	Yes	No	No	No		
—	—	—	Yes	Yes		
—	—	—	—	—		
—	—	—	Did no work, too ill.			
Yes	Short time	—	Yes	Yes	Ceased work 9 months before he died.	Moderate drinker.
—	—	—	Yes	Yes		
—	—	—	Yes	Yes		
—	—	—	Yes	Yes		
Yes	Yes	No	No	No	Worked on tin streams some years, also as mine surface labourer.	Moderate drinker.
			Tried boring machines for a short time only.			
—	—	—	—	—		
Yes	Yes	No	No	No	Did not work for the last 12 years.	Very moderate drinker
Yes	Yes	—	No	No		
Gold Mine	diggings. engine driver.					
No	No	No	Yes	Yes	Dolcoath tin yard before he went to America.	Very moderate. Home 3½ years and died.
No	No	No	Yes	Yes		
Yes	Yes	No	No	No	Hurt at Carn Brea, and worked as tin dresser for 25 years.	Moderate drinker formerly, latterly total abstainer.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
—	—	—	—	—	—	Coroner's certificate.

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
33	29	Fibroid disease of lungs, tubercular disease of lungs.	Tin miner ...	Dolcoath ... } about 14 years { Wheal Basset ... } South Africa, 2 years ... Dolcoath, some months ...
34	48	Epilepsy 30 years ...	Tin miner ...	Worked underground for a short time only.
35	32	Miners' decline ...	Gold miner ...	Dolcoath, some years ... Cooks Kitchen, 9 years ... South Africa, 18 months ...
36	28	Sacro iliac disease, lardaceous disease.	Tin miner ...	East Pool, 2 years ... Dolcoath, 2 years ... Dolcoath, 4 years ...
37	58	Phthisis pulmonalis ...	Formerly miner, latterly insurance agent.	South Tregolls, some years ... California, 3 years ...
38	18	Scarlet fever ...	Tin miner ...	Dolcoath, 3 years ...
39	30	Miners' phthisis ...	Tin miner ...	Dolcoath, 8 years ... East Pool, 1 year ...
40	37	Miners' phthisis ...	Tin miner ...	East Pool, 2 years ... South Crofty, 10 years ... South Africa, 2½ years ...
41	61	Angina pectoris, syncope ...	Retired miner ...	West Seton, 10 years ... Cooks Kitchen, 17 years ... Home, 14 years ...
42	36	Fibroid phthisis, pulmonary tuberculosis.	Tin miner ...	Dolcoath, 6 years ... South Crofty, 4 years ... East Pool, 2 years ...
43	55	Phthisis pulmonalis ...	Tin miner ...	Condurrow, many years ... Newton, some years ...
44	30	Fibroid phthisis, pulmonary tuberculosis.	Fruit-dealer, formerly a miner.	Dolcoath, about 4 years ...
45	51	Miners' phthisis ...	Tin miner ...	West Francis, some years ... South Condurrow, 5 years ... Wheal Grenville, 18 years ...
46	56	Failure of heart, dropsy ...	Tin miner ...	Newton, some years ... Lakes, U.S., 16 years ... South Condurrow, 8 years ... King Edward Mine, 3 years ...
47	34	Phthisis ...	Gold miner ...	Tincroft, some years ... Cooks Kitchen, 14 years ... Mysore, India, 3½ years ...
48	74	Mitral regurgitation, cardiac dropsy.	Tin miner ...	Breage Mines, some years ... Basset Mines, some years ... Wheal Grenville, 5 years ...
49	30	Fibroid phthisis, asphyxia ...	Gold miner ...	Tincroft, as a boy ... Dolcoath, 8 years ... South Africa, 5 years ... Six months interval home between the 5 years.

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
No No No —	No No No —	No No No —	Yes Yes Yes —	Yes Yes Yes —	A short time as assistant to wall masons.	Very moderate drinker.
Stopping	No	No	No	No	—	—
Yes No No	Yes No No	No No No	Yes For short time. Yes Yes	Yes Yes Yes	Home from Africa 10 months and died.	Moderate drinker.
Yes Yes No	Yes Yes No	No No No	No No Yes	No No Yes	Ceased work 2 years before he died, and nearly 1 year of that spent in the hospital.	Moderate drinker.
Yes Yes	Yes Yes	No No	No No	No No	Over 20 years as an insur- ance agent.	Drank moderately.
Yes	Yes	No	No	No	For a short time worked on the tin streams.	—
No Yes	No Yes	No No	Yes No	Yes No	Worked 1 year as farm labourer. Home 4 months and died.	Moderate drinker.
Yes No Yes	Yes No Yes	No No No	No Yes No	No Yes No	Home 14 months before he died. His wife says he spat up his lungs.	Moderate drinker.
Sinking — —	Driving — —	— Pitman —	No No —	No No —	Carpenter up to 20 years of age. Retired.	This man's son, a miner, says, from his obser- vation, rock drill stopping is not very injurious; he worked a boring machine for 18 months, stopping, without ill effect.
Yes No No	Yes No No	No No No	Yes Yes Yes	Yes Yes Yes	6 years a soldier before he went underground.	Moderate drinker.
Yes Yes	Yes Yes	No No	No No	No No	Last 2 years worked as a farmer.	Moderate drinker.
Yes	Yes	No	No	No	Reared in a flour mill up to 16 years of age.	General labourer. Moderate drinker.
Yes Yes Yes	Yes Yes Yes	No No No	No No No	No No No	Ceased to work 2 years before he died.	Very moderate drinker.
Yes Yes Yes	Yes Yes Yes	No No No	No No No	No No No	Hurt lifting a rock in South Condurrow.	Total abstainer.
Yes	As mining instructor.					
Yes Yes —	Yes Yes —	No Pitman —	No Little while with machines. Yes, for 6 months.	No No No	Afterwards surface agent	Very temperate man.
Yes Yes Yes	Yes Yes Yes	No No No	No No No	No No No	Did no work for last 15 years.	Moderate drinker for- merly, abstainer laterly.
—	—	—	Assistant with bor- ing machines. Boring machines Driving Little and rising. stopping.	No	No	Informant thinks miners returning to their work so soon after the blast in Africa is one of the worst features. He has proved it. Drank very little alcoholic drink.

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
50	32	Miners' complaint	Greengrocer, formerly gold miner.	Dolcoath, some years Mysore, 3 years Montana, 6 years South Africa, 4 years
51	38	Phthisis pulmonalis	Gold miner	South Condurrow, 15 years Montana, 5 years Nevada, 2 years
52	58	Bronchitis, asphyxia	Tin miner	South Condurrow, some years
53	48	Phthisis pulmonalis	Tin miner	Cooks Kitchen, some years Central America, 3½ years South Africa, 2 years Dolcoath, some years
54	54	Phthisis	Tin miner	Tolcarne, some years Carn Camborne, some years Dolcoath, many years
55	52	Pernicious anæmia, syncope	Tin miner	West Seton, 15 years South Condurrow, 10 years
56	71	Miners' decline	Tin miner	Carn Brea, some years West Seton, some years
57	57	Malignant stricture of cardiac end of stomach, exhaustion.	Tin miner	Condurrow, some years Newton, 3 years Dolcoath, 30 years
58	58	Phthisis pulmonalis	Tin miner, gold miner.	Condurrow, some years Durham Coal Mines, 15 years Montana, 2 years Tolcarne, 2 years South Africa, 5 years
59	36	Miners' fibroid disease, pleurisy	Gold miner	Newton, 3 years Montana, 11 years South Africa, 3 years
60	39	Tubes dorsalis 1 year, influenza 4 days.	Mine labourer	Dolcoath, 7 years underground
61	46	Sarcoma (Ilii?)	Formerly tin miner, tin dresser.	Wheal Johnny, 9 years Dolcoath, some years
62	29	Phthisis	Tin miner	Dolcoath, some years Dolcoath again, 5 years
63	65	General decay, gastritis 3 days	Retired gold miner	Dolcoath, 4 years Lake Superior British Columbia California Cariboo, 2 years } 29 years
64	35	Phthisis pulmonalis 2 years	Gold miner	South Crofty, 7 years Mysore, India, 3 years South Africa, 10 years
65	48	Killed by and explosion in Dolcoath mine.	Tin miner	—
66	56	Natural causes	Retired miner	—
67	45	Phthisis, morbus cordis	Tin miner	West Seton, 1 year Lake Superior, 2 years Dolcoath, 18 years

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes	Yes	No	Yes	Yes	Sold fruit and vegetables for 2 years before he died.	Total abstainer.
Yes	Yes	No	Yes	Yes		
Yes	Yes	No	No	No		
No	No	No	Yes	Yes		
Yes	Yes	No	No	No	No	Total abstainer, attributes his illness to boring machines.
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
Yes	Yes	No	No	No	Worked on tin streams for some years. Did no work for 16 years before he died.	Abstainer.
—	—	—	—	—	General labourer for short time before his death	Moderate drinker.
No	No	Shaftman	Yes	Yes		
Yes	Yes		Yes	Yes		
—	—	—	—	—		
Yes	Yes	No	No	No	Did no work for 8 years before he died.	Total abstainer.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	Yes	No	No	Ill for 8 years, then died. Remainder of his time as a mine labourer.	Drank very little, and smoked less.
Yes	Yes	Yes	No	No		
Yes	Yes	No	No	No	For the last 25 years worked as a cobbler.	Very moderate drinker.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No	Home from Dolcoath about 4 weeks and died.	Very moderate drinker.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No	Hurt his back in Africa, and did no work for 2 years before he died.	Total abstainer.
As a collier	Yes	No	No	No		
Yes	Yes	No	No	No		
—	—	—	Yes, short time			
—	Foreman of black	labour.				
Yes	No	No	No	No	Ceased work 1 year before he died.	Very moderate drinker.
—	—	—	Yes	Yes		
—	—	—	Yes	Yes		
Tributer	Yes	No	No	No	Labourer before he went as miner; 12 years on surface after.	Moderate drinker.
Yes	Yes	No	No	No	For 12 years as a tin dresser.	Total abstainer.
Yes	Yes	No	No	No		
Yes	Yes	No	Yes latterly.	Yes	Worked in a dynamite works for 3 years.	Moderate drinker.
No	No	No	Yes	Yes		
Yes	Yes	No	No	No	Did no work for last 15 years.	Very moderate drinker.
Yes	Yes	—	No	No		
—	Mining contractor	—	—	—		
No	No	No	Boring machines.	Yes	—	Always with boring machines. Moderate drinker.
No	No	No	Boring machines.	Yes		
No	No	No	Boring machines.	Yes		
—	—	—	—	—	—	Coroner's certificate.
—	—	—	—	—	—	Coroner's certificate.
Yes	Yes	No	No	No	Blacksmith up to 24 years of age. Never worked boring machines.	Drank freely.
Yes	Yes	No	No	No		
Yes	Yes	Yes	No	No		

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
68	40	Phthisis pulmonary	Tin miner	Wheal Grenville, 10 years South Condurrow, 10 years America, 1 year
69	46	Phthisis pulmonary	Tin miner	Newton, some years Mysore, India, 2 years
70	69	Chronic pulmonary tuber- culosis.	Retired mine agent	North Roskear, years Mexico, 20 years Home, retired for 20 years
71	32	Phthisis pulmonary, cardiac failure.	Tin miner	Dolcoath, 6 years Dolcoath, 10 years
72	50	Pulmonary phthisis, cardiac failure.	Tin miner	West Francis, short time Dolcoath, 12 years
73	40	Phthisis pulmonalis 12 months	Tin miner	Carn Brea, 14 years South Africa, 2 years Home, 1 year South Africa, 2 years
74	50	Fibroid miners' phthisis ...	Tin miner	Tincroft, 15 years North America, 6 months
75	35	Pulmonary phthisis	Tin miner	Dolcoath, 12 years West Coast Africa, 9 months... .. Dolcoath, 4 years
76	40	Carcinoma of liver	Tin miner	Dolcoath, 15 years
77	76	Natural decay	Tin miner	Dolcoath, from 8 years old Dolcoath, nearly 60 years
78	57	Fibroid phthisis about 8 months	Tin miner	Tincroft, about 35 years Another mine in his youth
79	41	Cirrhosis of lung	Tin miner	Wheal Grenville, 2 years Dolcoath, 5 years Began underground work when about 23 years of age.
80	60	Pulmonary tuberculosis ...	Tin miner	Dolcoath, years... .. Carn Camborne, years West Wheal Seton, years
81	46	Pulmonary tuberculosis ...	Tin miner	Great Breage Work, 4 years Crenver, 2 years Tincroft, 6 years Cooks Kitchen, 11 years Newton, 4 years
82	43	Fibroid phthisis	Tin miner	West Basset Tincroft Carn Brea Dolcoath, 7 years Mysore, 3 years... ..
83	33	Heart disease, 3 months bron- chitis.	Tin miner	Dolcoath, 15 years South Africa, 4 years West Africa, out and back only

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes Yes Yes	No No Yes	No No —	No — Boring for 6	No — machines months.	Short time as mine labourer.	Moderate drinker.
Yes —	Yes —	— —	Yes For short time. Yes	Yes Yes	Ceased work about 12 months before he died.	Total abstainer.
— Yes —	— Yes —	— No —	— No —	— — —	Ten years mine agent; afterwards farming in Mexico.	
Yes No	Yes No	No No	No Yes	No Yes	Tin floors first 2 years, last 6 months in a foundry. Then brought up blood and died.	Very moderate drinker.
Yes Yes	Yes Yes	No No	No No	No No	The run at the 412 fathom level, Dolcoath, gave him a great shock. He assisted in recovering the bodies.	Fairly free drinker.
Little — —	No — —	No — —	Yes Yes Yes	Yes Yes Yes	Home from Africa 2 years, unable to work, and died.	Very moderate drinker.
No Yes	No Yes	No No	Yes No	Yes No	Worked on tin streams to 33 years of age; Dolcoath surface 1 year.	Free drinker.
No No No	No No No	— — —	Boring machines. Boring machines. Boring machines.	Yes Yes Yes	—	Sinking for some years with machines. Always worked boring machines. Drank moderately.
Yes	Yes	No	No	No	Tin dresser up to 25 years of age.	Total abstainer.
Yes Tributer	Yes sometimes.	No —	No —	No —	Stamps watcher. Home 2 years before he died.	Total abstainer. Sterling character.
— Yes	— Yes	— No	— No	— No	Always a miner, but never worked boring machines. Home 2 years and died.	Moderate drinker.
Yes Yes	Yes Yes	No No	No No	No No	Last 10 years of life mine labourer on surface.	Total abstainer.
Over 40 years hand mining.	! ! !	— No —	No No —	No No —	Last 2 years garden labourer.	Drank very little.
Yes Yes — Yes Yes	Tributer Tributer — No No	No No — No No	No No — No No	No No — No No	Did nothing the last 4 years of his life.	Newton being cold and damp is said to have caused his death. Moderate drinker.
Yes	Yes	No	No	No	Home 4 years ill, and died	Total abstainer at home. Abroad (!)
Yes No	Yes No	No No	No Yes	No Yes		
No No No	No No No	Shaftman part of time.	Yes Yes —	Yes Yes —	—	Was suffering from miners' complaint. Moderate drinker.

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
84	68	Acute bronchitis, cardiac failure.	Tin miner ...	West Francis, some years ... South Condurrow, 3 years ...
85	81	Bronchitis 2 months ...	Tin miner ...	West Francis, many years ...
86	33	Acute phthisis 2 months ...	Tin miner ...	West Seton, 3 years ... South Crofty, 3½ years ... Central America, 3 years ... South Africa, 6 months ... Dolcoath, 1 year ...
87	35	Gastric ulcer, asthenia ...	Tin miner ...	Dolcoath, some years ...
88	46	Accidentally killed by skip striking him in the back.	Tin miner timberman	—
89	30	Phthisis 10 months ...	Tin miner ...	Dolcoath, 14 years ... Newton, 1 year ...
90	20	Acute rheumatism, pericarditis	Tin miner ...	Dolcoath, 5 years ...
91	40	Miners' fibroid phthisis ...	Tin miner ...	Newton, some years ... Mexico, 5 years ... South Africa, 3 years ...
92	45	Miners' phthisis ...	Tin miner ...	Tincroft, 17 years ... South Africa, 18 months ... Home, 17 months ... Italy, 4 months ...
93	46	Miners' fibroid phthisis, asphyxia.	Tin miner ...	Dolcoath, some years ... Peru, 3 years ... California, 8 years ... South Africa, 1½ years ... South Africa, 4 years ...
94	65	Acute bronchitis, asphyxia ...	Tin miner ...	South Francis, some years ... Tolcarn, some years ... South Condurrow, some years ...
95	60	Acute bronchitis, asphyxia ...	Tin streamer	Never worked underground ...
96	69	Bronchitis 3 weeks ...	Tin miner ...	Dolcoath, 40 years ... South Crofty, 2 years ...
97	35	Miners' phthisis, asphyxia ...	Tin miner ...	Dolcoath, 4 years ... North America, 7 years ... South Africa, 6 years ...
98	60	Fibroid phthisis of lungs, exhaustion.	Tin miner ...	Crenver, some years ... South Crofty, some years ... East Pool, some years ... Dolcoath, 10 years ... Carn Brea, 2 years ...
99	37	Pulmonary tuberculosis, exhaustion.	Tin miner ...	Wheal Grenville, 3 years ... Newton, 4 years ... Dolcoath, 12 years ...

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes	Yes	No	No	No	For last 25 years on surface at West Wheal Francis, and Dolcoath.	In sample house dust was very plentiful, and he inhaled it.
Yes	Yes	No	No	No	Was injured 7 times. Farmed for more than 25 years.	Moderate drinker.
Yes	Yes	—	—	—	—	Had typhoid fever in Africa. Moderate drinker.
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
No	No	No	Yes	Yes		
Yes	Yes	No	No	No	For the last 4 years sold fish. A fish hawker.	Total abstainer.
—	—	—	—	—	—	Coroner's certificate
Yes	Yes	No	Yes	Yes	Worked on tin streams before he went underground.	Moderate drinker
Yes	Yes	No	No	No	No other employment ...	Drank very little.
Yes	Yes	No	No	No	For 2 years before he died carted about ginger-beer.	Moderate drinker. Narrow chested; never ought to have been a miner.
Yes	Yes	No	No	No		
No	No	No	Yes	Yes	Lived 7 months after his return from Italy. Managed 2 boring machines in South Africa.	Moderate drinker.
—	—	—	Yes	Yes		
—	Too ill to work in	Italy.	—	—		
Yes	Yes	No	No	No	Ill 12 months and died ...	Total abstainer.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
No	No	No	Yes	Yes		
No	No	Yes	No	No		
Yes	—	Yes	No	No	Did not work for several years, then looked after the "dry" for 2 years.	Moderate drinker.
—	—	Nearly all his time.	—	—		
Yes	—	Yes	No	No		
—	—	—	—	—	—	
Yes	Yes	No	No	No	For last 12 years worked on surface at Dolcoath. Home 3 weeks and died.	Very moderate drinker.
Yes	Yes	No	No	No		
Hand mining some years.	Yes	No	—	—	—	Home for 6 months between the 6 years in Africa. When rising inhaled much dust. Drank freely.
	Yes	No	5 years Boring machines, mostly rising.	Yes		
Yes	Yes	No	No	No	Carried coal for 4 years, and finished at Carn Brea.	Moderate drinker.
—	—	—	—	—		
Yes	Yes	No	No	No		
Sinking	—	Shaftman	No	No		
Yes	Yes	No	No	No	Lifted a ladder down in Dolcoath and broke a blood vessel.	Very moderate drinker.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
100	43	Chronic atrophy of liver, ascites asthenia.	Gold miner ...	Dolcoath, some years ... Pachuca, 3 times ...
101	36	Fibroid phthisis of lungs ...	Tin miner ...	Dolcoath, some years ... South Africa, 3 years ... Lake Superior, 1 year ...
102	49	Phthisis pulmonalis, exhaustion.	Gold miner ...	West Stray Parks, some years ... Wheal Grenville, 5 years ... Nevada, 4 years ... California, 4 years ... Mexico, 2 years ... South Africa, 6 years ...
103	72	Chronic cardiac disease, broncho-pneumonia.	Retired mine agent	As a boy 3 years in Wheal Trenoweth Carn Brea, 10 years ... Polcrebo, some years ... West Francis ... Condurrow ...
104	41	Miners' phthisis, asphyxia ...	Gold miner ...	Tincroft, some years ... Dolcoath, 2 years ... South Africa, 10 years ...
105	48	Miners' fibroid phthisis, cardiac dilatation.	Tin miner ...	Tincroft, some years ... South Crofty, 4 years ... Wheal Grenville, 11 years ...
106	51	Pneumonia 11 days ...	Tin miner ...	—
107	56	Acute pneumonia 9 days ...	Tin miner ...	South Crofty, 5 years ... West Seton, 15 years or more ... Dolcoath, 15 years ...
108	66	Phthisis ...	Tin miner ...	South Condurrow, many years ... North Roskear, 6 years ... Gilly Mine, many years ... South Crofty, 20 years ...
109	60	Bronchitis 14 days, heart failure	Tin miner ...	Dolcoath, many years ... West Seton ...
110	46	Phthisis pulmonalis, exhaustion.	Tin miner ...	West Grenville, 10 years ... South Condurrow, 5 years ... West Francis, 2 years ...
111	62	Heart disease ...	Retired mine agent	North Crofty, some years ... West Condurrow, some years ... Cooks Kitchen, 25 years ...
112	57	Bronchitis, heart failure ...	Retired mine agent	St. Day Mines, first ... Dolcoath, some years ... California, 7 or 8 years ... Mysore, India ...
113	44	Pyloric carcinoma, asthenia ...	Gold miner ...	Dolcoath, 5 years ... Lake Superior, 5 years ... Dolcoath, 3 years ... Mysore, 4 years ... Mysore, 6 years ...

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
No Yes	No Yes	Yes No	No No	No No	Home 9 months from Mexico and died. Al- ways very yellow com- plexion.	Moderate drinker.
No No Yes	No No Yes	No No No	Yes Yes No	Yes Yes No	Not well when he went to America. Home 1½ years and died.	Very moderate drinker.
Yes Yes Yes Yes Yes No	Yes Yes Yes Yes Yes No	Yes No No No No No	No No No No No Yes	No No No No No Yes	Home 5 years and died ...	Total abstainer.
No Yes — Yes —	Yes Yes — Yes —	No Sometimes in close First pit- man, then agent.	No No — — —	No No — — —	—	Plenty of powder smoke, and long distances from shaft to dry, encouraging colds, and no advantages as at present.
Yes No No	Yes No No	No No No	Yes Yes Yes	Yes Yes Yes	Did no work for 2½ years before he died.	Moderate drinker.
Yes Yes —	Yes Yes —	No No Shaftman	No No No	No No No	No	Moderate drinker.
—	—	—	—	—	—	All relatives left the town.
Yes Yes Yes	Yes Yes Yes	Tributer Tributer Tributer	No No No	No No No	No other employment ...	Moderate drinker. Caught cold in the shaft.
Yes No No Yes	Yes No No Yes	No Yes Yes No	No No No No	No No No No	Last 5 years as farmer's help.	Free drinker.
Yes Yes	Yes Yes	Yes Yes	No No	No No	For the last 15 years farmed a piece of ground.	Moderate drinker.
Yes Yes —	Yes Yes —	No No —	Yes No Yes	Yes No Yes	For last few years kept a coal yard.	Very moderate drinker.
Yes Mine Mine	Yes agent. agent.	No No No	No No No	No No No	Last 9 years kept a grocer's shop.	Drank very little alco- holic liquor.
Yes —	Yes —	— Timber- man.	No —	No —	Latterly a mine agent ...	Drank very little.
Yes Yes	Yes Yes	— —	No No	No No		
Yes No Yes No No	Yes No Yes No No	Part time timbering. No — Timber- man. Timber- man.	No Yes No No No	No Yes No No No	—	Drank very freely—too freely.

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
114	58	Bronchitis, heart failure ...	Tin miner ...	Wheal Harriet as a young man ... Great Condurrow, 4 years ... Colorado (3 spells), 10 years ... South Condurrow, 12 years ...
115	75	Mitral valvular disease, cardiac dilatation.	Tin miner ...	Wheal Druid, some years ... Wheal Seton, some years ... South Crofty, 8 years ... Dolcoath, 12 years ...
116	55	Phthisis ...	Tin dresser...	Never worked underground ...
117	29	Miners' phthisis, exhaustion ...	Tin miner ...	South Condurrow as a boy ... Carn Brea, 2 years ... Dolcoath, 2 years ... America, 4 years ... Africa, 4 years ...
118	49	Phthisis 6 months ...	Tin miner ...	West Seton as a boy ... Basset Mine ... Dolcoath, many years ... Students' Mine, 4 months ...
119	30	Miners' phthisis, asphyxia ...	Tin miner ...	Tincroft, 1 year ... South Africa, 2 mines, about 5 years
120	36	Accidentally killed by falling rock.	Tin miner (timberman).	—
121	31	Phthisis pulmonalis, asthenia	Tin miner ...	Basset Mine, 1 year ... Dolcoath, 8 years ... East India, 6 months ... Mysore, 2 years ...
122	41	Pneumonia 4 days, heart failure 1 day.	Tin miner ...	Tincroft, some years ... Newton, some years ... West Seton, some years ... Dolcoath, 7 years ... South Africa, 3 years ... South Africa, 1½ years ...
123	63	Phthisis ..	Tin miner ...	South Francis, some years ... South Condurrow, some years ... Wheal Grenville, some years...
124	41	Miners' disease, asthenia ...	Tin miner ...	Dolcoath, several years ... Lake Superior, 3 years ... Carn Camborne, 6 years ... South Africa, 1½ years ...
125	59	Cancer of lung, exhaustion ...	Tin miner ...	South Crofty, some years ... Dolcoath, 12 years ... America, 2 years ... South Africa, 5 years ...
126	43	Phthisis ...	Tin miner ...	Wheal Grenville, over 20 years ... Wheal Grenville, last 10 years ...

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes	Yes	No	No	—	For 7 last years home doing little or nothing.	Moderate drinker.
Yes	Yes	Yes, occasionally.	No	—		
Yes	Yes	—	No	—		
Yes	Yes	—	No	—		
Pumped	air to tributers.		—	—	Hurt 3 times in Dolcoath.	Total abstainer.
No	No	Yes	No	No	Home 9 years unable to work, and died.	
No	No	Yes	No	No		
Yes	Yes	No	No	No		
—	—	—	—	—	Dolcoath, tin dresser.	
Yes	Yes	No	No	No	—	Last 2 years only with boring machines; he wore respirators, &c.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	—	No	No		
Last two years			Yes	Yes		
Yes	Yes	No	No	No	—	Moderate drinker.
Yes	Yes	Yes	No	No		
Yes	—	No	No	No		
General instructor in mining.						
6 months stopping.	—	—	6 months boring machine.	—	Until 24 years worked on tin streams.	Total abstainer.
—	—	—	Boring all the machines time.	—		
—	—	—	—	—	—	Coroner's certificate.
—	—	—	Foreman, boring machine.	—	—	Bad food when in India
Last 5 years.	—	Yes, 6 months.	Yes	Yes		
Yes	—	—	Boring machine, occasionally.	Yes		
—	—	—	Yes	Yes		
Yes	Yes	No	No	No	Worked in Dolcoath last 12 months. Home nearly 12 months and died.	Moderate drinker.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	No	No	No	For last 8 years iron-monger's storekeeper.	Very moderate drinker.
Yes	Yes	No	No	No		
Yes	Tributer	—	Boring machine.	—	One year with horse and cart after return.	Moderate drinker.
No	No	No	Boring machine.	3 years		
Yes	Yes	No	No	No		
Yes	—	—	Boring all the machine time.	—		
Yes	Yes	No	No	No	Home 2 years and died ...	Total abstainer.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Mine contractor			No	No		
Yes	Yes	No	—	—	Worked 1 year in a foundry, then for a short time hand work in a stope. Home 9 months and died.	Very moderate drinker.
—	—	—	Yes	Yes		

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
127	43	Miners' phthisis, 4 years, asthenia.	Gold miner ...	Colorado, 26 years ... Colorado, 2 years ...
128	46	Pulmonary tuberculosis, asthenia.	Tin miner ...	South Condurrow, 3 years ... Dolcoath, some years ... South Africa, 1 year ... Montana, 3 years ... South Africa, 5 years ...
129	60	Chronic bronchitis, 8 months...	Tin miner ...	Dolcoath, over 40 years ...
130	34	Miners' phthisis, exhaustion ...	Gold miner ...	Tincroft, as a lad ... Dolcoath, some years ... South Africa, 4 years ...
131	74	Natural decay ...	Tin miner ...	Dolcoath, some years ... West Seton, some years ... Dolcoath, 23 years ...
132	44	Congestion of lungs ...	Tin miner ...	Tincroft, some years ... Dolcoath, some years ...
133	37	Miners' phthisis, asthenia ...	Tin miner ...	Dolcoath, 10 years ... Colorado, 4 years ... Dolcoath, 4 years ...
134	37	Gold miners' phthisis, asphyxia	Gold miner ...	Dolcoath, 6 years ... United States ... } 7 years ... Several places ... } South Africa, 7 years ...
135	39	Miners' phthisis, asthenia ...	Gold miner ...	South Wales, 6 years ... Dolcoath, some years ... South Africa, 2½ years ... South Africa, 1 year ... Colorado, 1 year ...
136	42	Diabetes insipidus, phthisis pulmonalis.	Gold miner ...	Dolcoath, 18 years ... India, 3 years ... Africa, 2½ years ... Ceylon, 2½ years ...
137	28	Miners' phthisis, asthenia ...	Tin miner ...	Dolcoath, 6 years ... Carn Brea, 2 years ... Tincroft, 3 years ...
138	20	Acute rheumatism, pericarditis	Tin miner ...	Dolcoath, 5 years ...

Sub-District—cont.

Nature of Employment.						REMARKS (Including Alcoholic tendencies).
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes	Yes	No	No	No	No other employment ; attributes death to light air of Colorado.	Moderate drinker.
As a mine agent			No	No		
Yes	Yes	No	No	No	Took part in the war for 4 months. Home 6 months and died.	Little rum as a medicine.
Yes	Yes	Yes	No	No		
Yes	No	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	Shaftman for some years.	No	No	Received hurt to hip joint, and did jobbing. Guarding for 4 years before his death.	Moderate drinker.
Yes	Yes	No	No	No	Home from Africa 9 weeks and died.	Moderate drinker.
Yes	Yes	No	No	No		
No	No	No	Yes	Yes		
		Kept 2 machines going.				
Yes	Yes	No	No	No	Worked on mine floors 3 years. Home 2 weeks and died.	Moderate drinker. One pint of ale a day.
Yes	Yes	Yes	No	No		
Yes	Yes	No	No	No		
Yes	Yes	No	No	No	Worked on farm for a few years, also on the tin streams. Home 3 weeks and died.	Total abstainer.
Yes	Yes	No	Yes	Yes		
Yes	No	No	No	No	Tin stream labourer. First had pneumonia in America.	Moderate drinker.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Yes	Yes	Chiefly	No	No	Mining contractor ...	Moderate drinker. Father died of miners' disease.
Yes	Yes	No	No	No		
Yes	Yes	No	No	No		
Coal mines		No	No	No	Ill in America, came home and in 9 months died. Hard to breathe, but little or no spitting.	Moderate drinker.
Yes	Yes	No	Yes	Yes		
No	No	No	For 3 years.	Yes		
No	No	No	Yes	Yes		
Yes	Yes	No	Yes	No		
Yes	Yes	Mostly	No	No	Prospecting ...	Total abstainer.
Yes	—	—	No	No		
—	Yes	—	Yes	No		
—	—	—	For a short time	—		
Yes	Trammer also	Yes	Yes	Yes	Home 7 months and died. Mother says 4 sons (3 miners) and 1 daughter died of phthisis. Husband died of same.	Moderate drinker.
Short time.			5 years.			
No	No	No	Yes	—		
No	No	No	Yes	—		
Yes	Yes	No	No	No	No other employment ...	Drank very little.

II.—Illogan Sub-District.

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
1	56	Miners' phthisis, asthenia ...	Tin miner ...	West Seton Mine; then to West Francis, and 2 years in Germany; finishing work at Basset Mines for about 20 years.
2	26	Phthisis ...	Gold mine agent ...	Tincroft Mine, then in India, afterwards South Africa.
3	48	Capillary bronchitis, cardiac failure.	Tin miner ...	Carn Brea Mines, some years afterwards farming.
4	53	Ascites, chronic nephritis ...	Tin mine labourer	Originally a miner at Carn Brea, but for 30 years later working at surface.
5	62	Carcinoma of liver, bronchitis	Tin miner ...	Tincroft Mines for over 20 years ...
6	51	Phthisis ...	Tin miner ...	Dolcoath Mine, with the exception of 3 or 4 years in coal mines, South Wales.
7	22	Killed underground in Illogan	—	—
8	26	Pneumonia ...	Tin mine labourer	Carn Brea Mines ...
9	58	Cerebral hæmorrhage...	Tin miner ...	East Pool Mine for 40 years ...
10	22	Accidentally killed in Illogan	—	—
11	39	Rheumatism ...	Tin miner ...	Tincroft Mine ...
12	40	Lung disease, heart failure ...	Tin miner ...	Carn Brea Mines for many years ...
13	23	Drowned accidentally ...	Tin miner ...	—
14	27	Pulmonary tuberculosis ...	Tin miner ...	Carn Brea and East Pool Mines ...
15	50	Bronchitis, cardiac failure ...	Tin miner ...	Entered the workhouse from Illogan parish; was formerly employed at Gwennap Mine in general mining; cannot get more particulars.
16	39	Phthisis ...	Tin miner ...	Tincroft, many years ... Then South Africa for 3 years ...
17	27	Tubercular disease of lungs ...	Gold miner ...	East Pool Mine; then Montana, U.S.A., for 4 years; returning to East Pool Mine.
18	31	Phthisis, exhaustion ...	Gold miner ...	Carn Brea Mines ... Then South Africa for 7 years in 2 periods.
19	62	Heart disease ...	Tin miner ...	Tincroft and Pednandrea Mines ...
20	16	Accidentally drowned...	Miner ...	—
21	46	Phthisis, exhaustion ...	Gold miner ...	Cornish mines, with exception of 17 years in Africa.
22	70	Phthisis, exhaustion ...	Tin miner ...	Entered workhouse from Camborne parish; spent part of his life abroad.

(Mr. W. Phillips, Sub-Registrar).

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Raising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Raising.	Stopping and Sinking.		
Yes	Yes	—	2 or 3 years during his employment at Basset Mines.		—	Moderate.
Yes	—	Yes	2 years in Africa		—	Indulged at times too freely.
Yes	—	—	—	—	—	Moderate.
—	—	—	—	—	—	Sustained injury in his youth, and was subject to fits.
On tribute for over 20 years.		—	No	No	—	Moderate drinker.
Solely on tribute		—	—	—	—	Moderate drinker.
—	—	—	—	—	—	Coroner's certificate.
—	—	—	Yes	Yes	—	—
Yes	—	—	No	No	—	Intemperate at times.
—	—	—	—	—	—	Coroner's certificate.
Entirely about timber and general pit work.		—	—	—	—	Very moderate drinker.
—	—	—	Yes, for a long period.		—	Intemperate at times.
—	—	—	—	—	—	Coroner's certificate.
Yes, at Carn Brea.		—	For a number of years at East Pool and Carn Brea.		—	—
—	—	—	—	—	—	—
Yes	Yes	—	—	—	—	Temperate.
—	—	—	Yes	—	—	—
Yes	Yes	—	No	No	—	Steady habits.
Yes	Yes	—	—	—	—	Steady habits.
—	—	—	Yes	Yes	—	—
Yes	Yes	—	—	—	—	Steady habits.
—	—	—	—	—	—	Coroner's certificate.
About 5 years		—	17 years at intervals in South Africa, 8 years in Cornish mines.		—	Very temperate, but not abstainer.
—	—	—	—	—	—	—

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
23	64	Bronchitis, heart failure ...	Retired tin miner...	Carn Brea and Tincroft Mines for over 40 years.
24	83	Natural decay	Copper miner ...	Entered workhouse from Illogan parish.
25	40	Miners' disease	Tin miner	Carn Brea Mines Then 3 years in India
26	31	Phthisis pulmonalis, asthenia	Tin mine engine driver.	East Pool Mine... .. Then South Africa, 2 or 3 years ...
27	70	Old age	Tin miner	St. Agnes Mines Carn Brea Mines
28	26	Phthisis, cardiac disease ...	Gold miner ...	Carn Brea Then 6 years in South Africa in 2 periods.
29	74	Old age	Tin mine labourer	East Pool Mine... ..
30	70	Cystitis	Tin mine labourer	Wheal Basset Mine for a great number of years.
31	71	Natural decay	Tin mine labourer	Various mines
32	64	Phthisis	Retired tin miner	Tincroft Mines for a long period of years.
33	60	Bronchitis	Tin miner	Carn Brea Mines, chiefly
34	61	Influenza, bronchitis	Tin mine labourer	Various farms Tincroft Mine, surface
35	36	Pneumonia, cardiac failure ...	Tin miner (Included as miner.)	Various mines
36	20	Pulmonary tuberculosis ...	Tin miner	Carn Brea Mines
37	32	Phthisis	Gold miner ...	Carn Brea and Tincroft Mines; then for a period of 6 years in South Africa; and after the war commenced at Cooks Kitchen Mine.
38	37	Pleurisy, bronchial asthma, heart failure.	Gold miner ...	East Pool South Africa, 4 years
39	60	Cancer of stomach	Tin mine labourer	Gamekeeper for a number of years... Lander at Tincroft, many years ...
40	50	Phthisis	Gold miner ...	East Pool, South Crofty Then 8 years in South Africa ...
41	43	Hypertrophic cirrhosis of liver	Retired tin mine labourer.	St. Ives Then Illogan Mines
42	47	Fibroid phthisis	Retired gold miner	Very many years in U.S. America, and after this 6 years in South Africa; last occupation for a year or two was farming.
43	22	Tuberculosis of lungs... ..	Tin miner	East Pool Mine... ..
44	30	Phthisis pulmonalis, asthenia	Tin miner	East Pool Mine... ..
45	34	Fibroid phthisis	Tin miner	Cooks Kitchen Mine

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes (Tributer)	—	—	No	No	—	Steady habits.
—	—	—	—	—	No information available	—
Yes	Yes	—	—	—	—	Moderate.
—	—	—	Yes	Yes	—	—
—	—	—	—	—	Engine hand ...	Steady habits.
—	—	—	Yes	Yes	—	—
—	—	—	—	—	Engine driver for 30 years, last occupation.	Temperate.
—	—	—	—	—	—	—
General	mining	—	—	—	—	Intemperate.
—	—	—	Yes	Yes	—	—
—	—	—	—	—	Surface labourer ...	Moderate.
—	—	—	—	—	Lander at mouth of shaft	Moderate drinker.
—	—	—	—	—	Surface labourer; many years latter part of his life a greengrocer.	Steady habits.
Yes, for many years.	—	—	No	No	—	Very temperate.
No	—	Yes, for a long number of years; much exposed to water.	—	No	—	Temperate.
—	—	—	—	—	Farm labourer ...	Temperate.
—	—	—	—	—	Mine surface hand.	—
—	—	?	—	—	General labourer (not underground).	Moderate.
Yes	—	—	—	No	—	Temperate.
Last employment at Cooks Kitchen.	—	—	6 years' in South Africa.	—	—	Temperate.
Yes	Yes	—	—	—	—	Moderate.
—	—	—	Yes	Yes	—	—
—	—	—	—	—	Gamekeeper ...	Intemperate occasionally.
—	—	Never employed underground	—	—	Lander at pit's mouth.	—
Yes	Yes	—	—	—	—	Intemperate at times.
—	—	—	Yes	Yes	—	—
—	—	—	—	—	Fisherman ...	Generally moderate.
—	—	—	—	—	Surface labourer.	—
Yes	Yes	—	Yes, for nearly 20 years.	—	—	Moderate drinker.
—	—	—	Yes	Yes	—	Moderate.
—	—	—	Yes, from boyhood	—	—	Moderate drinker
Yes	—	Yes	—	Yes	—	—

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
46	30	Pericarditis, bronchitis ...	Tin miner ...	Basset Mines ... Then South Africa, 6 years ... Bolivia, 8 months ...
47	35	Pulmonary tuberculosis ...	Tin miner ...	Various mines in and out of Cornwall
48	72	Cerebral hæmorrhage, cardiac failure.	Tin miner ...	—
49	47	Pulmonary tuberculosis ...	Tin miner ...	Wheal Agar Mine, with the exception of 1 year in U.S. America, last employment.
50	60	Pernicious anemia, cardiac failure.	Tin miner ...	Carn Brea Mines for very many years
51	25	Valvular disease of heart, syncope.	Tin mine labourer	Carn Brea and Tincroft Mines chiefly
52	61	Diseased heart, bronchitis ...	Tin mine agent ...	St. Just Mines; then 10 years employed at Basset Mines.
53	29	Phthisis, measles, heart failure	Tin mine agent ...	Carn Brea, with interval of 3 years in South Africa.
54	71	Chronic cystitis, cardiac failure	Tin miner ...	In U.S. America for many years, afterwards for 10 years in Basset Mines.
55	62	Peritonitis, hyperpyrexia ...	Tin dresser ...	Various places ...
56	69	Chronic bronchitis, cardiac valvular incompetence.	Tin miner ...	Lelant Mines; then Carn Brea; finished as a quarryman.
57	29	Pulmonary tuberculosis, 11 months' exhaustion.	Tin miner ...	Pool, many years ... Dolcoath Mine, 3 years ...
58	38	Pulmonary tuberculosis, 1 year 3 months' exhaustion.	Tin miner ...	Tincroft and Dolcoath Mines ...
59	37	Disease of liver and lung, cardiac failure.	Beerhouse keeper...	Wheal Basset Mine; then a publican
60	50	Bronchitis, 8 months; acute broncho-pneumonia, 5 days.	Tin miner ...	Wheal Agar Mine mostly ...
61	45	Pulmonary tuberculosis, 10 months; exhaustion.	Tin miner ...	Carn Brea Mine; then in India; finished employment at Tincroft.
62	48	Bronchitis and cardiac degeneration, pneumonia and dropsy.	Gold miner ...	Towednack Mines; then Australia, 20 years. Thence to America for some years ...
63	41	Pulmonary tuberculosis, 8 months; exhaustion.	Gold miner ...	Various places as general labourer; then East Pool, mining; and Finished in South Africa for 3 years
64	56	Pulmonary tuberculosis, 6 months; broncho-pneumonia, 6 days.	Tin miner ...	Carn Brea Mines ...
65	36	Pulmonary tuberculosis, 7 months; exhaustion.	Gold miner ...	Carn Brea; then 6 years at intervals in South Africa; latterly a carrier at Parkbottom for 2 years.
66	39	Miners' disease ...	Tin miner ...	East Pool Mines mostly ...

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
—	—	—	—	—	Assayer	Moderate.
General	mining	—	Yes	Yes		
—	—	—		Yes	This man was for many years employed as an overseer of rock drill work, teaching others, &c.	Steady habits.
—	—	—	—	—	Unable to give any information.	—
Yes	Yes	—		No	—	Very intemperate.
Yes, some years.	Yes	—	—	—	Surface cartwork overseer for 20 years' or more, latter part of his life.	—
Yes	—	Yes	—	—	—	—
Yes	Yes	—	No	No	—	Temperate.
Yes	—	—		No	Underground foreman in mundic stopes.	Moderate.
Yes	Yes	—	No	No	The 10 years in Bassett Mines as surface labourer.	Steady habits.
—	—	—	—	—	Tin dressing, hewer, and miner.	—
Yes	Yes	—	—	—	—	Moderate.
—	—	—	—	—	Horseman	Very temperate.
—	—	—	Yes	Yes	Removing and tramping away stuff from rock drill work.	
Yes	Yes	—	Yes (10 years)	Yes	—	Steady habits.
Yes	—	—	—	—	Publican	Intemperate.
—	—	Yes		Yes	—	—
Yes, in mundic stopes.	—	—	—	—	—	Moderate.
Yes	Yes	—	—	—	—	Temperate.
—	—	—		Yes	—	
—	—	—	—	—	—	Moderate.
—	—	—	Yes	Yes	—	
—	—	—	—	—	Tramping stuff from rock drills for a number of years.	—
Yes	—	—	Yes, in Africa some years.	—	Carrier	Indulged at times too freely.
Yes	—	—	—	—	—	Steady habits.

II.—Illogan

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
67	57	Pulmonary tuberculosis, asphyxia.	Retired farmer ...	Illogan parish ... Then Montana, U.S.A., for nearly 20 years mining; last occupation, a farmer.
68	25	Pulmonary tuberculosis, 3 years; exhaustion.	Tin miner ...	East Pool Mine ...
69	64	Cardiac dilatation and valvular incompetence, general anasarca.	Tin miner ...	Wheal Kitty, on tribute some years; then at Carn Brea and Tincroft, first-class pitman, near 20 years; closed his career, refreshment-house keeper.
70	33	Very acute phthisis, rapid heart failure.	Tin miner ...	East Pool Mine... Then in South Africa for 5 years in two periods.
71	25	Phthisis ...	Gold miner ...	Cornish mines until 19 years of age; then left for South Africa, worked as engine driver there till the war commenced; removed to Australia; returned to Africa; came home very ill.
72	62	Phthisis (tubercular)...	Tin miner ...	Entered the workhouse from Gwinear Parish.
73	44	Bronchitis, heart failure ...	Tin miner ...	Carn Brea Mine, Illogan; then U.S. America for 5 years; afterwards in Indian mines 5½ years.
74	51	Fibroid phthisis (South Africa)	Gold miner ...	Originally farm labourer; since then solely employed abroad—Brazil, Cuba, South and West Africa, the latter district for 9 months to finish.
75	29	Phthisis ...	Rock drill overseer in tin mine.	East Pool ... With interval of 4 years in South Africa.
76	44	Phthisis ...	Tin miner ...	Gentleman's servant 10 years; Tincroft Mine afterwards.
77	61	Fibroid phthisis, 10 months ...	Retired tin miner	Dolcoath Mine ...
78	48	Chronic bronchitis ...	Retired tin miner	Wheal Agar, 25 years ...
79	51	Cancer of kidney, 1 year; dropsy and exhaustion, 1 month and 14 days.	Retired tin miner	South Crofty for many years; latterly a greengrocer.
80	40	Phthisis ...	Tin miner ...	In Illogan parish, as a carpenter; then at East Pool, mining. And at mines in South Africa for 2 years.
81	38	Pulmonary (miners') tuberculosis, 6 months; exhaustion.	Tin miner ...	Illogan Mines, with intervals of 5 years in Africa.
82	33	Bronchitis, cardiac failure, and dropsy, 2 months.	Tin miner ...	East Pool Mines ... Then South Africa, 6 years, with a short interval. Afterwards at East Pool and South Crofty.

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
— Yes	— Yes	— —	— —	No —	—	Generally of steady habits, but at intervals would drink freely.
—	Yes	—	No	No	Sustained injury at the mine, and for last few months of employment was a vegetable hawker.	—
Yes	—	Yes	—	No	—	Steady habits
Yes —	Yes —	— —	— Yes	— Yes	—	Steady habits.
Believed to be so employed a short time in Australia.		—	Last occupation in South Africa.		Engine driver first trip to South Africa.	Total abstainer.
General	mining	—	—	—	—	—
—	5 years in U.S. America previous to going to India.	5½ years in India, last employment.	Some years in Carn Brea Mines.		—	Abstainer 18 years.
—	—	—	—	—	Prospecting for mineral a large portion of his time; underground at very short intervals.	Moderate.
Yes —	— —	— —	Yes Yes	Yes Yes	—	Moderate.
—	—	—	Yes, in mundic stopes		Gentleman's servant ...	Intemperate at times.
Yes	—	—	—	No	Foreman of stoping, bottom of mine.	—
Yes	—	—	No	No	—	Steady habits.
Yes	—	Yes	—	No	Greengrocer ...	Indulged at times rather freely.
Yes —	— —	— —	— Yes	— Yes	—	Steady habits.
Various		—	8 years in Cornish mines; 5 years in South Africa.		2 years of boyhood with horse and cart on mine work.	Very temperate.
Yes —	— —	— —	— —	Yes Yes	—	Moderate drinker.
Yes	—	—	—	—	—	

III.—Gwennap Sub-District.

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
1	84	Bronchitis, senile decay ...	Tin mine agent, retired.	Cornwall, all his life
2	73	Bronchitis	Gold miner ...	Cornwall, 18 years Australia, 7 years California, 10 years Africa, 4 years Africa, 5 years
3	35	Pneumonia, cardiac debility ...	Gold miner ...	Cornwall, 30 years Africa, 5 years
4	29	Hæmoptysis	Gold miner ...	Cornwall, 21 years Wales, 2 years Africa, 6 years
5	40	Phthisis	Tin miner ...	Cornwall, all his life
6	35	Paralysis, general debility ...	Tin miner ...	Cornwall, lifetime
7	73	Bronchitis, 4 months	Tin miner ...	Cornwall, lifetime
8	48	Sarcoma of tonsil and cervical glands.	Gold miner, retired	Cornwall, 25 years South America, Bolivia, 10 years Africa, 5 years
9	40	Phthisis, bronchial asthma, heart failure.	Gold miner ...	Cornwall, 31 years Mexico, 5 years Africa, 4 years
10	55	Chronic asthma, chronic bronchitis, cardiac failure.	Tin miner ...	Cornwall, lifetime
11	46	Phthisis, exhaustion	Gold miner ...	Cornwall, 40 years North America, 1 year Africa, 3 years Africa, 2 years
12	36	Phthisis, 1 year	Tin miner ...	Cornwall, 29 years North America, 7 years
13	54	Acute bronchitis, 12 days ...	Tin miner ...	Cornwall, lifetime
14	30	Tubercular disease of lungs ...	Gold miner ...	Cornwall, 22 years Africa, 3 years Africa, 5 years
15	28	Phthisis, heart failure ...	Tin miner ...	Cornwall, 22 years Africa, 3 years Africa, 3 years
16	32	Phthisis, exhaustion	Tin miner ...	Cornwall, 22 years Africa, 5 years Africa, 5 years
17	54	Bronchitis, heart failure, dropsy.	Tin mine labourer	Cornwall, all his life

(Mr. Thomas Curnow, Sub-Registrar).

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
No	No	No	No	No	—	—
—	—	—	—	—	—	Alcohol drinker.
7 years	—	—	—	—	—	
10 years	—	—	—	—	—	
—	4 years	—	No	No	—	
—	5 years	—	—	—	—	
12 years	—	No	No	No	—	Very steady, no drinker
—	—	—	—	5 years	—	
3 years	—	—	—	—	—	No alcoholic drinker.
—	—	—	—	—	Coal mine 2 years.	
—	—	—	6 years	—	—	
—	—	—	—	10 years	—	Very steady, no drinker.
18 years	No	No	No	No	—	Took a little alcohol.
From a boy.	No	No	No	No	—	—
7 years	—	—	—	—	—	No drinker.
10 years	—	—	—	—	—	
—	5 years	No	No	No	—	
10 years	—	—	—	—	—	No alcohol drinker.
5 years	—	—	—	—	—	
—	—	—	4 years	No	—	
35 years	—	—	—	—	—	Can't say.
22 years	No	No	No	No	—	Very steady man, no
1 year	No	No	No	No	—	drinker.
—	—	—	—	3 years	—	
—	—	—	—	2 years	—	
10 years	—	—	—	—	—	No drinker. Family
7 years	No	No	No	No	—	complaint, phthisis.
38 years	—	—	—	—	—	No drinker.
4 years	No	No	No	No	—	Alcohol tendency.
—	—	—	—	3 years	—	
—	—	—	—	5 years	—	
5 years	—	—	—	—	—	No drinker.
—	—	—	3 years	—	—	
—	—	—	3 years	—	—	
4 years	—	—	—	—	—	No alcohol drinker.
—	—	—	—	—	—	
—	—	—	3 years	5 years	—	
—	—	—	—	2 years	—	
—	—	—	—	—	—	No alcohol drinker. Worked at surface, lifetime.

III.—Gwennap

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
18	34	Incipient phthisis, 5 months...	Tin miner ...	Cornwall, 32 years ... Africa, 2 years ...
19	40	Chronic phthisis, exhaustion...	Tin miner ...	Cornwall, 38 years ... Africa, 2 years ...
20	29	Lung disease ...	Gold miner ...	Cornwall, 23 years ... Africa, 6 years ...
21	68	Bronchitis, heart failure ..	Tin miner ...	Cornwall, lifetime ...
22	71	Bronchitis, cardiac failure ...	Tin miner ...	Cornwall, lifetime ...
23	53	Phthisis, 1 year ...	Tin miner ...	Cornwall ... California, 14 years ... Africa, 4 years ...
24	64	Bronchitis ...	Tin miner ...	Cornwall, lifetime ...
25	33	Bronchitis, heart failure ...	Gold miner ...	Cornwall, 20 years ... California, 10 years ... Africa, 3 years ...
26	36	Phthisis, 1 year ...	Tin miner ...	Cornwall, 35 years ... Africa, 1 year ...
27	57	Catarrh, gastritis, disease of lungs.	Copper miner ...	Cornwall, until he was 20 years old South America, Chili, 4 years ... Bolivia, 30 years ... Cornwall, 3 years ...
28	43	Phthisis, heart failure ...	Gold miner ...	Cornwall, until he was 20 years old Soldier, 7 years ... Africa, 3 years ... Africa, 4 years ...
29	55	Phthisis ...	Woodman ...	Cornwall, 25 years ... North America, 10 years ... Cornwall, 3 years ... North America, 3 years ... Cornwall, 10 years ...
30	58	Cardiac disease ...	Tin miner ...	Cornwall, all his life, and worked underground 34 years from 14 years old.
31	36	Miners' disease, hæmoptysis ...	Gold miner ...	Cornwall, 29 years ... Africa, 2 years ... Cornwall, 1 year ... Africa, 4 years ...
32	68	Bronchitis ...	Tin and copper miner.	Cornwall ... And South America, Chili, 10 years
33	50	Apoplexy ...	Tin miner ...	Cornwall, all his life ...

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
10 years	—	—	4 years	—	—	Alcoholic tendency.
—	—	—	—	2 years	—	—
12 years	—	—	8 years	—	—	Alcoholic tendency.
—	—	—	—	2 years	—	—
No	No	No	No	No	Carpenter and painter before he went to Africa.	Took a little alcohol at times.
—	—	—	6 years	—	—	—
45 years	No	No	No	No	—	—
—	—	20 years	—	—	—	No drinker.
—	—	—	—	—	—	Took a little alcohol.
—	—	14 years	—	—	—	—
—	—	—	—	—	Shift boss.	—
40 years	—	—	—	—	—	Very steady man, no drinker.
—	—	—	—	—	—	No drinker.
10 years 3 years	— No	— No	— No	— No	—	—
—	—	—	5 years	—	—	No drinker.
—	—	—	1 year	—	—	—
—	—	No	No	No	Agent about 10 years ...	When young took too much alcohol.
4 years	—	—	—	—	—	—
20 years	—	—	—	—	—	—
—	—	—	—	—	—	—
No	—	—	—	—	—	No alcohol drinker, very steady man.
—	—	—	3 years	—	—	—
—	—	—	4 years	—	—	—
—	In Corn- wall as a boy,	—	—	—	—	At times took too much alcohol.
In America	driving;	No	—	—	—	—
10 years,	7 years;	—	—	—	—	—
stoping.	man,	—	—	—	—	—
—	5 years.	—	—	—	—	—
No	No	—	No	—	Woodman, 5 years.	—
34 years	No	No	—	No	Cobbler	Not an abstainer, but very steady.
—	—	—	—	—	—	—
—	—	—	2 years	—	—	Not an abstainer, but very steady.
—	—	—	4 years	—	—	—
—	—	—	—	—	—	No alcohol drinker
10 years stoping.	No	No	No	No	—	—
—	20 years	No	No	No	—	Sometimes took too much.

III.—Gwennap

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
34	52	Emphysema of lung, phthisis	Gold miner ...	Cornwall, until he was 22 years old Chili, 7 years Africa, 3 years Africa, 4 years
35	80	Old age	Mine agent ...	Cornwall, until he was 25 Australia, 6 years
36	44	Phthisis	Farmer, but formerly miner.	Cornwall, until young man North America, 9 years
37	71	Pleurisy, abscess of lung ...	Tin mine agent ...	Cornwall, all his life
38	72	Morbus cordis	Tin miner	Cornwall, all his life, and worked underground.
39	49	Phthisis	Gold miner ...	Cornwall, until he was 18 years old North America and California, 10 years. Africa, 3 and 4 years
40	67	Bronchitis	Copper miner ...	Cornwall, until he was 30 Chili, 10 years Cornwall, the rest of his life, as buyer of eggs.
41	31	Phthisis	Innkeeper	Cornwall Africa, 3 years Cornwall, 2 years Africa, 2½ years
42	26	Phthisis	Tin miner	Cornwall, until he was 20 years old Africa, 6 years
43	33	Fibroid phthisis	Tin miner	Cornwall, 27 years Africa, 6 years
44	23	Meningitis	Tin miner	Cornwall, lifetime
45	41	Broncho-pneumonia, phthisis ...	Tin miner	Cornwall America, about 10 years Africa, 2 years
46	62	Chronic bronchitis	Copper miner ...	Cornwall North America, 20 years
47	36	Phthisis	Copper miner ...	Cornwall, until he was 30 years old Africa, 5 years North America, 1 year
48	65	Phthisis	Tin miner	Cornwall, lifetime
49	45	Phthisis	Tin miner	Cornwall, worked underground from a boy. South Africa, 3 years.

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
—	—	—	—	—	—	Worked underground from boyhood. No drinker.
Both for 7 years	—	—	3 years	—	—	
—	—	—	3½ years	—	Shift boss 6 months.	
—	—	—	—	—	—	Mine agent for many years. Not an abstainer, but very steady.
6 years	—	—	—	—	—	
—	—	—	—	—	—	Was blasted in America, lost one eye. Not an abstainer, but very steady.
9 years	—	—	—	—	—	
—	—	25 years	—	—	—	Shaft man until he was put agent. Very steady.
Stopping and sinking up to 5 years of his death.	—	Worked up to his death.	—	—	—	No drinker of alcohol.
—	—	—	—	—	—	Not an abstainer, steady.
—	Both for 10 years.	—	—	—	—	California hurt him.
Looking after natives	—	—	—	—	—	
—	—	—	—	—	—	Very steady, no alcohol drinker.
10 years	stopping and sinking.	—	—	—	—	
—	—	—	—	—	—	
No	No	No	3 years	—	Innkeeper 1 year ...	Not an abstainer, but very steady.
—	—	—	—	2½ years	—	
2 years	—	—	2 years	—	Worked rock drill 2 years before he went to Africa.	Not an abstainer, but steady.
No	No	No	2 years	4 years		
—	—	—	—	—	—	Not an abstainer, very steady.
2 years	—	—	4 years	—	—	
4 years	No	No	No	—	—	—
—	—	—	—	—	—	No drinker.
—	—	—	2 years	—	—	
—	—	—	—	—	—	Very steady
20 years	No	No	No	No	—	
12 years	—	—	—	—	—	Very steady, no drinker.
6 months	—	—	5 years	No	—	
No	No	No	No	No	—	—
25 years	—	—	—	—	—	No alcohol drinker.
—	—	—	3 years	—	—	

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
50	37	Fibroid phthisis... ..	Stone quarry labourer.	Cornwall, until he was 21 years old Africa, 6 years Cornwall, 1 year Africa, 2 years Cornwall, 1 year
51	40	Phthisis	Copper miner ...	Cornwall, 33 years North America, 7 years
52	42	Fibroid phthisis	Tin miner	Cornwall, lifetime
53	61	Bronchitis	Tin miner	Cornwall, lifetime
54	25	Phthisis, exhaustion	Copper miner ...	Cornwall, 20 years America, 4 years Africa, 1 year
55	66	Cardiac disease	Silvermineengineer	Cornwall, about 40 years Mexico, 26 years
56	81	Old age	Tin mine labourer	Cornwall, lifetime
57	31	Valvular disease of heart, syncope, phthisis.	Grocer	Cornwall, 26 years Africa, 4 years
58	62	Chronic bronchitis	Tin miner	Cornwall, all his life
59	33	Bronchitis, asthma	Tin miner	Cornwall, lifetime
60	40	Fibroid phthisis	Tin miner	Cornwall, 35 years Africa, about 5 years
61	41	Emphysema, bronchitis ...	Tin miner	Cornwall, lifetime
62	66	Disease of liver, heart failure	Copper miner ...	Cornwall, 20 years North America, about 20 years ...
63	30	Pulmonary fibrosis, general oedema.	Farmer	Cornwall, 25 years Africa, 4 years

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
5 years	—	—	—	—	Stone quarry labourer 1 year.	Alcohol drinker.
—	—	—	6 years	—		
—	—	—	—	2 years		
—	—	—	—	—		
15 years	—	—	—	—	—	—
—	Can't say	—	—	—	—	—
22 years	or more	—	—	—	—	Can't say.
Lifetime	No	No	No	No	—	No alcohol drinker.
—	—	—	—	—	—	No drinker. Mother died of phthisis.
4 years	—	—	—	—	—	
1 year	—	—	—	—	—	—
No	No	No	No	No	—	—
—	—	—	—	—	—	—
No	No	No	No	No	—	—
8 years	—	—	—	—	Grocer 1 year	No alcohol drinker, very steady.
—	—	—	4 years	—		
30 years	No	No	No	No	—	—
18 years	No	No	No	No	—	—
14 years	No	—	5 years	—	—	No alcohol drinker.
—	—	—	—	—	—	—
20 years or more.	No	No	No	No	—	Very steady, no alcohol drinker.
—	—	—	—	—	—	—
Can't say.	say.	No	No	No	—	—
6 years	—	—	—	—	Farming 1 year	At times alcohol tendency.
—	—	—	—	4 years		

IV.—Redruth Sub-District

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
1	73	Broncho-pneumonia, influenza	Retired gold mine manager.	Various Cornish mines Brazil, 40 years
2	69	Influenza, bronchitis	Copper miner	Various Cornish mines Chili, 15 years
3	54	Cardiac dropsy	Gold miner	Various Cornish mines, till about 24 America, 1½ years Various Cornish mines, over 20 years South Africa, 1½ years
4	40	Phthisis	Tin miner	Various Cornish mines, about 6 years Swansea, about 7 years East Pool and Bassett Mines, about 10 years.
5	58	Bronchitis (inquest)	Miner	Various Cornish mines, till about 26 Chili, 4 years California, 24 years
6	52	Cerebral hæmorrhage... ..	Gold miner	Various Cornish mines, till about 27 Namaquatana, 6 years... .. Cornish mines, 15 years India, 3 years
7	25	Phthisis	Tin miner	Very little mining, principally farm- ing, hedging, &c.
8	39	Hæmoptysis	Gold miner	Various Cornish mines, till about 20 America, about 12 years Home, about 3 years South Africa, about 1 year
9	49	Phthisis	Tin miner	In Cornish mines all his life, with exception of about 9 months in Africa, where he did little if any work.
10	61	Bronchitis	Tin miner	Various Cornish mines, till about 28 South Wales, about 14 years... .. Cornish mines, about 14 years
11	18	Phthisis	Tin miner	Carn Brea Mine, about 2 years
12	73	Chronic bronchitis, cardiac failure.	Retired tin miner...	Numerous Cornish mines, till about 45 years of age.
13	47	Phthisis, hæmoptysis	Gold mine agent	In several Cornish mines Nevada, 4 years India, Demerara, Straits, South Africa, and West Africa.
14	40	Tubercular phthisis	Gold miner	Carn Brea and East Pool Mines Michigan and Montana, America South Africa, about 6 years
15	60	Bronchitis, cardiac failure	Retired tin miner...	—
16	33	Phthisis	Gold miner	Carn Brea Mine, till about 19 America, about 8½ years South Africa, about 3 years
17	58	Hæmatensis	Gold miner	Wheal Uny Redruth, as a boy Australia, gold mining, 4 years America, California, 20 years South Africa (twice), 3 years

(Mr. C. Bawden, Sub-Registrar).

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes —	Yes —	— —	No No	No No	—	Went to Brazil when about 26 years of age; was an agent there nearly all the time.
Yes Yes	Yes Yes	— —	No No	No No	—	Went to Chili when about 40 years of age. Home about 13 years before his death.
Yes Yes Yes —	Yes Yes Yes —	— — — —	No No Yes Yes	No No Yes Yes	— — Principally machines during this period.	Very sober man.
Yes — Yes	Yes — Yes	No — No	No — Yes	No — Yes	— Working in gas works. Mostly machine working.	—
Yes Yes Yes	Yes Yes Yes	Yes — Yes	No No No	No No No	—	Never worked machines as far as is known.
Yes — — —	Yes — — —	— — Yes Yes	No No No No	No No No No	— Exploring and prospecting. — Principally pitman and millman.	—
Yes	Yes	No	No	No	—	Very consumptive family; father, 4 sisters and 2 brothers died of this disease.
Yes Yes — —	Yes Yes — —	Yes — — Yes	No Yes — No	No Yes — No	—	Very sober, steady young man.
Yes	Yes	Yes	?	?	—	Is not known ever to have worked machines.
Yes — Yes	Yes — Yes	Yes — Yes	No No No	No No No	— Coal mining.	—
Ordinary mining boy			No	No	—	Family can't say how employed.
Yes	Yes	Yes	No	No	—	Never out of Cornwall.
Yes Yes Yes	Yes Yes Yes	No No No	No No No	No No No	—	Left home when about 18 or 19. For many years was an agent.
Yes Yes —	Yes Yes —	No No No	No No Yes	No No Yes	—	General mining. No machine work.
—	—	—	—	—	—	Family left the neighbourhood.
Yes Yes —	Yes Yes —	— — —	Yes Yes Yes	? Yes Yes	—	Very sober.
Yes — Yes Yes	Yes — Yes Yes	— — — —	No — No No	No — No No	— — — Was sub-agent in Africa.	Very steady, sober man. Never worked in England after 15 years of age. Never worked machines in his life.

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
18	52	Hæmoptysis, Syncope ...	Tin miner ...	Various Cornish mines from 11 years of age to within 3 or 4 months of his death.
19	45	Phthisis... ..	Tin miner ...	West Basset, about 10 years ... South Africa, 3 to 4 years ...
20	22	Acute cellulitis, hyperpyrexia	Tin miner ...	Various Cornish mines, about 6 years
21	62	Pleurisy, bronchitis ...	Tin miner ...	—
22	42	Phthisis pulmonalis, exhaustion.	Gold miner ...	East Pool Mine... .. Montana, America, 9 years ... South Africa, 8 years ...
23	33	Pneumonia 35 days, cardiac failure.	Gold miner ...	Wheal Uny and Carn Brea Mines ... South Africa, 5 to 6 years ...
24	34	Miners' disease ...	Gold miner ...	Cornish Mines, till about 29 ... South Africa, 4½ years ...
25	35	Miners' disease ...	Tin miner ...	East Pool, about 8 years ... Cumberland, about 6 years ... East Pool, 2 years ...
26	57	Lung disease, 4 months ...	Gold miner ...	Various Cornish mines, in his youth America and South Africa ...
27	67	Bronchitis, heart failure, dropsy.	Gold miner ...	In Cornwall, America, Mexico, Chili, Argentine, South Africa, &c.
28	54	Bronchitis, asthma exhaustion	Tin miner ...	With the exception of a year or two in Durham in coal mines worked all his life in Cornish mines.
29	66	Bronchitis ...	Tin miner ...	Various Cornish mines, till nearly 60 years of age.
30	36	Phthisis ...	Gold miner ...	Was cabinet maker until about 30 years of age. South Africa, 4 years ...
31	46	Pleurisy, bronchitis, heart failure.	Tin miner ...	In Cornish mines, till about 25 ... America, 3½ years ... South Africa, about 11 months ... Cornish mines, 20 years ...
32	44	Tubercular phthisis, cardiac failure.	Tin miner ...	Various Cornish mines, till about 32 ... America, 2½ years ... Carn Brea, 4½ years ... India, 2 years ...
33	62	Pneumonia, cardiac failure ...	Retired gold miner	Various Cornish mines in youth ... California, great number of years ... South Africa, several years ...
34	33	Phthisis ...	Gold miner ...	Carn Brea Mine ... America, 10 months ... South Africa, 4 years ...

Sub-District—cont.

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stopping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stopping and Sinking.		
Yes	Yes	—	Yes	?	—	Worked machine for several years, but not for some time before his death.
Yes	Yes	—	Yes	Yes	—	Worked drills before going to Africa, and whilst there. Fairly steady.
—	—	—	Yes	No	—	
Yes	Yes	—	Yes about 2 years.	Yes	—	Never out of England.
—	—	—	—	—	—	Family left the neighbourhood.
Yes	Yes	No	No	No	—	Did all kinds of mining except rock-drilling. Very sober, steady man.
Yes	Yes	Yes	No	No	—	
Yes	Yes	—	No	No	—	Fairly steady.
—	—	—	Yes	Yes	—	
Yes	Yes	Yes	Yes	Yes	Machines about 2 years before going to Africa.	Steady man.
—	—	—	Yes	Yes	—	
Yes	Yes	—	Yes	Yes	—	Not too careful of himself in his younger days. Never out of England.
—	—	—	Yes	Yes	—	
Yes	Yes	—	No	No	—	Is not known to have worked machines.
Yes	Yes	Yes	No	No	—	
Yes	Yes	Yes	No	No	Worked at mining in all these countries, but never worked machines.	Family left neighbourhood.
Yes	Yes	Yes	Yes, in Wheal Basset, don't know how long.		—	—
Yes	Yes	Yes	No	No	—	—
—	—	—	—	—	—	—
—	—	—	—	—	Query if ever worked underground, chiefly at surface in crushing-room.	—
Yes	Yes	—	No	No	—	Family gone from the neighbourhood. Since found in Illogan.
Yes	Yes	—	No	No	—	
Yes	Yes	—	Yes	Yes	Did little work in Africa. Machine working in Wheal Agar for many years during this latter period.	
Yes	Yes	Yes	No	No	—	Never worked drills. Principally a timber man.
Yes	Yes	—	No	No	—	
—	—	Yes	No	No	—	
Yes	Yes	Yes	No	No	—	Never worked machines.
Yes	Yes	Yes	No	No	—	
Yes	Yes	—	No	No	Was agent most of the time he was in Africa.	
Yes	Yes	—	No	No	General mining; worked as blacksmith sharpening tools underground.	Very steady man.
—	—	—	No	No	—	
Yes	Yes	—	Yes, driving.	No	—	

No.	Age.	Certified Cause-of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
35	37	Lung disease, cardiac failure...	Gold miner ...	Various Cornish mines, till about 22 America, 3½ years ... Cornish Mines, 3½ years ... South Africa, 7½ years ...
36	34	Miners' disease ...	Gold miner ...	Wheal Agar ... South Africa (three times), 12 years
37	65	Bronchitis, heart failure, dropsy.	Retired tin miner	Many Cornish mines, till about 40 years of age.
38	45	Cancer of liver, pleurisy ...	Gold miner ...	Carn Brea Mines ... South Africa, 1½ years ... Carn Brea, 1½ years ... India, 3 years ...
39	69	Bronchitis, heart failure ...	Retired tin miner	Various Cornish mines, till about 50 years of age, with exception of a very short period in America.
40	35	Fibroid phthisis, cardiac failure.	Tin miner ...	Carn Brea till about 30 years ... South Africa about 1 year ... Carn Brea about 3½ years ...
41	22	Rheumatism, congestion of lungs.	Tin miner ...	Wheal Basset, 1 year ... East Pool and Carn Brea, 4 years ...
42	40	Phthisis ...	Gold mine agent ...	East Pool Mine, till about 22 ... Australia, 3 years ... South Africa, 3 times, 8 years ... India, 14 months ...
43	30	Fibroid phthisis ...	Gold miner ...	Carn Brea, for 6 weeks only ... South Africa, about 3 years ...
44	32	Phthisis ...	Retired silver miner	In East Pool, 3 or 4 years ... America, 9 years ...
45	35	Fibroid phthisis ...	Gold miner ...	Carn Brea, 8 years ... India, 1 year ... Carn Brea, 1 year ... South Africa, 9 years ...
46	66	Hæmoptysis ...	Retired tin miner	Numerous Cornish mines, till about 60 years of age.
47	32	Abscess of liver ...	Gold miner ...	East Pool and Carn Brea ... South Africa, about 4 years ... Carn Brea, about 1 year ... West Africa about 8 years ...
48	62	Heart disease ...	Retired silver mine agent.	Carn Brea, till about 20 years of age California, about 1 year ... Mexico, 30 years ...
49	62	Chronic nephritis, asthma ...	Tin mine manager	Various Cornish mines, all his life; never out of England, except as inspector for a short time.
50	66	Pneumonia ...	Retired tin miner	Various Cornish mines, over 40 years; general mining of all kinds.
51	42	Phthisis, heart failure ...	Gold miner ...	East Pool, 12 years ... South Africa, 12 years ...

V.—*Phillack Sub-District*

No.	Age.	Certified Cause of Death.	Certified Occupation.	Place and Duration of Work since Boyhood.
1	34	Phthisis	Gold miner ...	Cornwall, 15 years, but not as a miner South Africa, 3 years
2	57	Phthisis	Tin miner	Cornwall, from boyhood
3	57	Miners' phthisis	Tin miner	Cornwall, from boyhood
4	52	Heart disease, nephritis ...	Tin miner	Cornwall, from boyhood
5	64	Phthisis pulmonalis	Tin miner	Cornwall, 50 years
6	33	Miners' phthisis	Tin miner	Cornwall, 10 years South Africa, 8 years
7	45	Miners' phthisis	Licensed victualler (for about last year of his life).	Cornwall, about 20 years South Africa, 9 years
8	61	Miners' phthisis	Tin miner	Cornwall, from boyhood

(Mr. Charles Hosking, Sub-Registrar).

Nature of Employment.						REMARKS. (Including Alcoholic tendencies.)
Stoping or Sinking by hand.	Driving or Rising by hand.	Pitwork.	Rock Drills.		Other Employment.	
			Driving and Rising.	Stoping and Sinking.		
—	—	—	—	—	—	Temperate.
—	—	—	Driving	—		
Tin dresser	30 years	—	—	—	Farming until death ...	Temperate.
—	—	—	Driving 5 years.	—	—	Temperate
		Yes (?)				
—	—		—	—	—	—
—	—	Yes (?)	—	—	—	Temperate.
—	—	—	—	—	—	Temperate.
—	—	—	Driving	—		
—	—	—	—	—	—	Temperate.
—	—	—	Driving	—		
—	—	Yes, 50 years (?)	—	—	Greengrocer 4 years ...	Temperate.

APPENDIX III.

EXPERIMENTS AND OBSERVATIONS ON THE AIR, VENTILATION, AND
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In the course of our inquiry we have investigated the air of several Cornish Mines, and the present Appendix contains the main results thus obtained. For purposes of comparison we also examined the air of two ironstone mines. Ironstone mining, as shown by the Decennial Supplements of the Registrar-General's Reports, is an extremely healthy employment, and ironstone miners are, in particular, exceptionally free from respiratory diseases up to the age of 55. This appears from the following tables.

ANNUAL DEATHS from ALL CAUSES but ACCIDENT per 1000 Living.

	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.
Occupied Males, England and Wales, 1890-92 ...	2.05	4.5	6.6	11.5	19.6	35.3
Tin Miners, Cornwall, 1890-92 ...	2.0	4.9	7.2	14.0	32.9	61.7
" " 1900-02 ...	1.1	4.0	12.5	27.3	38.4	66.8
All Miners, " " 	1.2	4.1	20.1	38.5	43.4	70.0
Ironstone Miners, 1890-92 ...	2.5	3.5	4.7	6.9	15.3	31.4
Farm Labourers, " " 	1.35	3.55	4.7	7.7	12.1	23.5

ANNUAL DEATHS from LUNG DISEASES per 1000 Living.

	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.
Occupied Males, England and Wales, 1890-92 ...	0.95	2.7	3.7	5.9	8.6	13.0
Tin Miners, Cornwall, 1890-92	1.3	3.7	3.9	9.5	23.0	40.7
" " 1900-02	0.5	2.6	10.5	23.2	29.6	42.8
All Miners, " "	0.7	2.7	17.3	33.2	52.2	42.6
Ironstone Miners, 1890-92	1.6	1.5	2.1	3.5	7.8	18.7
Farm Labourers, " "	0.5	1.9	2.5	3.7	4.8	7.6

A few words will suffice as to the methods of air-analysis, &c., employed in the investigation. The percentages of oxygen, CO₂, CO, &c., in the air were determined with an apparatus similar to that described by Dr. Haldane in the Journal of Physiology, Vol. 22, p. 465, the special burette for air-analysis being employed, and the combustible gases being determined with the help of an electrically-heated spiral of platinum wire. The samples were collected in stoppered glass bottles, with the precautions described in the Journal of Hygiene, Vol. 2, p. 416. Latterly, however, some of the determinations of CO₂ and CO were made underground by means of a portable apparatus devised during the course of the inquiry.* The results are reliable to within .01 per cent.

The amount of moisture in the air was determined by means of two carefully compared wet and dry bulb thermometers, which were waved about in the air until the readings became steady. For reading these and other instruments an ordinary pocket bull's-eye electric light was found very useful.

Rock-temperatures were determined by means of slow-acting thermometers arranged as follows. An ordinary open-scale verified thermometer was enclosed in a tube of stout glass of nearly one inch diameter, the bulb of the thermometer being embedded in a cork fixed in one end of the tube, and the other end of the tube being closed by another cork. The whole was then inclosed in a metal case with a cord attached and pushed to the end of the bore-hole, which was then closed and left for 24 hours or more. The thermometer thus inclosed could easily be withdrawn and read, as the heat of the hands, surrounding air &c., did not affect the reading till some considerable time after the thermometer was withdrawn, the cork being a most efficient non-conductor of heat.

Stone-dust in the air was determined by drawing the air through a small plug of cotton wool in a constricted piece of glass tube by means of a brass hand-pump with an efficient valve. The plug was afterwards burnt and the residue weighed. The wool itself left no weighable residue. The air was measured by counting the strokes of the pump, the capacity of the latter having previously been ascertained, and care being taken that the full amount of air had entered the pump before a new stroke was begun.

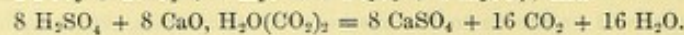
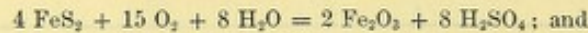
DOLCOATH MINE.

This mine, which is situated close to Camborne, employs about 700 men underground, in three shifts. Plate I. represents in longitudinal section the shafts and workings in the main lode. Plate II. shows the lodes in cross section. To obtain a general idea of the composition and amount of the air passing through the mine we measured and analysed the air passing out from the upcast shafts on April 13th, 1903. The results are shown on the plate. The total volume of air passing through the mine was 68,300 cubic feet per minute, or about 300 cubic feet per man per minute on an average of the 24 hours. In this air the oxygen was on an average diminished from 20.94 per cent. to 20.874 per cent., i.e. by .066 per cent., while the CO₂ was increased from .03 per cent. to .087 per cent., i.e. by .057 per cent. It will be seen that the temperature at the top of the upcast shafts varied from 61° to 72°, according to the depth of the shafts. In all cases the air was saturated and misty. Since these measurements were made the ventilation has been greatly increased in consequence of the connection made with the new shaft (see Plate II.). It follows from the figures just given that 39 cubic feet of CO, per minute, or 2,340 cubic feet per hour, were being produced in the mine. There were, however, not more than 200 men underground at the time. By respiration they would produce only about 200 cubic feet per hour, their candles producing about 100 cubic feet extra, and explosives about 20 cubic feet.† It is thus evident that of the very minute proportion of CO, present in the air only about a seventh is due to respiration and combustion of candles and explosives—so small a proportion, in fact, as to be almost incapable of detection by ordinary methods of analysis. The CO₂ from blasting, and *a fortiori* any CO or nitrous fumes formed at the same time, would be absolutely inappreciable in the upcast air: and as a matter of fact no CO was found in the air of the shafts and stopes, either in Dolcoath or in any other mine which we visited. The method employed would have detected with certainty as little as .01 per cent.

* A complete account of these methods of analyses will shortly be published.

† The explosives used per day at Dolcoath average 125 lbs., or .36 lbs. per ton of mineral raised.

Nearly the whole of the formation of CO_2 and absorption of oxygen in the mine must have been due to chemical processes occurring in the material exposed to the air. Decomposition of timber may perhaps account for an appreciable fraction of this oxidation, but it seems probable that by far the greater part is due to oxidation of iron pyrites and consequent decomposition of carbonate, or bi-carbonate, of lime. We obtained very clear evidence on this point in the partly driven 375-fathom level, west of Harriet's shaft (see Plate I.). This level had been left unworked for a considerable time, and was not then ventilated except by its opening to the shaft. It was very hot (105°F.), and as it also had a slight rise, the warm and foul air inside could not readily escape. The air was so bad that it was impossible to keep a candle alight right up to the end. An analysis of a sample collected at about the furthest point where a candle could be kept alight, showed that the CO_2 in the air was increased by 3.32 per cent. and the oxygen diminished by 3.13 per cent. On the roof and sides of the level there were abundant deposits of hydrated oxide of iron and crystals of calcium sulphate. The lode itself contained much iron pyrites. The reactions occurring were apparently as follows:—



Bi-carbonate of lime dissolved in the water percolating the lode was coming into contact with the products of oxidation of the iron pyrites present in the lode, with the result that oxygen was disappearing and oxide of iron, sulphate of lime, and CO_2 were being formed, and that fifteen volumes of oxygen were disappearing for every sixteen volumes of CO_2 formed. Where the sulphuric acid or sulphate of iron formed comes in contact with carbonate instead of bi-carbonate only half as much CO_2 will be formed, and where no carbonate or bi-carbonate is present no CO_2 will be formed. All these conditions are met with locally. We have observed places, for instance, where the drops of water on the roof of a level were intensely acid, had the astringent taste of sulphate of iron, and gave abundantly the chemical reactions of sulphuric acid and salts of iron. In other places stalactites are formed from excess of carbonate of lime. As a rule the volume of oxygen absorbed from the air exceeds that of the CO_2 produced, as will be seen from the analyses given below. The same chemical reactions probably account for the formation of "black-damp" in coal mines.*

The following table shows the results of a series of analyses made at various points underground in Dolcoath Mine. The letters in the table correspond to those marked on the section (Plate I.), and show where the samples were taken. The composition of other samples taken at the tops of each of the upcast shafts is marked on Plate I.:—

TABLE I.—Air from Dolcoath Mine, 16th September, 1902.

Samples taken at	Oxygen per cent.	CO_2 per cent.	Oxygen diminished per cent.	CO_2 increased per cent.	Temperature.		Remarks.
					Dry bulb.	Wet bulb.	
Surface	20.94	.03	.00	.00	50.0—55.0°	—	
A.—302 fathoms level in eastern (down cast) shaft, about 12,000 cubic feet per minute passing down.	20.94	.03	.00	.00	62.0°	59.5°	
B.—Same level at end of cross-cut through granite, air being blown in.	20.82	.08	.12	.05	82.0°	81.5°	
C.—375 fathoms level, north lode, in stope	20.80	{ .11 .115 }	.14	.08	—	—	
D.—412 level, large open gunnis ...	20.85	.095	.09	.065	77.0°	76.0°	
E.—440 " " " "	20.83	.09	.11	.06	77.0°	76.0°	
F.—470 level. Rise in cross-cut north of lode. Drill idle.	{ 20.66 20.67 }	{ .22 .23 }	.275	.195	91.0°	89.0°	
G.—455 level, in engine shaft (upcast)...	20.85	.095	.09	.065	79.0°	78.0°	
H.—220 level. Taken from gig in engine shaft.	{ 20.81 20.81 }	{ .115 .115 }	.13	.035	—	—	
K.—220 level, Harriet's shaft, in upcast part 5/2/04.	—	.075	—	.045	—	—	
L.—Same level, in an end just before blasting. Drill moved back, 5/2/04.	—	.36	—	.33	—	—	
M.—375 level, off Harriet's shaft, in end 60 fathoms from shaft. Ventilated by air-pipe.	20.58	.32	.36	.29	91.0°	88.5°	
Same level, 20 fathoms from shaft. Both analyses, 28/4/03.	20.68	.26	.26	.23	92.5°	89.0°	
N.—338 level, off Harriet's. In end a few fathoms in from winze. Drill out 24/4/03.	20.84	.11	.10	.08	81.0°	—	

* See Haldane and Meachem, *Trans. Inst. of Mining Engineers*, Vol. XVI., 1899.

Samples B, H, K, and L were very carefully examined for CO, CH₄, &c., but no traces were found.

These analyses clearly show that except in some of the ends and rises the gaseous impurities met with in the air of the mine were very small in amount.

CARNBREA AND TINCROFT MINE.

This mine is on the same series of lodes as Dolcoath, and the general arrangement of the mine is somewhat similar.

TABLE II.—Air from Carnbrea and Tincroft Mine, 17th October, 1904.

Samples taken at	Oxygen per cent.	CO ₂ per cent.	Oxygen diminished per cent.	CO ₂ increased per cent.	Temperature.		Remarks.
					Dry bulb.	Wet bulb.	
In stope, 270 level, west of Martin's east shaft.	20·91	·06	·03	·03	65·0°	—	
330 level, south of same shaft, in air-current from Highborough East Shaft.	20·91	·05	·03	·02	68·5°	66·5°	
362 level, south-east of same shaft on level, midway from shaft to end.	20·86	·08	·08	·05	85·5°	85·5°	
Same level at end. Compressed air blowing out freely from open end of pipe.	20·72	·20	·22	·17	89·5°	85·0°	
390 level, south of Highborough East Shaft. On level midway from shaft to end.	20·58	—	·36	—	—	—	
At end, same level, rock drill at work ...	20·67	·235	·27	·205	90·0°	88·0°	
370 level, same shaft, half way along level to end, where rise is begun.	20·59	—	·35	—	89·5°	89·0°	
Same level, at rise 125 fathoms from cross-cut to shaft. Rock drill at work.	20·71	—	·23	—	89·9°	88·0°	

It should be remarked that the last six samples were taken in levels with blind ends. In the stopes, open levels, and shafts the air seemed to be very free from gaseous impurities. Several weeks elapsed before some of the samples from Carnbrea, West Kitty, and East Pool Mines could be analysed, and it was found that some moisture had condensed inside the glass of several of the sample bottles. As water slowly dissolves alkali from the glass, and this alkali absorbs CO₂ from the air inside the bottles,* the CO₂ determinations for these samples had to be rejected.

EAST POOL AND AGAR MINE.

This mine, which is near Carnbrea and Dolcoath, but is not so deep, has good through ventilation between the East Pool and Agar shafts. The connection was made on the amalgamation of the two mines a few years ago. The stopes are cool and fresh.

TABLE III.—Air from East Pool and Agar Mine, 21st November, 1902.

Sample taken at	Oxygen per cent.	CO ₂ per cent.	Oxygen diminished per cent.	CO ₂ increased per cent.	Temperature.		Remarks.
					Dry bulb.	Wet bulb.	
Stope, 215 level, at junction of East Pool and Agar workings.	(20·87 20·88)	—	·065	—	65·0°	—	
Stope, 212 level, at bottom of New Shaft	20·91	—	·03	—	63·5°	—	
Top of rise from 270 level, Agar Shaft, 1-hour since blasting.	20·01	·75	·93	·72	87·0°	—	No CO.
Top of rise 10 fathoms up from 212 level in New North Lode. Men out an hour.	20·51	·33	·43	·30	80·5°	—	
On 235 level above stope, near Agar Shaft (upcast). Air smoky from blasting below on stope.	20·86	—	·08	—	76·5°	—	

* Haldane, *Journal of Hygiene*, Vol. II., p. 416.

WEST KITTY MINE.

This is a comparatively shallow mine situated at St. Agnes, and differs greatly from the mines near Camborne.

TABLE IV.—Air from West Kitty Mine, 17th November, 1902.

Sample taken at	Oxygen per cent.	CO ₂ per cent.	Oxygen diminished per cent.	CO ₂ increased per cent.	Temperature.		Remarks.
					Dry bulb.	Wet bulb.	
50-fathom level in Thomas' Shaft (up-cast).	20·76	·14	·18	·11	—	—	
Off same level at end, half-hour after blasting with gelignite. Smoky.	20·13	·53	·81	·50	67·0°	66·0°	Contains ·02 % of CO.
96 level off same shaft in stope. Two hours after blasting. Still smoky. Men at work.	20·73	·15	·21	·12	67·5°	67·0°	
Cross-cut from Wheal Kitty stopes. Strong air-current. Same level.	20·74	—	·20	—	64·0°	63·0°	
65 level in end. About 1½ hours after blasting. One man working.	20·53	·305	·41	·275	69·0°	67·0°	

LEVANT MINE.

This mine is situated near St. Just, a few miles from Land's End. The workings are under the sea. There are three shafts opening on the top of the cliffs and all on the main lode, which only inclines slightly to the north. These shafts are close together. The one furthest east and inland is the man-engine shaft, and contains the only man-engine now left in England. There is almost no air-current in this shaft, as it is obstructed by the man-engine platforms; but a slight upcast current can be detected at places. The middle shaft contains the pump. At the adit level near the top a slight downcast current can be detected in this shaft, but at the bottom there is a very distinct downcast current. The shaft next the sea and furthest west is the winding shaft. In this shaft there is a very slight downcast current at the adit level, but a fair downcast current at the bottom. So far as we could ascertain by anemometer observations at the adit level, less than 5,000 cubic feet of air per minute were entering the mine. Both anemometric observations at the adit level and analyses of the air in the downcast shafts at the bottom proved that the large air-current leaving the downcast shafts at the bottom consisted mainly of air which had already circulated through the mine. This air passed upwards through old submarine workings, where it was cooled, and then entered the skip and pumping shafts (which are close together and in free communication) to pass downwards and circulate through the workings again. It felt fairly fresh, and so far as we could judge was not distinguishable by the senses from pure air. From the bottom of the skip shaft the air passes out to sea along the 278 fathoms level (pony road), and then down winzes to the deep submarine workings, from which ore is raised to the pony road by two submarine shafts with winding apparatus worked by compressed air. The workings run out about a mile under the sea. The air from the bottom workings, which are very hot, ascends through the stopes and gunnises above, where it cools and condenses moisture. The consequence is that the whole mine is damp although very little water needs to be pumped.

The mine is provided with an excellent "dry," which is reached by an underground passage from the man engine shaft, so that men coming up are not exposed to the weather until they have changed their clothes.

TABLE V.—Air from Levant Mine.

(First six samples collected 18th December, 1902; the rest collected 23rd April, 1903.)

Samples collected at	Oxygen per cent.	CO ₂ per cent.	Oxygen diminished per cent.	CO ₂ increased per cent.	Temperature.		Remarks.
					Dry bulb.	Wet bulb.	
230 level in skip shaft (strong downcast), 1 p.m.	20·58	—	·36	—	70·0°	69·0°	
278 level in skip shaft, 6 p.m. ...	20·60 20·59	·235 ·225	·345	·20	74·0°	72·0°	No CO.
230 level, 800 yards west of skip shaft, under sea.	20·44	·30	·50	·27	84·0°	84·0°	
Same level at end 1,600 yards under sea from skip shaft. No rock drill.	20·07	·62	·87	·62	80·0°	80·0°	No CO.
250 level, 1,200 yards west of skip shaft	20·35	·295	·59	·265	86·5°	86·5°	
Same level, at end about 1,600 yards from skip shaft. No drill here.	19·94	·74	1·00	·71	82·5°	82·5°	

TABLE V.—continued.

Sample collected at	Oxygen per cent.	CO ² per cent.	Oxygen diminished per cent.	CO ² increased per cent.	Temperature.		Remarks.
					Dry bulb.	Wet bulb.	
278 level near skip shaft, in main air current from skip and pumping shafts.	20·51	·265	·43	·235	72·5°	71·0°	
302 level in main air-current at bottom of long winze.	20·45	·285	·49	·255	81·5°	80·5°	
Same level, at stable, 10 fathoms east of New Submarine Shaft. Dry, little air current.	20·40	·33	·54	·30	87·5°	85·0°	
326 level. Close to escape valve for compressed air, much air blowing off.	20·43	·30	·51	·27	87·0°	84·0°	
Same level at end east of New Submarine. Compressed air blowing out of pipe about 10 fathoms back.	20·63	·22	·41	·19	92·5°	90·0°	
338 level at east end, about 10 fathoms in. Drill at work.	20·77	·15	·17	·12	88·0°	82·0°	92° after stopping drill.
Near top of Man-Engine Shaft, 2 fathoms below adit.	20·46	·285	·48	·255	69·0°	68·5°	

It will be seen from these analyses that the gaseous impurities in the air of the Levant Mine are on the whole far greater in amount than in any of the other Cornish mines visited. The difference is most marked on the open levels, stopes, &c. The air entering the mine by the downcast shaft is far more impure, chemically speaking, than the air in the upcast shafts of any of the other mines examined. Much the purest air met with was at the end of the bottom level with a drill at work. What is most striking, however, is the high temperature of the mine. Thus, following the downcast current, the temperature at the bottom of the long winze on the 302 fathoms level was 80·5°, while at the 302 fathom level in the downcast shaft at Dolcoath the temperature was only 62°. The difference is due to the restricted admission of fresh air at Levant. Levant has, however, the great advantage as regards health conditions that it is almost everywhere damp, so that there is little dust; and it has the reputation of being a relatively healthy mine. The amount of work per shift which can be done by a man is somewhat limited on account of the high temperature; and persons visiting the mine are apt to be disabled by rise of body temperature unless they divest themselves of as much clothing as possible, and carefully guard against over-exertion. The miners have a very healthy appearance; and the ponies, which live on the 278 fathom level and are never brought to the surface, seem also to be very healthy. There is no ankylostomiasis among the miners, and this is probably attributable to the fact that the water of the mine is very salt.*

LUMPSEY AND ESTON IRONSTONE MINES.

These mines are situated in the Cleveland district in the north of Yorkshire, and were selected on the advice of Mr. A. L. Stevenson and Mr. Donald Bain, H.M. Inspector of Mines, as typical examples of the mines in the district. The iron occurs in thick seams in the form of carbonate. The method of working is by pillar and stall, and the ventilation, which is produced by fan, is carefully arranged, regulated, and measured, just as in a coal-mine. Fire-damp is only occasionally met with in appreciable amounts on the edges of the goaf. The mineral is entirely got by blasting with compressed gunpowder, of which very large quantities are used. The holes are drilled by rotary drills, mostly by hand; but a number of electric rotary drills are also employed. The ore is soft and often somewhat oily; and the drills produce no appreciable quantity of dust. Some dust must be produced by blasting, but this seems to settle quickly. The air is often pretty thick from blasting, but the suspended matter carried away as smoke seems to be chiefly carbonaceous to judge from the appearance of the walls of return air-ways. Nevertheless a good deal of ironstone dust must be inhaled by the men, and this dust is probably more or less harmless.

LUMPSEY MINE, ROTTON.

The seam lies 288 feet below surface. 290 men are employed underground in one shift and 30 horses. About 330 lbs. of gunpowder are used per shift. The air-current up the upcast shaft is 85,000 cubic feet per minute.

* Boycott and Haldane, *Journal of Hygiene*, Vol. IV., p. 108, 1904.

TABLE VI.—Air from Lumpsey Mine, 29th April, 1903.

Sample taken at	Oxygen per cent.	CO ₂ per cent.	CH ₄ per cent.	Oxygen diminished per cent.	CO ₂ increased per cent.	Temperature.		Remarks.
						Dry bulb.	Wet bulb.	
Intake of Cross-cut District, 300 yards from shaft. 13,600 cubic feet per minute.	20·90	·055	—	·04	·025	56·0°	51·5°	
Middle of Cross-cut workings. Rather smoky.	20·80	·15	·025	·14	·12	63·0°	61·5°	No CO.
Return from same district, in which there are 80 men and 5 horses.	20·74	·175	·03	·20	·15	64·0°	63·0°	No CO.
South return, 195 men and 22 horses on this side. Air- current = 47,000 cubic feet per minute.	20·73	·175	·025	·21	·145	59·5°	59·5°	
Top of upcast shaft	20·75	·165	—	·19	·135	—	—	

ESTON MINE.

The mine lies under a hill, and is approached by open drifts on the hill-side used for haulage, and as intakes, though there are also downcast and upcast shafts immediately above the workings. 808 men are employed underground, nearly all in one shift, and 65 horses. The total ventilation is 270,000 cubic feet per minute. About 750 lbs. of gunpowder are used per shift.

TABLE VII.—Air from Eston Mine, 20th April, 1903.

Sample taken at	Oxygen per cent.	CO ₂ per cent.	CH ₄ per cent.	Oxygen diminished per cent.	CO ₂ increased per cent.	Temperature.		Remarks.
						Dry bulb.	Wet bulb.	
Intake of Jubilee District, a long distance from entry of intake drift. 20,000 cubic feet per minute.	20·795	·14	—	·145	·11	55·0°	54·5°	
Centre of Jubilee workings. Smoky.	20·34	·395	·04	·60	·365	61·5°	59·5°	No CO.
Return from same district, in which there are 53 men and 5 horses. Smoky.	20·39	·34	·05	·55	·31	60·5°	60·5°	No CO.

These analyses are interesting as giving for, we believe, the first time, a fair idea of the nature and sources of the gaseous impurities met with in the air of ironstone mines, where the ore occurs as carbonate.

In the cross-cut workings, Lumpsey Mine, there were 80 men and 5 horses, who would produce by respiration about 95 cubic feet of CO₂ per hour, along with about 30 cubic feet from lights, or in all about two cubic feet per minute. The ventilation was, however, 13,600 cubic feet per minute, and carried off 24 cubic feet of CO₂ per minute, or 12 times as much as was produced by the men and lights, so that nearly all the CO₂ was produced by other causes than respiration and lights. Each man used on an average about a pound of gunpowder per shift, producing about 3 cubic feet of CO₂ and CO, so that in all about 32 cubic feet of CO₂ and CO per hour or 0·5 cubic feet per minute would be produced. This quantity diluted in 13,600 cubic feet of air would be practically inappreciable by ordinary gas analysis. The impurities in the air must thus have been due almost entirely to oxidation processes occurring in the minerals.

In the Jubilee District, Eston Mine, the men, horses, lights, and gunpowder would produce about 110 cubic feet of CO₂ per hour, or 2 cubic feet per minute, while the return air was carrying off about 80 cubic feet per minute, or 40 times as much. Practically speaking, therefore, the impurities in the air had nothing to do with the presence of the men in the mine.

From the ratio between CO₂ formation and disappearance of oxygen it seems probable that most of the oxidation going on in these mines is of iron pyrites as in coal mines. The

carbonate of iron itself seems to be little liable to oxidation, and would in any case give quite a different ratio between formation of CO_2 and disappearance of oxygen. The small amounts of fire-damp in the air seemed to consist of pure methane (CH_4), as the contraction on combustion was just double the volume of CO_2 formed. This fire-damp probably came from the shale next the ironstone seam, and possibly the shale was also largely responsible for the oxidation occurring in the mine.

AIR OF COAL MINES.

As shown in the tables printed in the body of our Report, English colliers are on the whole nearly as healthy as ironstone miners, and up to the age of 55 suffer considerably less from respiratory diseases than occupied males generally. We have not thought it necessary to make any new investigations of the air of coal mines, but we may quote here the results of analyses made by one of us* by the same methods as were used in the investigations of the air of Cornish and ironstone mines. The average deficiency of oxygen in seven samples of return air was found to be 0.67 per cent. (partly due to presence of fire-damp), and the average excess of CO_2 2.55 per cent. Of this CO_2 only an extremely small fraction could have been formed by men, horses, and lights.

CONCLUSIONS DRAWN FROM THE ANALYSES.

On comparing the percentages of gaseous impurities in the air of Cornish mines with the corresponding impurities in the air of ironstone mines and coal mines it will be seen that except in "ends" and "rises" the air in the Cornish mines was, on the whole, purer. Except in the case of Levant mine, the air in the stopes, open levels and shafts was found to be surprisingly free from gaseous impurities, and even in "ends" and "rises," where it must be remembered only a comparatively small proportion of the men work, the gaseous impurities were not usually excessive.

This general result came to us as a surprise. It is certainly the case that far less attention is paid to ventilation in metalliferous mines generally, including Cornish mines, than in coal mines (with which ironstone mines may be included as regards ventilation); and metalliferous mines are commonly believed to be insufficiently ventilated. In the case of some metalliferous mines there is doubtless abundant justification for this belief; but in the existing Cornish mines the general air-supply to the stopes, &c., is certainly in most cases very free. The comparative lowness in the percentage of gaseous impurities in the air of Cornish mines, and also, as will be shown below, the comparative lowness of the temperature of the workings at corresponding depths, is due to the fact that there is much less oxidation in the exposed minerals in Cornish mines than in coal mines or ironstone mines. The fact that in spite of excellent ventilation in ironstone mines the air in them is more smoky than in Cornish mines is evidently due to the use of gunpowder in the former and nitro-glycerine explosives in the latter. In former times, when gunpowder was also used in Cornish mines, the air was very smoky. The excellent health enjoyed by ironstone miners shows, however, that very little harm arises from a little gunpowder smoke, and that the mere smokiness of air is no index whatever of its effects on health. The stone-dust produced by the pulverising action of detonating explosives is doubtless much more deleterious than the light carbonaceous smoke produced by gunpowder with its far less violent action.

The ventilation of a Cornish mine depends entirely on differences of temperature in the air of the downcast and upcast shafts, and corresponding differences of temperature in the various winzes, stopes, and gunnises throughout the mine. The shafts are small, but as they are frequently sunk on the lodes, and are consequently more or less open on either side to the workings, air can usually pass up or down very freely; and as the connections between upcast and downcast shafts are very free, through open levels, stopes, and gunnises, there is usually scarcely any resistance to the passage of air across from shaft to shaft—a very different condition from what obtains in coal mines, where there is necessarily great resistance to the passage of air round the workings from downcast to upcast shaft.

It might be supposed that variations of temperature in the outside air would very greatly affect the air-supply. For instance, the air at the top of the main upcasts at Dolcoath has a temperature of about 70° to 72° , and in summer the outside temperature is occasionally higher. Nevertheless the air currents in the shafts are not markedly less in summer than in winter. The reason of this is that the air, in travelling down the downcast shaft, is rapidly cooled to the temperature of the walls of the shaft (or warmed in winter), and this temperature varies but little at different seasons of the year, and is always much lower than that of the upcasts. In fairly deep mines, therefore, variations of outside temperature do not greatly affect the ventilation, although they certainly do so in shallow mines.

A further point, which is perhaps at first sight surprising, is that in the absence of doors, curtains, &c., the distribution of fresh air throughout the open workings is on the whole so good. This is due to the fact that the workings are usually so laid out that, except in ends and rises there are, or ought to be, communications everywhere by winzes with levels above or below. In consequence of these communications warmer air always escapes upwards. Wherever there is a stagnation the air will rise in temperature and

* *Transactions of the Institution of Mining Engineers*, 1895, Vol. VIII., p. 549, and 1896, Vol. XI., p. 272.

consequently tend to pass upwards. The distribution of air thus regulates itself automatically, provided the workings are so laid out as to allow of this automatic distribution. If the lode or deposit of ore lay horizontally there would, of course, be no such automatic distribution of the air.

Where two or more shafts are close together, and at the same time in free communication, as at Levant mine, the air of course short circuits, with the result that very little *fresh* air passes downwards, in spite of the existence of large air currents in the shafts and a good circulation through the mine of the air which exists in it.

COMPOSITION OF COMPRESSED AIR.

In accordance with our terms of reference we have made investigations into the composition of the compressed air supplied in the mines for the purpose of working rock-drills, winches, &c., and for ventilating purposes. It has been suspected that this air is contaminated in the compressors by coming in contact with heated oil, and that oily vapours and carbon monoxide and dioxide thus become mixed with the air and cause injury to men working rock-drills. The Transvaal Miners' Phthisis Commission has adopted this view, and an Appendix to their Report gives analyses showing in the case of two mines as much as .10 per cent. and .13 per cent. of CO in the compressor air, together with an excess of .06 per cent. and .02 per cent. of CO₂.

We have examined the air from three compressors—a large two-stage compressor at Dolcoath ("valvoline" oil used for lubrication), a much smaller single stage compressor at South Crofty Mine, a large single-stage compressor at Levant, and a small single-stage compressor used for experimental tests at Messrs. Holman's Rock-drill and Engineering Works in Camborne. The lubricating oils used were of very different qualities and prices. In the last-mentioned case the samples were taken direct from the exhaust of a drill, and analysed on the spot. The compressor was driven hard, so that it became extremely hot, and a cheap lubricating oil was purposely used. The results of the analyses were as follows:—

TABLE VIII.—Air from Compressors.

	Oxygen per cent.	CO ₂ per cent.	Oxygen diminished per cent.	CO ₂ increased per cent.	CO per cent.	Other hydro- carbons per cent.
Dolcoath compressed air pipe, end of morning shift.	29.91	.055	.025	.025	.00	.00
Dolcoath compressed air pipe, during shift.	—	—	—	—	.00	.00
Do. do. do.	—	.04	—	.01	.00	.00
Do. do. do.	—	.03	—	.00	.00	.00
South Crofty compressed air pipe, early in shift.	—	.035	—	.005	.00	.00
Messrs. Holman's compressor, exhaust from drill.	—	.06	—	.03	.00	.00
Do. do. do.	—	.07	—	.04	.00	.00
Do. do. do.	—	.07	—	.04	.00	.00
Levant compressed air pipe	—	—	—	—	.00	.00

These results show that the air was free from appreciable quantities of either CO or hydro-carbon vapours (their absence was ascertained by the platinum spiral method), and that the proportion of CO₂ present was so small as to be of no physiological significance. A very slight amount of oxidation did usually occur in the compressors, but so little as to be practically inappreciable.

It seems very improbable that CO can be formed in the compressors under normal conditions, as there is always an enormous excess of oxygen present, so that if oxidation occurs, CO₂ and not CO will be formed. Considering, also, that if as much as .10 or .13 per cent. of CO had been present in the compressed air referred to in the Transvaal Miners' Phthisis Commission's Report the men working drills in ends, &c., would have been rapidly disabled, we think there must have been error as to the presence of carbon monoxide in the samples examined. The same Report contains a description of a case in America of the oil in a compressor firing, with fatal results to four men working in a rise, who were poisoned by CO. Though we have not heard of any such case resulting fatally in England, we entirely agree with the Transvaal Commission in recommending that great care should be taken that only lubricating oils of very high flash-points should be used with air-compressing cylinders. A certain quantity of oil is certainly carried forward into

the pipes near a compressor, as it can be seen on the water which condenses in the receiver as the air cools;* but our analyses show that with the ordinary precautions the amount of oily vapour in the cooled air is not appreciable. We also satisfied ourselves that the air smelt quite fresh; and we have never noticed any inconvenience of any kind from breathing exhaust-air from drills in close ends or rises, although a little oil from the drills themselves is certainly often blown out.

AIR OF "ENDS" JUST AFTER BLASTING.

The following analyses, made at Dolcoath Mine, show the composition of samples obtained just after blasting.

—	Oxygen per cent.	CO ₂ per cent.	Oxygen diminished per cent.	CO ₂ increased per cent.	CO per cent.	Tempera- ture.
In end, 338 level, Harriet's shaft, just before blasting.	20.84	.11	.10	.08	.00	81.0°
Same end just after blasting with gelatine dynamite. Dust very thick and stifling.	20.51	.925	.33	.895	.05	85.0°
In end, 220 level, Harriet's shaft, just after blasting six holes with gelatine dynamite, followed by blast of water and air. Air clear.	20.71	.34	.23	.315	.065	—
		.35				
In end, 352 level, Eastern Shaft, 3 minutes after blasting two holes.	20.59	.665	.35	.635	.02	—
In end, 220 level, Harriet's Shaft, just before blasting.	—	.36	—	.33	.00	—
Same place, just after blasting, followed by blast of water and air. 5 lbs. gelatine dynamite used. Air clear.	—	1.00	—	.97	.02	—

It will be seen that in all the samples taken just after blasting small percentages of CO were present; but that the ratio of CO to the extra CO₂ due to the blasting is by no means constant. Although the percentage of CO was not formidable in any case, there can be little doubt that more than .1 per cent. would be often enough present. It should be remarked that these samples were taken almost immediately, *i.e.*, at a time when men would not go in under ordinary circumstances. It should also be remarked that with certain other explosives (*e.g.*, guncotton or blasting powder) far more CO would have been present. Nitrous fumes were not distinctly perceptible, though they were present in traces, as shown by the fact that slips of filter paper moistened with an acid solution of starch and iodide of potassium were turned blue in an end after blasting.

The following table shows the composition by volume of the gaseous products of combustion of some of the chief explosives, as ascertained by Sarrau and Vieille, Károlyi, and Noble and Abel.

—	CO ₂	H ₂ O.	N ₂ .	O ₂	CO.	NO.	CH ₄ .	H ₂ .	H ₂ S.
Nitro-glycerine, exploded under pressure ...	41.4	34.5	20.7	3.4	—	—	—	—	—
„ burnt in vacuo... ..	12.7	—	1.3	—	35.9	48.2	0.3	1.6	—
Guncotton, exploded under pressure ...	20.8	25.3	12.7	—	28.9	—	7.2	3.2	—
„ burnt in vacuo	18.4	—	5.8	—	41.9	24.7	1.3	7.9	—
Blasting powder	32.15	—	19.03	—	33.75	—	2.73	5.24	7.10
Gunpowder (Curtis and Harvey, No. 6) ...	50.22	—	34.46	—	7.52	—	2.46	3.26	2.08

It will be seen that nitro-glycerine when properly exploded gives off no poisonous gas, but that if it burns away without exploding nitric oxide is formed. Other nitro-explosives also give nitric oxide when they burn quietly. Gunpowder and guncotton give fairly large proportions of carbonic oxide, and gunpowder gives sulphuretted hydrogen, which is intensely poisonous. One pound of nitro-glycerine yields about 5 cubic feet of CO₂ on explosion. Thus 5 lbs. exploded in an "end" would probably suffice to vitiate the air for about 25 yards back with 1 per cent. of CO₂.

* The oily water ought to be blown off at frequent intervals.

Dynamite is a mixture of about 75 per cent. of nitro-glycerine with 25 per cent. of kieselguhr as an absorbent. Blasting gelatine is a mixture of about 91 per cent. of nitro-glycerine with 9 per cent. of gun-cotton. The "gelatine dynamite" or "gelignite," which is so commonly used in Cornish and other metalliferous mines, is a mixture of about 65 per cent. of blasting gelatine with about 35 per cent. of an "active" absorbent consisting of sodium nitrate and wood meal.

ACTION ON MEN OF GASEOUS IMPURITIES IN THE AIR OF CORNISH MINES.

The air of a mine may differ as regards its gaseous constituents from pure atmospheric air in several respects. The percentage of oxygen may be diminished; the percentage of CO_2 may be increased; and there may be present perceptible proportions of CO , NO_2 , or other gases.

Effects of Deficiency of Oxygen.—If air containing a diminishing percentage of oxygen be breathed no difference can be detected until the deficiency exceeds about 5 per cent. With a deficiency of 8 or 10 per cent., however, the breathing begins to become distinctly deeper, and the train of symptoms familiar to mountaineers as "mountain sickness" begins to be produced. A deficiency of about 14 per cent. or more is necessary to directly endanger life, but dizziness or fainting on exertion may occur with a less deficiency than this. The dangerous effects produced by air which is very deficient in oxygen are apt to be produced suddenly and with very few warning symptoms. Fortunately a miner is always warned by his light, which is extinguished by air deficient to the extent of 3 to 4 per cent. in oxygen. It was discovered by Paul Bert that the effects of oxygen and other gases depend on the pressure which they exercise. Thus in mountain and balloon ascents the effects of diminution in the pressure exercised by the oxygen of the air are the same as those produced by a diminution of the oxygen percentage at ordinary atmospheric pressure. It is, however, a well-known fact that an ascent of about 5,000 feet, corresponding to a diminution of about a sixth in the atmospheric pressure, produces no ill effects whatever; hence it is only what might be expected that a considerable diminution in the oxygen percentage of the air would likewise produce no ill effects. Actually, as will be shown below, any moderate diminution in the oxygen percentage in the air of metalliferous mines is usually more than compensated by other causes, so that in any air in which a light will burn the supply of oxygen to the lungs is better underground than above-ground.

Effects of Excess of Carbon Dioxide in Air.—When air containing an increasing percentage of CO_2 is breathed the effects do not become very markedly noticeable during rest until about 3 per cent. is present. The breathing is then considerably deeper and any exertion causes unusual panting. At 4 per cent. the breathing is very markedly deeper, and the rate of breathing is usually also increased. The person breathes as if he were exerting himself; and with any slight actual exertion there is marked panting. At 5 per cent. there is marked panting even during rest; and with still higher percentages the panting becomes more and more distressing. At the same time the face becomes flushed and the pulse stronger and more frequent. Headache is also apt to be produced. With more than 10 per cent. the gas begins to have a stupefying effect; and with more than about 20 per cent. it may, if breathed for a long time, prove fatal to warm-blooded animals. Air containing only about 3 to 5 per cent. may, however, be breathed by animals for weeks without causing noticeable bad effects.*

An investigation carried out by Dr. Haldane and Mr. J. G. Priestley during the course of the present enquiry has thrown considerable further light on the action of CO_2 and the part which it plays in normal breathing. It was found that the air contained in the air-cells of the lungs contains, at normal atmospheric pressure, a percentage of CO_2 which is almost constant for any individual. (A sample of this air can easily be obtained by catching in a tube the last part of a breath of air as it is expired.) The breathing is in fact unconsciously so regulated as to keep the percentage of CO_2 in the air of the lungs constant at about 5.5 or 6 per cent. Thus if more CO_2 is produced in the body the breathing becomes slightly deeper or more frequent. Similarly if the percentage of CO_2 in the air breathed is raised, the breathing becomes just so much deeper that there is no appreciable increase of the CO_2 percentage in the air of the lungs. The regulation is extraordinarily delicate, and is of course brought about quite unconsciously. If there is only 1 per cent. of CO_2 in the air breathed a very slight increase in the depth of the breathing is sufficient to effect the compensation, but with higher percentages the increase becomes more and more noticeable, particularly during any exertion. It is very difficult to suppose that any appreciable harm or inconvenience could result from the mere breathing constantly of air containing, say, less than 1 per cent. of CO_2 , as the effect on the breathing is very slight, and not more than what might be caused by an alteration of diet, or some extremely slight muscular exertion. When, however, 1 per cent. is much exceeded a man's working capacity begins to be limited by the extra demands on his breathing power. Older colliers seem to have often suffered in former times from shortness of breath, due, apparently, to emphysema, and attributed by them to bad air. This affection may perhaps have been due to the constant over-stretching of the lungs from working in air containing 2 or 3 per cent. of CO_2 . It seems to have been a common thing at one time for miners in non-fiery mines to work in air which would scarcely keep a candle alight. Such air would usually contain nearly 3 per cent. of CO_2 .

As already mentioned, the physiological effects of a gas depend upon the pressure which it exercises. For instance, the CO_2 in air containing 2 per cent. of CO_2 would

* Haldane and Lorrain Smith, *Journal of Pathology*, Vol. I., p. 168.

produce the same effects with a barometric pressure of 60 inches of mercury as in air containing 4 per cent. of CO_2 at a barometric pressure of 30 inches. The increased barometric pressure underground is thus a factor which would be expected to have some effect, and an experiment was made to test this. The percentage of CO_2 in the air of the lung air-cells was determined at the bottom of the Dolcoath engine shaft (2,240 feet below sea level) at Oxford, and at the top of Ben Nevis (4,406 feet above sea level). The average results of several determinations at each place were as follows :—

	Percentage of CO_2 in lung air-cells.		Barometric pressure in inches of mercury.	Pressure of CO_2 in inches of mercury.	
	J. G. P.	J. S. H.		J. G. P.	J. S. H.
Bottom of Dolcoath	5.57	5.01	32.7	1.82	1.63
Oxford	6.19	5.59	29.9	1.85	1.67
Top of Ben Nevis	7.065	6.165	25.4	1.79	1.56

It appears from these experiments that the percentage of CO_2 in the lung air falls in proportion as the barometric pressure rises. In other words, it is really the pressure, and not the percentage, of CO_2 that remains constant in the air-cells of the lungs.

Several interesting consequences follow from the facts just stated. Firstly, it is clear that with increasing depth and, consequently, increasing barometric pressure, the percentage, and, still more, the pressure, of oxygen in the lung air-cells rise; for the oxygen percentage in the lung air is increased in proportion as the CO_2 percentage is diminished, and *vice versa*, so that at the bottom of a mine the oxygen percentage in the lung air will be higher than at the surface. But the atmospheric pressure at the bottom is also higher, so that the oxygen pressure in the lung air is increased in two ways at the bottom of a mine. In the above experiment the percentage of oxygen in the lung air would be about .5 per cent. higher, and the pressure of oxygen would be nearly 2 per cent. of an atmosphere higher, so that the physiological effect of the air would be similar to that of air 2.5 per cent. richer in oxygen than atmospheric air and at average atmospheric pressure. Secondly, it is equally clear that even if the oxygen percentage in the mine air were diminished to a very noticeable extent it is not probable that there would be any diminution in the oxygen pressure of the lung air. For as a general rule diminution of oxygen in the mine air goes hand in hand with increase of CO_2 , and pretty nearly in the same relative proportions as in expired air. The consequence of this is that where the oxygen percentage is diminished in the air of a mine, the lung ventilation is correspondingly increased. Hence, even when the air is moderately deficient in oxygen, the oxygen pressure in the lung air will still be higher under ground than above ground. To take an example, the oxygen pressure in the lungs, and consequently the oxygen supply to the blood and tissues, must have been considerably better in a person breathing the very foul air of the deserted 375 fathom level at Dolcoath (see above, p. 82), where a candle would not burn, than on the surface.

It thus appears that on account of the peculiar physiological relations between CO_2 and the regulation of the breathing, and on account also of the increased atmospheric pressure underground, such small variations as are found in the percentage of oxygen and CO_2 in the air of the ordinary working places in Cornish mines could not by themselves cause any harm to the men. The excess of CO_2 was in all cases less than one per cent. and provided this limit is not exceeded we think there is no reason to fear any effects directly due to excess of CO_2 or diminution of oxygen. Where, however, the excess of CO_2 exceeds about one per cent. the effects on the breathing begin to become distinctly appreciable, particularly during work; the working efficiency of a man begins to be decreased, and the light given by his candle is also greatly diminished*. Probably also he is more apt to breathe with his mouth open, and at any rate he breathes more deeply, and thus absorbs more dust if dust be present. For these reasons we think that in no case should men be allowed to work regularly in air containing more than 1 per cent. of CO_2 . Air which is so foul that an upright candle will scarcely burn in it, usually contains 2 to 3 per cent. of CO_2 , and is certainly quite unfit for men to work in, although there is no danger in going into such air for a short time in case of necessity. Air in which a candle will not burn should always be assumed to be dangerous, as there is no ready means of ascertaining whether it is safe.

Excess of CO_2 and a deficiency of oxygen, though they may not in themselves be sufficiently great to be of importance, may of course be an index of other impurities, such as organic matter from the bodies of the persons present, candle smoke, poisonous gases from explosives, &c. For the general air of a mine, however, it is seldom the case that any very considerable part of the CO_2 present comes from other sources than the slow oxidation of mineral substances. This was shown to be the case by examples given above. Hence

* Angus Smith (*Appendix B to Report of the Royal Commission on Metalliferous Mines*, p. 254, 1864) estimates the diminution of light from an upright candle as being nearly five per cent. of the full illuminating power for every one per cent. of CO_2 in the air, when the CO_2 is produced by respiration or combustion of candles, and is therefore accompanied by a somewhat greater diminution of the oxygen percentage.

excess of CO_2 and diminution of oxygen have by no means the same significance in the air of mines as in the air of inhabited buildings, where a given excess of CO_2 in the air is an index of a number of important impurities arising from the persons present, the gas burning, &c. Mine air containing 5 per cent. of CO_2 may feel perfectly fresh and pleasant, whereas the air of an inhabited room vitiated to the same extent by persons or by gas burning (which produces sulphuric acid) would feel extremely unpleasant.

Effects of Carbon Monoxide.—As we did not find this gas to be present in appreciable amounts in the air of Cornish mines, except in "ends" or "rises" just after blasting, and as the action of carbon monoxide was very fully discussed in a former Report to the Home Secretary* by one of us, little need be said here on the subject. As little as .2 per cent. of carbon monoxide in air may produce fatal effects if breathed for over an hour, and .1 per cent. will gradually disable a man completely. Even .05 per cent., if breathed for several hours may cause fainting or dizziness on exertion, and probably anything over .02 per cent. will after some time reduce distinctly a man's power of doing work. Recent experiments by one of us have tended to show that this gas is in reality somewhat more poisonous than was stated in the Report first referred to.

Carbon-monoxide in appreciable proportions (.01 per cent. or more) ought certainly never to be present in air continuously breathed by miners, and was not present in any of the open workings in the mines we visited. Less than .01 per cent. would certainly make no appreciable difference to a miner however long he stayed in the contaminated air, and there is no reason to fear that the gas would gradually accumulate in the blood to such an extent as to produce symptoms.

When air is really dangerous from admixture with carbon monoxide, the presence of the gas may be recognised by the mouse test described in the above-mentioned report. The animal is simply left in the suspected air for a few minutes, when it will show very distinct symptoms if more than .1 per cent. of CO is present. If only about .1 per cent. is present the animal becomes sluggish and unsteady in gait, while with larger proportions it becomes more and more helpless, or may actually die. As the gas acts far more quickly on the mouse than on the man, it may be safely carried into a suspected atmosphere if fresh air is close at hand. Small birds may also be used for this test, but larger animals react much more slowly. The mouse may also be used indirectly in another way as a much more delicate test. The animal is killed at the place after being left about ten minutes in the suspected air, and taken to the surface, where a drop or two of its blood is obtained by opening the heart and diluted with a little distilled water. A very dilute solution of normal blood is then prepared by diluting a drop or two of blood from some one on the surface. This blood must be so diluted that it has a yellow tint by daylight when examined in a test-tube. About 5 cc. of this solution are poured into each of two test-tubes of equal size, and the solution in one of these test-tubes is saturated with CO by allowing some lighting gas to pass through rubber tubing into the test-tube, quickly closing it with the thumb, and shaking. The solution rapidly assumes the pink tint produced by saturation with CO. Some of the blood solution from the animal is then poured into a third test-tube and cautiously diluted till it has the same *depth* of colour as the other two solutions. Its tint will now appear pinker or yellower, according to the percentage of CO which was present. With about .08 per cent. of CO in the air the animal's blood will be about half-way between the pink of the saturated blood and the yellow of the normal blood; with .04 per cent. it will be about a third of the way, with .02 per cent. a fifth of the way, with .16 per cent. two-thirds of the way, and so on. The degree of saturation of the blood with CO can be roughly judged of by the eye, so that as little as .01 per cent. of CO can be detected and estimated sufficiently accurately for practical purposes. We found this method very useful in exploring the mine and testing the air in every part on the occasion of a recent fire at Dolcoath. As a general rule, however, it was easiest to determine CO on the spot with the small portable gas analysis apparatus referred to above.

In metalliferous mines CO is only produced by explosions or by underground fires so far as we are aware. Under ordinary conditions it is met with in appreciable quantities only in ends and rises after blasting. In former times, when black powder and gun cotton were extensively used for blasting, there must have been considerable risk of "gassing" by CO. Even with gelatine dynamite, etc., there is some risk if the ventilation is bad, and the charges explode badly.

Nitrous Fumes, etc.—When from any cause nitro-explosives burn quietly, instead of detonating, they give off nitric oxide (NO), which at once combines with the oxygen of the air to form the red gas nitric peroxide (NO_2). In contact with moisture this further decomposes to form nitrous and nitric acids. Persons exposed for any time to air containing much of this mixture are in great danger. The effects on the air-passages, etc., are of an irritant nature, but the irritant effect at the time is not so great that a man unaware of the real danger will always endeavour to escape at once. On the other hand the effects which may develop a few hours after the exposure are most serious. Very acute bronchitis may set in ending rapidly in death. Accidents involving the death from bronchitis of as many as 20 men at a time have, for instance, sometimes resulted from boxes of dynamite catching fire accidentally underground. Although no such serious accidents have ever occurred in Cornish mines it is well that all miners working with nitro-explosives should be aware of the danger which may arise from nitrous fumes in a close end if a shot has failed to detonate and burnt quietly instead. If this has occurred the peculiar smell of the

* Report to the Home Secretary on the Causes of Death in Colliery Explosions [C.—8112] 1896.

nitrous fumes can be detected at a considerable distance and should act as a warning to be cautious in returning. Those who do not know this smell can familiarise themselves with it by cautiously lighting a small piece of a nitro-explosive.

We have seen nothing to lead us to suppose that exposure to nitrous fumes has anything directly to do with the causation of lung disease among Cornish tin miners. With the excellent explosives and detonators used the smell of nitrous fumes is seldom prominent after a blast, though it is easy enough, by means for instance of slips of paper dipped in a solution of starch and potassium iodide, to detect traces of nitrous acid in the air of ends after blasting. Small quantities of both NO and CO seem, indeed, to be commonly formed even when shots are fired perfectly satisfactorily, and with explosives which ought theoretically not to yield either kind of gas.

Apart altogether from both CO and nitrous fumes, the "smoke" from nitro-glycerine explosives is apt to cause headaches in some persons. This is probably due to the presence in the air of very small quantities of nitro-glycerine in suspension. It is well known that contact, even through the skin, with nitro-glycerine is apt to cause severe headache in persons not accustomed to handle it, although those accustomed to it are unaffected. The headache caused by dynamite smoke seems to be of this nature, and is occasionally inconvenient. In factories where nitro-glycerine explosives are made the employees enjoy excellent health, although they are constantly handling nitro-glycerine.

THE TEMPERATURES IN CORNISH MINES.

Although, as explained in our Report (p. 11), we do not attribute the excess of lung disease among Cornish miners to high underground temperatures, we, nevertheless, think that it may be of use to discuss shortly the causes of the high temperatures observed, and their effects on men. On looking over Tables I. to V. it will be seen that at depths exceeding about 250 fathoms, or 1,500 feet, temperatures of over 80° are commonly met with in close places, such as ends or rises, and that the temperature in practically the whole of the present workings in one mine, at from 1,500 to 2,000 feet, varied from 80° to 92° . Where, as is commonly the case, the air is at the same time nearly saturated, such temperatures are at any rate a great hindrance to work, and are thus a source of much loss to both mining companies and miners.

Effects on Men of High Temperatures.—The normal body temperature of man, taken in the rectum, varies between about 98° in the early morning and 100° in the early afternoon. The mouth temperature of a person going about as usual is generally nearly 1° lower, but is liable to be further lowered by accidental circumstances, so that it is not always a reliable index of the true body temperature. During muscular work, particularly in warm weather, the rectal temperature may rise to 101° without inconvenience being caused, but a rise of more than about a degree further causes definite discomfort, and more or less disables a man for working purposes.

As heat is constantly being produced by the body it must be got rid of in some way in order to prevent the body temperature from rising; and during muscular work a greatly increased amount of heat (commonly three to six times as much) must be got rid of. The only means of giving off this heat are by conduction, radiation, and evaporation. When the temperature of the environment reaches about 100° , and the air is saturated, it is clear, therefore, that a normal temperature cannot by any means be maintained, even in a strong air current and with all clothing removed. A normal body temperature can, however, still be maintained with air temperatures above 100° , provided the wet bulb thermometer is well below 100° . When the wet bulb thermometer reads 100° , the extreme limit of temperature is reached in which a man might conceivably remain for a short time without being disabled. It is very improbable, however, that a miner could remain and continue to do any appreciable work in such an atmosphere, and the practical limit of working temperature is certainly a good deal lower. In Levant Mine men were working in saturated air at a temperature of 92° , but the work they performed was apparently very light, and they were, of course, stripped to the waist. We took the mouth temperature of two miners who had been for some hours in a temperature of 88° to 92° , and both were below 99.2° . Our own experiences in Levant Mine were somewhat different. On our first visit to this mine one of us (J. S. H.) experienced much discomfort, and the mouth temperature rose to 102.5° . Even in the cooler parts of the mine where the air temperature did not exceed 86.5° , the air being saturated, the mouth temperature of another member of the party (J. S. M.) rose to 101.5° . At the time we were only walking slowly, and had not climbed any ladders, but were wearing flannel underclothing and canvas coats. At a second visit, when we climbed down to the very warm bottom levels, where the temperature was about 92° , and afterwards climbed up, the mouth temperature of one of us (J. S. M.), who had kept on a flannel shirt and underground coat, rose to 102.2 and marked discomfort and shortness of breath were produced. In the case of another member of the party (J. S. H.) who had a light cotton shirt, open in front, the mouth temperature rose to 100.7 , though no definite inconvenience was caused. In another member (F. O.) who was similarly clad, and was an assistant manager at another mine, the mouth temperature only rose to 99.7° , and no discomfort was felt. It seems to be a common thing for visitors to the bottom parts of the mine to be considerably affected by the heat and to experience much difficulty in climbing up again. The men who are accustomed to the mine, on the other hand, appear to bear the heat perfectly well, and not to suffer at all in health. They do not, however, seem to be able to do much work.

The following are notes of observations made by one of us (J. S. H.) in the very hot 375 fathom level west of Harriet's shaft at Dolcoath, on a day when the rock drill in the end was not at work, and no air was being blown in through the ventilating pipe. The temperature of the level varied from about 90° at the entrance near the shaft to 98° in the end; the dry and wet bulb thermometers reading practically the same at all parts of the level.

- 11.30 a.m., at surface. Rectum temperature, 100.2°; mouth temperature, 99.2°.
- 12.2 p.m. Entered level and remained standing at place where air temperature was 94° dry and 93.6° wet. All clothing removed except boots and stockings, flannel drawers and canvas trousers.
- 12.15 Sweating profusely. Rectum, 101°; mouth, 99.8°. Took temperatures of two miners who had been in the end mending an air-pipe for nearly an hour, and were coming out to "cool off." In each the mouth temperature was 101.6°.
- 12.40 Rectum, 101.4°; mouth, 100.8°. No discomfort.
- 12.45 Urine, 101.5°.
- 1.0 Some throbbing of head.
- 1.7 Rectum, 101.6°; mouth, 101.5°.
- 1.12 Pulse (standing), 138. Walked slowly up and down the level till 1.20.
- 1.25 Rectum, 102.6°; mouth, 102°. Pulse (standing), 144. Marked throbbing. Breathing seems deeper, and there is a tendency to breathe through the mouth.
- 1.45 Rectum, 103.5°, mouth 102.6°. Pulse (standing), 164; (sitting), 140. Respirations, 20; the breathing being both deeper and more frequent than usual. Much throbbing, and feeling of general discomfort.
- 1.55 Came out into air-current in a short cross-cut leading to the level. Air temperature, 85.5° dry; 81.5° wet. Clothes as before.
- 2.10 Rectum, 104.2°; mouth, 102.1°. Feeling better, but head still throbbing.
- 2.20 Put on flannel shirt and canvas coat, and ascended the shaft in the gig.
- 2.30 In office near the top of the shaft. Air temperature, 60°; rectum, 103.9°; mouth, 100.7° (10 minutes observation). Pulse (standing), 124. No hyperpnea now.
- 2.42 Rectum, 103.1°; mouth, 100.2°. Pulse (standing), 122; (sitting), 106. Quite comfortable, but still perspiring. Now walked about 4-mile to main office, and drank some milk and soda.
- 3.18 Rectum, 101.2°; mouth, 99.6°. Pulse (standing), 112; (sitting), 102. No sweating now, and no discomfort.
- 3.42 After a tepid bath and dressing. Rectum, 101.1°; mouth, 98.9°. Pulse (standing), 102; (sitting), 102.
- 5.35 After lunching and returning from the mine. Rectum, 100.1°; mouth, 98.2°; urine, 99.6°. Pulse (sitting), 98.
- 11.30 Urine, 98.6°; mouth, 97.6°. Pulse (sitting), 84.
- 9 a.m., next day. Rectum, 98.2°; mouth, 97.6°; urine, 97.9°. Pulse (standing), 80; (sitting), 76.

These observations show that the subject of the experiments was unable to maintain a normal body temperature in still and saturated air at 94°. Throbbing in the head and increased frequency of the pulse were the most marked symptoms observed. The throbbing was not marked until the rectum and mouth temperatures had reached about 101.5°. It is interesting to note that on coming into cool air the rectal and mouth temperatures differed by as much as 3.2°, although the mouth was kept closed, and the thermometer was left for 10 minutes under the tongue.

Serious cases of heat-stroke appear to be practically unknown among Cornish miners, although soldiers, who may be unable to divest themselves of hot and uncomfortable uniforms, often suffer severely from rise of body temperature, even when the air is far less warm, moist, and stagnant than that to which miners are commonly exposed; and fatal cases of heat-stroke among soldiers occur occasionally even in England. A miner has the advantage that he can divest himself of his clothing and can stop work if he feels too hot. When, however, he is compelled to protect himself against rise of body-temperature by frequent rests his work is, of course, greatly hindered. When the temperature indicated by the wet bulb thermometer exceeds about 85°, continuous hard work in a mine seems to be hardly possible. Horses in hot collieries are particularly liable to fatal injury from rise of body temperature unless the greatest care is taken that they are not over-driven or stinted as regards their supply of water.

The high temperatures met with in mining operations are sometimes set down as unavoidable, and due simply to the natural high temperature of the rock, or of the lode itself, or to the heating effects of explosives, lights, and men. On the other hand it is sometimes assumed that by sufficient ventilation the workings can be cooled down to the temperature of the air above-ground. Considerable diversity of opinion evidently exists on the whole question. It is thus desirable to discuss one by one the factors which determine the temperature in any part of a mine.

1. *Natural temperature of the rock.*—It is well known that the natural temperature of the rock increases steadily with depth. Numerous reliable observations in deep bore-holes, shafts, virgin coal, &c., indicate that on an average there is an increase of about 1° F.

for every 70 feet* of depths from the surface. The results differ very distinctly at different places, however. For instance at Rose Bridge Colliery the increase observed was 1° in 54·5 feet, while at Hamstead† and Baggeridge Wood‡ Collieries in South Staffordshire the increase was only about 1° in 110 feet.

No very reliable data seems to have hitherto been published as to natural rock-temperatures in Cornish Mines. As will be explained below, rock-temperatures taken in boreholes close to workings which have existed for some time may be either above or below the natural temperature of the rock, according as the cooling effects of air and water from above, or the heating effects of oxidation and warm air or water from lower levels happen to predominate. We have, therefore, made several observations at Dolcoath in virgin granite at a considerable distance from the present workings. The first three observations were made in 4½-foot bore-holes during the sinking of a new vertical shaft, about a quarter of a mile south of the present workings, and the other three in similar boreholes at the ends of two long cross-cuts driven southwards in the granite towards the line of the new shaft (see Cross Section, Plate II.). The temperatures observed were as follows :—

	°F
At 900 feet	62
„ 1000 „	67
„ 1100 „	69
„ 1210 „	71
„ 1520 „	76·5
„ 2160 „	87·5
„ 2160 „	87·5

The mean temperature on the surface at Dolcoath is about 51°. Hence the mean rate of increase to 2,160 feet was 1° in 59·2 feet, to 1,520 feet 1° in 59·6 feet, and to 1,210 feet 1° in 60·5 feet. The observation at 900 feet is probably unreliable, as a good deal of water was met with at this point. It would thus seem that at Dolcoath the rate of increase is about 1° in 60 feet. This would give a natural rock temperature of about 95° at the 455 fathom level of the present workings, although even in the main upcast shaft the actual air-temperature at this level is only about 79°. The actual temperatures in boreholes a few feet deep off the lower open levels of the present workings are mostly near the air temperatures at the same places, and are usually much below the calculated natural rock-temperature (see Plates I. and II.). In some places, however, the air temperatures observed are above the calculated natural rock-temperatures. For instance in the (at that time deserted) 375 fathom level west of Harriet's shaft an air-temperature of 105° was observed, whereas the natural rock-temperature must have been only about 89°. This level, as explained above (page 82) had been abandoned for some time, and was very hot, apparently from the rapid oxidation indicated by the composition of the air.

Production of heat in mines.—There are several means by which heat is *produced* in mines. Thus the persons present, the lights, and the explosives all produce heat by oxidation. Another and enormously more important source of heat is, however, commonly ignored, namely the production of heat by oxidation of the exposed minerals. To obtain some rough idea of the practical influence on the mine temperature of these sources of heat, the easiest method is to calculate what effects the heat produced by them would have on the temperature of the air, assuming that all the heat produced by them were taken up by the air current. To make this calculation it is necessary to know (1) the percentage of oxygen which the air has lost by oxidation; (2) the extent to which the heat production corresponding to a given percentage loss of oxygen is capable of heating the air.

It was shown above intypical cases, such as that of Dolcoath Mine (page 81) and Lumpsey and Eston Mines (page 86), that oxidation by men, horses, lights, and explosives is small in comparison with the oxidation of minerals; also that the oxidation of mineral matter is in all probability chiefly of iron pyrites. We may therefore approximately calculate the heat production in a mine on the assumption that the oxidation is of iron pyrites. It would, however, make little difference to the calculation if the oxidation were of other material, such as carbon and hydrogen.

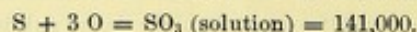
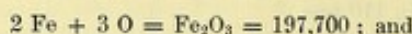
The actual heat of combustion of iron pyrites does not seem to have been experimentally determined as yet; but it can be calculated approximately from the heats of

* The older observations gave a much higher rate of increase on an average, but a good many of the observations were unreliable. Professor H. B. Dixon (First Report of the Royal Commission on Coal Supplies, Vol. II., page 116) quotes a number of observations giving a mean of 1° F. per 69 feet in boreholes passing through the carboniferous strata, and 1° in 76 feet for older formations.

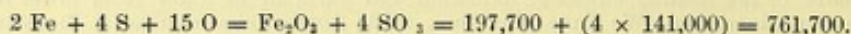
† Meachem, *Trans. Institution of Mining Engineers* Vol. VIII., 1895, Haldane and Meachem, *Ibid* Vol. XVI., 1899.

‡ Atkinson, *Report of the Royal Commission on Coal Supplies*, Vol. II.

combustion of iron and sulphur. The heat of formation of ferrous sulphide (FeS_2) is exceedingly small ($\text{Fe} + \text{S} = 24,500$),* and the same is doubtless true for iron pyrites (FeS_2). The equations for the heats of combustion of iron and sulphur are as follows:—



Combining these equations so as to obtain the heats of combustion of iron and sulphur in the proportions in which they exist in iron pyrites,



A small addition would be needed to represent the further heat liberated in the decomposition of calcium carbonate by sulphuric acid, but this may be left out of account, as the decomposition in question may only occur partially (see page 82), and the heat of formation of iron pyrites, which would tell in the opposite direction, has also not been allowed for.

From the above equation it follows that, as the atomic weight of oxygen is 16, for every $15 \times 16 = 240$ grammes of oxygen consumed in oxidising iron pyrites, sufficient heat is liberated to raise 761,700 grammes of water 1°C ., or for every gramme of oxygen consumed about 3,170 grammes of heat are liberated. The specific heat of air is $\cdot 24$; 1 gramme of oxygen = $\cdot 70$ litre; and 1 gramme of air = $\cdot 77$ litres. Hence the consumption of $\cdot 70$ litres of oxygen would liberate sufficient heat to warm $\frac{3,170}{\cdot 24} \times \cdot 77 = 10,170$ litres of air by 1°C . In other words the consumption of one part by volume of oxygen in 14,530 of air, or $\cdot 007$ per cent., would give heat enough to raise the air current 1°C . or $1\cdot 8^\circ \text{F}$.; and the consumption of $\cdot 01$ per cent. of oxygen would give heat enough to raise the air-current $1\cdot 45^\circ \text{C}$., or $2\cdot 6^\circ \text{F}$., provided none of the heat was absorbed in evaporating water.

This calculation shows the great significance, in relation to underground temperature, of the slight changes in composition undergone by air in passing through a mine; for a diminution of even as little as $\cdot 1$ per cent. in the oxygen of the air passing through the mine will correspond to a heat production sufficient (apart from evaporation) to raise the temperature of the air by 26°F ., and this heat production might entirely neutralise the cooling effect which ventilation would otherwise produce.

It may be well to state here that the percentage loss of oxygen by air in travelling through a mine is not quite the same thing as the diminution in the percentage of oxygen; for in the first place part of this diminution may be due (in coal mines at least) to the addition of fire-damp to the air; and, secondly, the real loss of oxygen may be partly masked by the fact that, as is nearly always the case, the air has been diminished in volume by the oxidation processes, the volume of CO_2 formed being smaller than the volume of oxygen absorbed. Hence it is necessary to calculate from the nitrogen percentage in the return air the original volume of oxygen corresponding to the percentage of oxygen found in the return air. For instance, in the air at the bottom of the downcast shafts at Levant Mine, the oxygen percentage was diminished by $\cdot 49$ per cent. (i.e., from 20.94 to 20.45 per cent.), and the CO_2 increased by $\cdot 255$ per cent., while the nitrogen percentage was increased from 79.03 to 79.265. Hence the original volume of oxygen corresponding to the 20.45 actually found must have been $20.94 \times \frac{79.265}{79.03} = 21.00$. The real loss of oxygen by the air thus amounted to $\cdot 55$ per cent. The difference in this case is not very great, but the proper method of calculation should be kept in mind, particularly in the case of coal mines.

Where heat is produced by the combustion of explosives, which contain their own oxygen, the heating effect must of course be calculated directly from the weight of explosive used; but, as shown above, the heat liberated by explosives amounted to only a very minute fraction of the total heat formed in the mines which we investigated.

On examining the analyses quoted in Tables I. to V. of the air in "ends" and "rises" it will be seen that, apart altogether from the gases produced by explosives, the air in these situations commonly contains $\cdot 2$ or $\cdot 3$ per cent. less oxygen than in the neighbouring shafts and open levels. The oxidation is thus sufficient to raise the temperature of the air by 50° to 80° , or by 12° to 20° , allowing for the heat rendered latent by evaporation. It is thus only to be expected that, as is actually the case, high temperatures should be met with in "ends" and "rises," in spite of such ventilation as ordinarily exists. Much of the heat formed by oxidation will of course be absorbed by the rock, but the layer of rock immediately surrounding the "end" or "rise" will thus be raised above the natural rock-temperature.

* The data quoted are from Berthelot's *Thermo-Chimie*, Vol. II. The figures given indicate the number of unit weights of water raised 1°C . for each unit weight of either of the elements entering into the reaction, multiplied by the atomic weight of the element and by the number of atoms of it required to form a molecule of the resulting substance. Thus, in the above reaction, 1×56 grammes of iron give 24,500 gramme calories.

Warming and Cooling of Mine Air by Compression and Decompression.—To understand the effects of air-currents on the temperature of mines it is necessary to take into consideration that air is warmed by compression and cooled by expansion. It follows from this that the air in descending a dry downcast shaft is on an average necessarily heated to some extent, since the barometric pressure is greater at the bottom than at the top. This heating effect, and the corresponding cooling in the upcast, is of course quite independent of the increase in the natural temperature of the strata, and its true cause is commonly overlooked. The increase of temperature from compression amounts to about $5\frac{1}{2}^{\circ}$ F. for every 1,000 feet of descent, whereas the natural temperature of the rock usually increases about 14° F. per 1,000 feet. It appears to be the case in most downcast shafts, if the fresh air reaches the bottom undiluted and in sufficient volume, that the mean temperature at the bottom exceeds the mean temperature at the top by an amount only which corresponds to the heating effect of compression.* The air in its passage down a shaft will naturally cool to its own mean temperature the rock surrounding the shaft, and after a shaft has been in use for some time the layer of cooled rock surrounding it will extend outwards for a considerable distance, and thus place such an effective barrier between the air of the shaft and the naturally warm rock through which it has been sunk, that the warming effect of the rock on the air will on an average be slight. This layer of rock surrounding the shaft has also the effect of steadying the temperature of the air in the shaft, so that the variations of temperature in the shaft are far less than in the outside air. Thus in warm weather the temperature at the bottom of a shaft may be actually lower than in the outside air, while in cold weather it will be far higher.† Rock-temperature observations in bore-holes a few feet deep off a shaft or air-way which has been in use for some time will of course only give approximations to the mean temperature of the air in the shaft, and not to the natural rock-temperature. This fact is clearly shown by observations which we have made at Dolcoath. Thus in the 220 fathom cross-cut to Williams' shaft (Plate II.) the temperature in a $4\frac{1}{2}$ feet bore-hole in the virgin granite was 76.5° and the air temperature 80° . At the same place a year later, after a strong intake air current had been passing for a year, the rock-temperature $4\frac{1}{2}$ feet in was only 58.7° , the air-temperature being 55° . To quote another instance, the temperature in a bore-hole $4\frac{1}{2}$ feet in the rock at the 302 fathom level in the eastern (downcast) shaft (see Plate I.) was 67° , with an air-temperature at the same level of 59° to 62° . The natural rock-temperature at this point must have been about 83° . The temperature in a $4\frac{1}{2}$ feet bore-hole at the 60 fathom level in the engine shaft (upcast) was found to be 71.5° , the air-temperature being 73° . The natural rock-temperature at this level would be about 60° .

In consequence of warming by compression the air at the bottom of a dry downcast shaft will tend to be relatively less saturated with moisture than at the surface, although actually the dew-point will be higher, since the pressure of aqueous vapour in the air has been increased in proportion to the increase of atmospheric pressure. Thus the air at the bottom of a colliery shaft is usually very dry, and along a dry intake road the dryness of the air will tend to increase further as the air is gradually warmed by the heat of the mine. In Cornish mines, however, where the shafts are usually moist and the air-currents not very rapid, the air at the bottom of a downcast shaft is usually nearly saturated. Thus in the eastern shaft at Dolcoath the air-temperature at the 302-fathom level, about 1900 feet from surface in November (at the end of summer) was found to be 62° , and in April (at the end of winter) 59° . The mean temperature at this level thus appears to be about 10° above the mean surface temperature. The amount of heat absorbed by the air in passing down this shaft is, however, much greater than appears from the rise of temperature, since the air has taken up a good deal of moisture in passing downwards, so that at the 302-fathom level there is only 1° of difference between the wet and dry bulb temperatures. Roughly speaking $1\frac{1}{2}$ times more heat has been taken up in the latent form than what can be accounted for by heating due to compression. In a large shaft with a rapid air-current nearly the whole of the heat taken up by the air-current in descending will be due to compression. The conditions are complicated if, as is the case, for instance, below the 302-fathom level in the Eastern shaft at Dolcoath and at higher levels in the Stray Park downcast shaft, warm and moist air from the workings mixes with the downcast air in the shaft.

In an upcast shaft the air of course cools by expansion as it rises. Since, however, the air at the bottom of an upcast shaft is almost always nearly saturated, the consequence of the cooling is that moisture is condensed in the form of mist. The latent heat of the aqueous vapour is thus liberated, so that air in ascending an upcast shaft is not actually cooled by expansion nearly so much as the air in the downcast is heated by compression. Roughly speaking, cooling of saturated air by expansion will only amount to about 2.0° per 1,000 feet, in place of $5\frac{1}{2}^{\circ}$ of heating by compression in a downcast shaft. In actual practice the average cooling of upcast air as it ascends seems always to be more than 2.0° per 1,000 feet, since heat is lost to the surrounding rock, particularly in the upper part of the shaft. At Dolcoath the average cooling is about 3° per 1,000 feet. In some shafts, however, the cooling is little more than 2° per 1,000 feet.

* See Haldane and Meachem, "The Relation of Underground Temperature to Oxidation, &c.," *Transactions of the Institution of Mining Engineers*, Vol. XVI, 1899.

† For instance, Haldane and Meachem record a temperature of 62° at the bottom (1880 feet below surface) of Hamstead Colliery downcast shaft in summer, with a surface shade temperature of 67° . The mean annual temperature at the bottom of this shaft is about 60° .

We are indebted to Mr. P. J. Kirkby, Fellow of New College, Oxford, for the following account of the cooling and heating effects of changes of atmospheric pressure in upcast and downcast shafts:—

UPCAST SHAFT.

- Let a = the weight of 1 c.c. of air at temperature θ° centigrade and pressure 760 millimetres of mercury.
 k = the specific heat of air under constant volume.
 s = the specific heat of water vapour under constant volume.
 w = the weight of saturated water vapour mixed with the weight a of air.
 f = the tension in *mm.* of mercury of the saturated water-vapour.
 λ = the latent heat of the water-vapour.
 t = the temperature centigrade of the mixture.
 v = the volume in cubic centimetres occupied by the weight a of air and by the weight w of vapour at any stage of the upward motion of the mixture.
 J = the mechanical equivalent in ergs of one calorie of heat.

Since the velocity of these associated masses up the shaft is practically constant, it will not enter into the thermodynamic equation which connects the variations of their common volume and temperature.

This equation is evidently

$$\lambda dw + kadt + swdt + \frac{1}{J} (p + f) dv = 0 \quad (1),$$

since no heat is supplied from without, and $(p + f) dv$ is the mechanical work done by the expansion.

Now,

$$s = .37 \quad k = .17$$

and $\frac{w}{a} = .62 \times \frac{f}{760}$, while f will not as a rule exceed 25.

Therefore,

$$\frac{sw}{ka} = .045 \text{ about.}$$

If then the approximation admits an error of 5 per cent. sw may be neglected in comparison with ka , and f in comparison with p .

Equation (1) thereupon takes the simple form.

$$\lambda dw + kadt + \frac{pdv}{J} = 0 \quad (2).$$

Of these quantities

$$\lambda = 606 - .7 \times t \text{ nearly,}$$

and so may be considered constant and equal to 590;

$$\text{and } w = .62 \times \frac{.0013}{760} \times \frac{fv}{1 + at}$$

where $a = \frac{1}{273}$.

It remains to express f in terms of t . It will be found from the table of aqueous vapours that, within a five-per-cent. error limit,

$$f = t - 2, \text{ when } t \text{ lies between } 12^\circ \text{ and } 26^\circ \text{ centigrade,} \\ \text{while } f = t, \text{ when } t \text{ lies between } 26^\circ \text{ and } 30^\circ.$$

Therefore, approximately,

$$w = .62 \times \frac{.0013}{760} \times v \frac{1 + at - \beta}{a(1 + at)} \text{ grams} \\ \text{(where } \beta = 1 + 2a, \text{ or } 1.) \\ = .00029 \times \frac{\theta - \beta}{\theta} v \text{ grams} \\ \theta \text{ being } = 1 + at$$

Therefore

$$\lambda dw = .17 d. \left[\frac{\theta - \beta}{\theta} v \right] \text{ calories.}$$

Again

$$kadt = \frac{kad\theta}{a} \\ = .17 \times .0013 \times 273 d\theta \\ = .06 d\theta \text{ calories.}$$

To express $\frac{pdv}{J}$ in calories, it is to be remarked that $\frac{pv}{\theta} = 76 \times 13.6 \times 981 = 10^4$ ergs nearly, while

$$J = 42 \times 10^4 \text{ ergs as equivalent to one calorie of heat.}$$

Therefore

$$\frac{pdv}{J} = \frac{1}{42} \frac{\theta}{v} dv = .024 \frac{\theta}{v} dv$$

The approximate equation (2) now becomes

$$.17 d \left[\frac{\theta - \beta}{\theta} v \right] + .06 d \theta + .024 \frac{\theta}{v} dv = 0 \quad (3)$$

or if, $A = 2.8$, $B = 4$

$$A \frac{d}{d\theta} \left(v - \frac{\beta v}{\theta} \right) + B \frac{\theta}{v} \frac{dv}{d\theta} + 1 = 0$$

Let $\frac{v}{\theta} = z$, then the equation (3) assumes the form

$$\frac{d\theta}{dz} + \theta \frac{Az + B}{z(Az + B + 1)} = \frac{A\beta}{Az + B + 1}$$

the integral of which is

$$\theta z^{\frac{B}{B+1}} (Az + B + 1)^{\frac{1}{B+1}} = A\beta \int \left(\frac{z}{Az + B + 1} \right)^{\frac{B}{B+1}} dz + \text{a constant} \quad (4).$$

Now $z = \frac{v}{\theta} = \frac{760}{p}$ if p is measured in millimetres of mercury.

Therefore, if

$$z = 1 + u$$

u will be at the most $\frac{1}{5}$ about, and (4) will then, on replacing A , B by their values, become

$$\theta (1 + u)^{\frac{2}{7}} \left(1 + \frac{2u}{3} \right)^{\frac{5}{7}} = \frac{2\beta}{3} \int \left(\frac{1 + u}{1 + \frac{2u}{3}} \right)^{\frac{2}{7}} du + \text{a constant.}$$

or with u^2 neglected

$$\theta \left(1 + \frac{2u}{7} - \frac{5u^2}{49} \right) \left(1 + \frac{10u}{21} - \frac{5}{49} \times \frac{4u^2}{9} \right) = \frac{2}{3} \left(u + \frac{u^2}{21} \right) + \text{a constant.}$$

Therefore to our order of approximation, since $\theta = 1 + \alpha t$,

$$(1 + \alpha t) \left(1 + \frac{16u}{21} \right) - \frac{2\beta u}{3} = \text{a constant,}$$

or

$$\alpha t + \frac{16 - 14\beta}{21} u + \frac{16 \alpha t u}{21} = \text{a constant.}$$

Now when t lies between 12° and 26° centigrade,

$$16 - 14\beta = 2 - \frac{28}{273} = 2.$$

with not much more than about a 5 per cent. error; or, if t is greater than 26° , and not greater than 30° , $16 - 14\beta = 2$ still more accurately.

Therefore,

$$\frac{t}{273} + \frac{2u}{21} \left(1 + \frac{8t}{273} \right) = \text{a constant} \quad (5).$$

But,

$$u = z - 1, \text{ where } z = \frac{v}{\theta} = \frac{760}{p} \text{ if } p \text{ is measured in millimetres of mercury, or } z = \frac{30}{P} \text{ if } P \text{ is the pressure measured in inches of mercury.}$$

Therefore,

$$t + \frac{2}{21} (273 + 8t) (z - 1) = \text{a constant};$$

or

$$16tz + 5t + 546z = \text{a constant};$$

or

$$(t + 34)(z + .31) = \text{a constant.}$$

If then, p_0, t_0 are the pressure and temperature centigrade at the bottom of the upcast shaft, p, t corresponding quantities at the top, $(t_0 + 34) \left(\frac{760}{p_0} + .31 \right) = (t + 34) \left(\frac{760}{p} + .31 \right)$ (6), p, p_0 being measured in millimetres of mercury. Or, if the pressures are P_0, P measured in inches of mercury, $(t_0 + 34) \left(\frac{30}{P_0} + .31 \right) = (t + 34) \left(\frac{30}{P} + .31 \right)$ (7).

It is scarcely necessary to remark that these formulas apply to the temperatures and pressures of any two points in the upcast shaft where the air is saturated with water-vapour.

The last formula may be more conveniently written

$$(t_0 + 34) \left(\frac{1}{P_0} + .01 \right) = (t + 34) \left(\frac{1}{P} + .01 \right) \quad (8).$$

As an example let the temperature at the bottom of an upcast shaft 1,800 feet deep be 20° centigrade. The pressure will be about 32 inches at the bottom and 30 inches say at the top.

Then,

$$(t + 34) \times .043 = 54 \times .041, \text{ so that } t = 18^{\circ} \text{ about.}$$

Thus the cooling due to expansion = 1° C. per 900 feet, or 2° F. per 1,000 feet of ascent.

N.B.—In formulas (6), (7), (8), t is measured on the centigrade scale.

DOWNCAST SHAFT.

During the descent of air, whether nearly saturated with aqueous vapour at the top of the shaft or not, no water vapour will be condensed; on the contrary, owing to the compression and consequent rise of temperature the vapour will depart further from its point of condensation. Therefore, with an error of not more than 2 or 3 per cent. at the most, the connection between the pressure p and volume v of a given mass of gas throughout its descent will be the well known adiabatic equation of a perfect gas

$$pv^{1.4} = \text{a constant (9).}$$

This may also be obtained at once from equation (3) above without its first term; viz. from

$$.06 \frac{d\theta}{\theta} + .024 \frac{dv}{v} = 0,$$

the integral of which is obviously

$$\theta v^{.4} = \text{a constant.}$$

For since $\frac{pv}{\theta} = \text{a constant}$, the last equation is equivalent to $pv^{1.4} = \text{a constant}$.

Again,

since $\frac{pv}{273 + t}$ is also constant, where t is the temperature centigrade, it follows at once from equation (9) that

$$\frac{p^{\frac{1}{1.4}}}{273 + t} \text{ is constant.}$$

If then p_0, t_0 are the pressure and temperature centigrade of the bottom of the shaft, and p, t apply to the top,

$$\left(\frac{p_0}{p}\right)^{\frac{1}{1.4}} = \frac{273 + t_0}{273 + t}$$

or, just as accurately,

$$\frac{p_0 - p}{p} = \frac{t_0 - t}{83} \text{ centigrade (10).}$$

For the Fahrenheit scale temperature and any scale of pressures

$$\frac{p_0 - p}{p} = \frac{T_0 - T}{150} \quad (11).$$

It may be added that (10) and (11) apply to any part of the upcast shaft where the water vapour is not saturated, so that the cooling from expansion in the upcast shaft may be determined by a combined use of equations (6) or (7) with equation (10), unless it is known that the air is saturated with water vapour at the bottom of the upcast shaft. In the latter case (6) or (7) alone will apply.

Cooling effects of Ventilation.—The cooling effect of air underground is partly due to its own temperature being below that of the rock and partly to heat becoming latent through evaporation of moisture. At the temperatures existing in deep mines the latter process is by far the more important one, and its relative importance increases the higher the temperature. This follows from the fact that the tension of aqueous vapour increases with rise of temperature much more rapidly in proportion than does the temperature itself, as is shown by the following table:—

Temperature.	Tension of Aqueous Vapour in inches of mercury.
50°	.36
60°	.52
70°	.73
80°	1.02
90°	1.41
100°	1.92

The heat absorbed in raising by evaporation the tension of aqueous vapour in air by .01 inch is about equal to that required to raise the temperature of dry air 1° F. Hence saturated air at 60° in rising to 61° and becoming again saturated will absorb nearly twice as much heat by evaporation as by mere warming, but saturated air at 90° will in rising to 91° and becoming again saturated absorb nearly 5 times as much heat by evaporation as by mere warming. The total cooling effect for a rise of 1° in the temperature of saturated air is thus twice as much at 90° as at 60° .

A given volume of rock, such as granite, weighs about 2,000 times as much as an equal volume of air, and the specific heat of air is about .24, while that of granite is .2. Hence if an air current of 1,000 cubic feet per minute, or 1,440,000 cubic feet for 24 hours, rises 1° in passing along an airway in a mine, it will carry off sufficient heat to cool 860 cubic feet of rock by 1° . Thus if the length of airway be 100 feet long and 40 feet in circumference, sufficient heat will be carried away to cool by 1° F. a layer of rock $\frac{860}{4000} = .21$ foot in thickness. If the airway is damp and the air is saturated both before and after it passes along the airway, and the temperature is about 80° , the heat carried away will be about 4 times as great. It is evident enough from this example that the gradual cooling action of air is very great provided that heat production by oxidation does not neutralise the effect. In downcast shafts, etc., where, even in Cornish mines, there is commonly an air current of more than 10,000 cubic feet per minute, the effect must be to gradually cool down a very extensive layer of rock round the shaft. In the upper parts of the workings and upcast shafts the warm air from below will of course have a corresponding warming effect on the surrounding rock.

It will be seen from Plates I. and II. and Table I. that in or about the upper parts of the upcast shafts at Dolcoath, the actual rock temperatures and air temperatures are far above the natural rock temperatures, whereas in the downcast shafts the actual air and rock temperatures are far below the natural rock temperatures. In all the open workings at lower levels the actual air and rock temperatures are also much below the natural rock temperatures. In ends and rises, however, the air temperatures are much nearer the natural rock temperatures, but usually above them in consequence of heat production from oxidation, combined with restricted ventilation, particularly when rock drills are not at work.

Cooling Effect of Water.—In Cornish mines there is a constant drainage of water, partly through the workings, and partly through fissures in the lodes, &c., to the sumps at the bottom of the pumping shafts. This water certainly comes from the surface, as is shown by the fact that its amount is largely dependant on rainfall. In consequence of the very excessive rainfall during 1903 the bottom workings at Dolcoath and other neighbouring mines have recently been flooded, although the pumps, which are ordinary far more than sufficient to deal with all the water, have been working continuously at full speed. The water which thus penetrates to the bottom will of course absorb heat as it passes down, and must thus help very materially to cool the rock. The cooling effect of water from above was well illustrated in the case of the Simplon tunnel, where much water has been met with. It was found that this water when first tapped was warm, but that as the fissures containing it were gradually emptied its temperature fell steadily.

The water met with in mining operations sometimes has a temperature higher than the natural rock temperature. Such water is evidently coming up from greater depths, in the same way as water rises in an artesian well, and the high temperatures caused by it may be a source of much difficulty.

Discussion of Observed Air-Temperatures.—On looking over the air-temperatures actually observed (Tables I. to VII., and Plates I. and II.) in the mines investigated it will be seen that they are very clearly dependent on (1) depth from surface, (2) air-supply, and (3) oxidation in relation to air supply. In general the air-temperatures increase with depth; but where the air supply is abundant in relation to the oxidation in the mine the air-temperatures are far lower than where the air supply is restricted. For instance at the 302 fathom level at Dolcoath (1,900 feet below surface) in a downcast current of pure air the temperature was 62° in November at the end of summer, and 59° in April at the end of winter, whereas at the 302 fathom level in Levant (about 1,700 feet below the sea), in a downcast current of air with the oxygen percentage diminished by .49 per cent., the temperature was 81.5° . In general the temperature of the open workings in Levant mine, with its relatively restricted air-supply, is nearly 20° degrees higher than in the freely ventilated mines in the Camborne district at corresponding depths. The reason is that whereas in the Camborne mines the free ventilation has a powerful cooling effect, the restricted admission of air at Levant has gradually warmed up the whole mine by oxidation. The loss of oxygen by the air of the mine averages about .6 per cent., corresponding to oxidation sufficient to heat the air-current to boiling-point, apart from the effects of evaporation, or 95° allowing for vaporation. In the shallower mines, such as West Kitty or the ironstone mines examined, the ventilation is also insufficient to carry off the heat produced by oxidation, and the observed air temperatures in the workings are thus all considerably above the calculated natural rock-temperatures, instead of considerably below them, as in the deep mines of the Camborne district. It is interesting to note that at Levant mine the temperature in the ends on the 230 and 250 fathom levels is about 4° lower than in the open level and stopes at the same depth. This is presumably due to the fact that in the older workings the rock surrounding the mine has had longer time to warm up. In the Camborne mines on the other hand, the ends and rises are always warmer than the open workings, which have been cooled by the ventilation. In the open workings in the latter mines the oxygen is seldom diminished by as much as .1 per cent.; hence, allowing for the heat absorbed into the air by evaporation, oxidation would not heat the air by more than about 6° or 8° . At the deep levels, therefore, the ventilation has a powerful cooling effect, far more heat being withdrawn by the air-current than is formed by oxidation.

Coal mines are commonly supposed to be much more efficiently ventilated than Cornish mines, but we know of no coal mine where the heat withdrawn by the upcast air current is not exceeded by the heat formed by oxidation in the strata.*

It seems clear that as mines become deeper more and more attention will need to be paid by mining engineers to the problem of controlling the high temperatures met with. So far as temperature is concerned there seems to be no reason why, with proper attention to all the conditions on which high air temperatures depend, much greater depths than those already attained should not be reached.

The difficulties from oxidation in coal mines could doubtless be avoided to a considerable extent by suitable methods of laying out the workings and by sufficiently increasing the air supply. In metalliferous mines such as those of Cornwall the amount of oxidation is slight as compared with that in coal mines, so that trouble arising from high temperatures can be overcome down to great depths without any recourse to artificial ventilation except in ends and rises.

VENTILATION OF ENDS AND RISES.

In a Cornish mine, or any mine laid out on the same general principle, the ventilation of all open workings, where the air is free to rise through winzes, &c., adjusts itself in the manner previously described (page 87), provided that there are downcast shafts sufficiently separated off from the upcast air-ways. In ends driven some distance from a shaft or winze, and particularly in rises, the hot and foul air has, however, no ready means of escape. In such places the cool and very dry air from the exhausts of rock-drills is of great value, but is often insufficient to keep down the temperature, and is of course not available just after blasting. Under these circumstances artificial ventilation of some kind through air pipes is usually desirable. The simplest and most easily available motive power for driving the air along the pipes is that afforded by a small jet of the compressed air used for working the drills, and this has been much used for the purpose. A far higher mechanical efficiency could certainly be attained by using small fans, or by water-sprays, but an air jet has great advantages on the score of simplicity and convenience. In Cornwall a special form of air jet ventilator devised by Mr. W. Teague has been much used.†

We have made a number of observations in order to obtain some rough ideas as to the amount of air which is driven through lengths of ordinary ventilating pipe by a simple air-jet blowing into the mouth of the pipe. A length of pipe 150 feet long was made in the ordinary way by jointing together by spigot and faucet joints (each of which was made tight by a layer of cloth) a number of 6-feet sheet-iron pipes. A fine nozzle connected with the compressed air main was then introduced into the centre of the ventilating pipe and pointed along it. The amount of air driven along the ventilating pipe was then measured with a tested anemometer at the far end. The amount of compressed air passing through the nozzle was separately measured by means of a large gas-meter. The following results were obtained:—

Approximate diameter of nozzle in inches.	Diameter of ventilating pipe in inches.	Flow of air through ventilating pipe in cubic feet per minute.	Cubic feet per minute of compressed air used, measured at atmospheric pressure.	Pressure of compressed air in pounds per square inch.
·08	8	196	6·6	53
·08	12	228	5·9	40
·10	8	258	11·8	50
·125	8	338	15·3	45
·125	12	502	14·5	40

It will be seen that the larger the air-jet, and the higher the velocity of air-flow in the ventilating pipe, the smaller is the volume of air driven through by a given volume of compressed air. The mechanical efficiency of an air-jet is extremely small, but where only low velocities are needed and the resistance is slight, it is not worth while to employ a fan, and in most cases where ends and rises have to be ventilated in Cornish and other metalliferous mines the air-jet can be used with great advantage. When the resistance

* This inference is drawn from the results of a number of analyses of upcast air, published by Haldane, Atkinson and Meachem in the "Transactions of the Institution of Mining Engineers," Vols. VIII., XI. and XVI. To quote instances, at Hamstead Colliery the heat carried off by a main return was only about a third of the heat formed in the corresponding working, and at Talk-o'-th'-Hill Colliery a similar calculation for one district shows that only a fifth of the heat formed was being removed by the air.

† Transactions of the Geological Society of Cornwall, Vol. X., 1887.

mounts up owing to the length of ventilating pipe being unusually long, considerable advantage may be obtained by letting the air-jet blow into the ventilating pipe through a piece of pipe of about half its diameter, the space intervening between the two pipes being blocked, or two or three jets may be inserted at different points along the length of pipes. By this means excess of pressure and consequent loss through leakage can be avoided.

It is best as a general rule to blow the air in rather than to exhaust, as by this means the temperature in an end or the top of a rise is much more effectually reduced, and the cooling power which the relatively dry air delivered from the ventilating pipe and from the exhaust of the drill is fully utilised.* In hot ends or rises the air should be blown in continuously in order to cool down the rock and carry off the heat which is being continuously produced by oxidation. The quantity blown in should be regulated according to the temperature met with.

We have already referred to an efficient method of laying the greater part of the dust produced by blasting in ends and rises (page 29), and at the same time damping the ore which has been brought away. If, however, it is necessary to return temporarily into a still more or less dusty atmosphere to fire a second series of shots, an efficient respirator of some kind should always be worn. A wet sponge tied over the mouth and nose answers sufficiently well for this purpose.

* It is, however, desirable to have the attachment of the nozzle made reversible, so that it may be used to exhaust and so clear out the dust and fumes after blasting; or a special nozzle with a larger opening may be employed for rapidly exhausting after a blast.

monies an owing to the length of ventilation pipe being necessarily long, considerable advantage may be obtained by letting the air blow into the ventilation pipe through a piece of pipe of about half its diameter, the space intervening between the two pipes being blocked, or two or three jets may be located at different points along the length of pipe. By this means excess of pressure and consequent loss through leakage can be avoided.

It is best as a general rule to blow the air in rather than to exhaust, as by this means the temperature in an end or the top of a shaft is much more effectively reduced, and the cooling power which the relatively dry air delivers from the ventilation pipe and from the exhaust of the shaft is fully utilized. In hot shafts or shafts the air should be blown in continuously in order to cool down the rock and curb of the shaft which is being continually produced by oxidation. The quantity blown in should be regulated according to the temperature of the shaft.

We have already referred to an efficient method of forcing the greater part of the dust produced by blasting in shafts and into these (see page 27), and in some cases forcing the dust which has been brought away. It is, however, it is necessary to retain some of the dust still more or less than it is necessary to this second series of shafts, and a method of retaining some dust should always be used. A wet sponge held over the mouth and nose of the miner is sufficiently well for this purpose.

DESCRIPTION OF FIGURES.

FIGURE 1.—Rock-drill at work with water-jet apparatus (*see* page 27). The cylinder holding the water has been brought close to the drill in order that it may show in the photograph. Figures 1, 2, 4, and 5 are from underground photographs by Mr. J. S. Burrow, Photographer, Camborne.

FIGURE 2.—Drilling by hand in an overhand stope.

FIGURE 3.—Cylinder and connections for water used in spraying (*see* page 27).

FIGURE 4.—To illustrate production of dust in handling dry ore and stone.

FIGURE 5.—Mouth of a level, showing (1), compressed air pipe fitted with arrangement for blowing a spray of water into the end of a level just after each blast (*see* page 29): (2) Ventilating pipe with reversible air-jet fixed in it about 12 feet from the open end, so that air can be blown into the level during work, and exhausted after a blast.

FIGURE 6.—Sanitary pails used underground at Dolcoath.



FIGURE 1.



FIGURE 2.

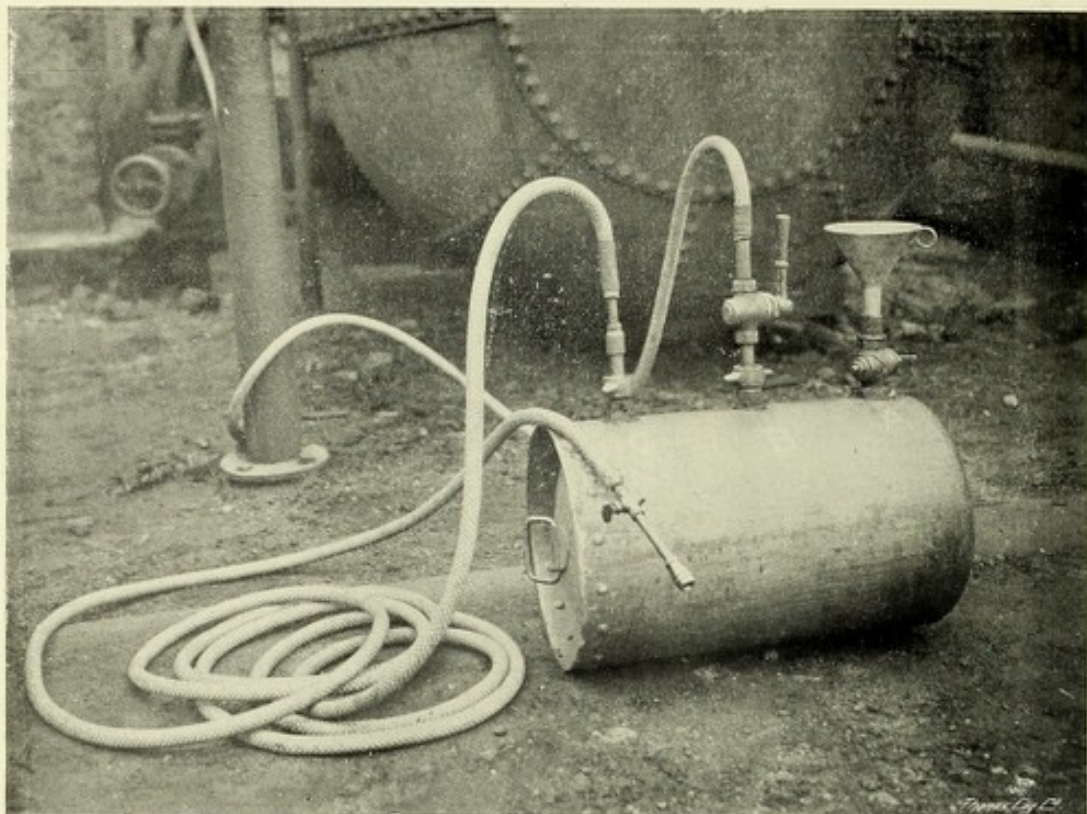


FIGURE 3.

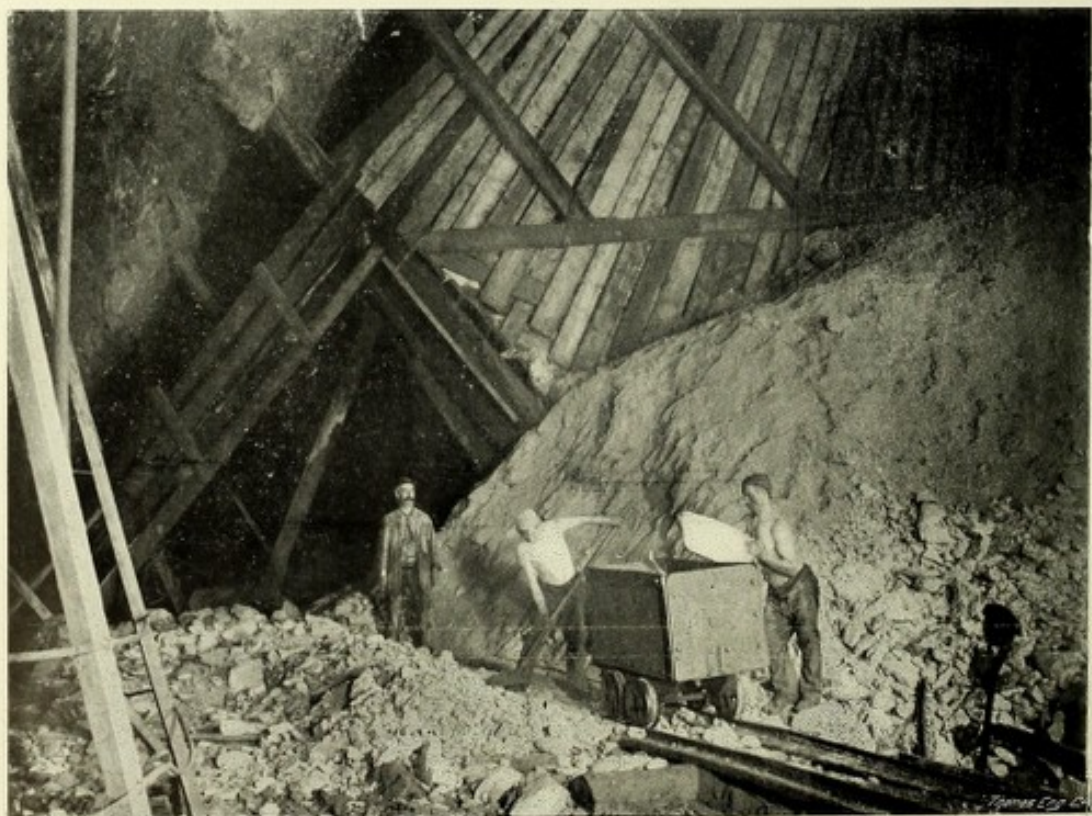


FIGURE 4.



FIGURE 5.



FIGURE 6.

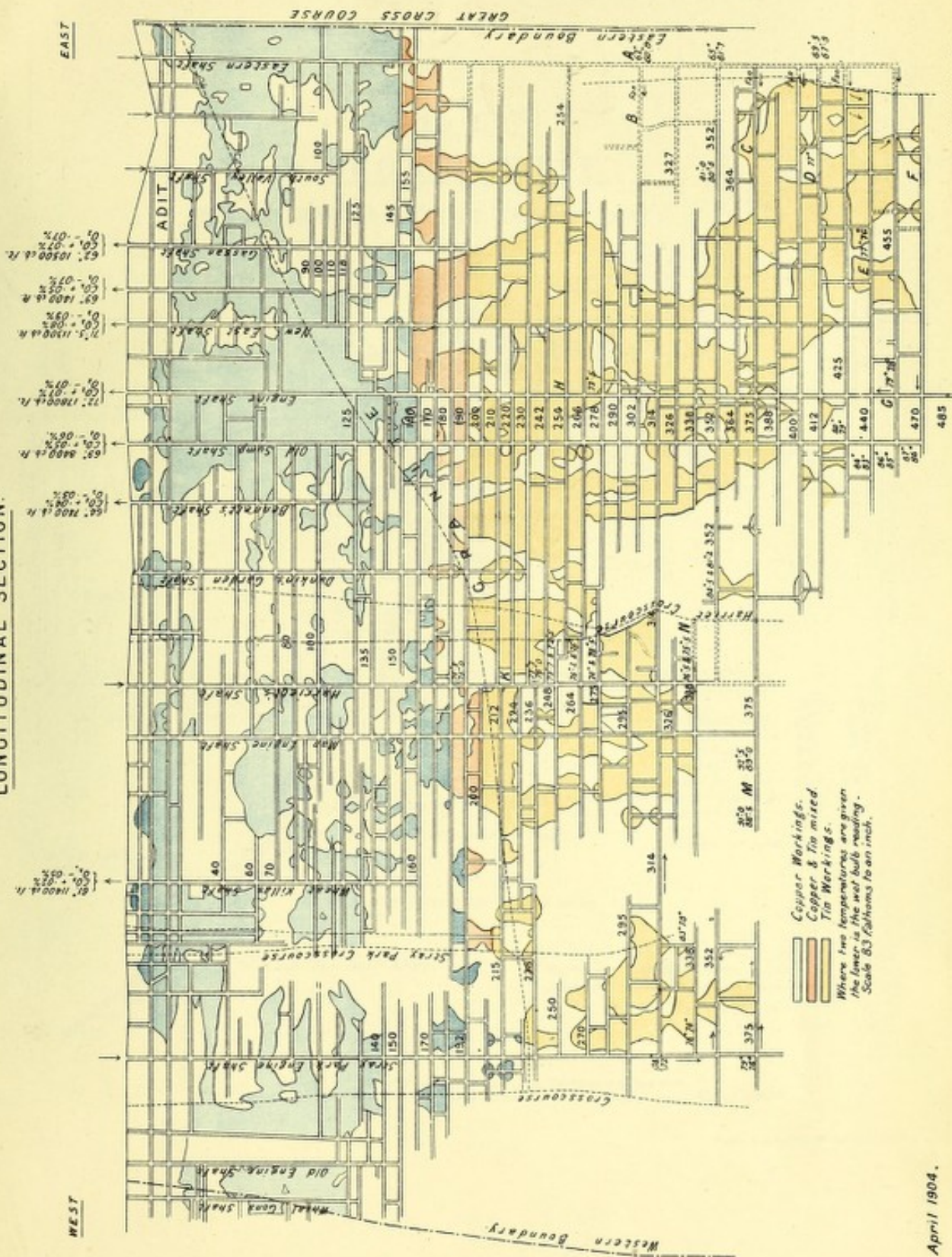


Fig. 1



Fig. 2

DOLCOATH MAIN LODE.
LONGITUDINAL SECTION.



April 1904.

49.23, 5.04

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Plate II

DOLCOATH MINE

TRANSVERSE SECTION AT ENGINE SHAFT

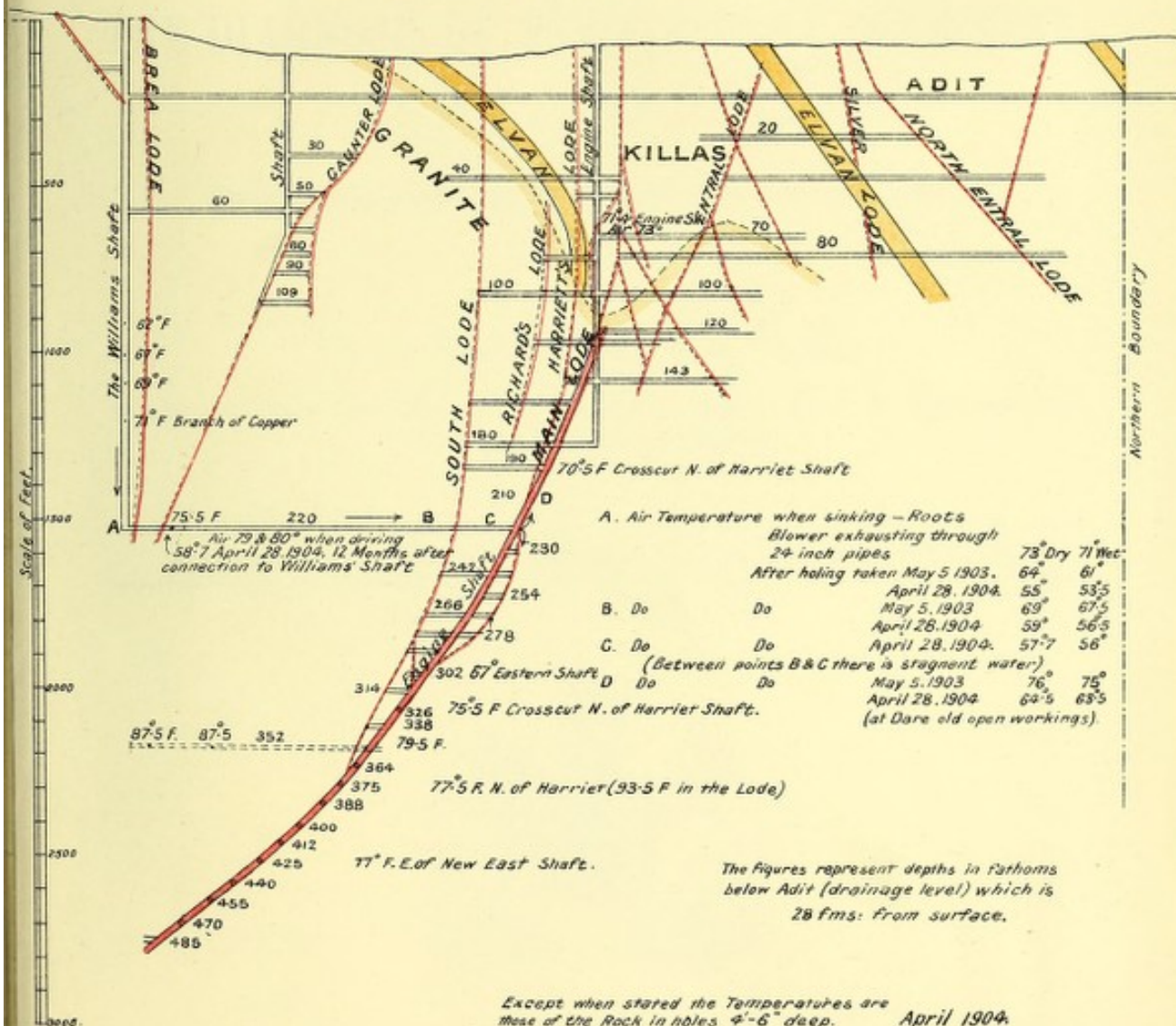
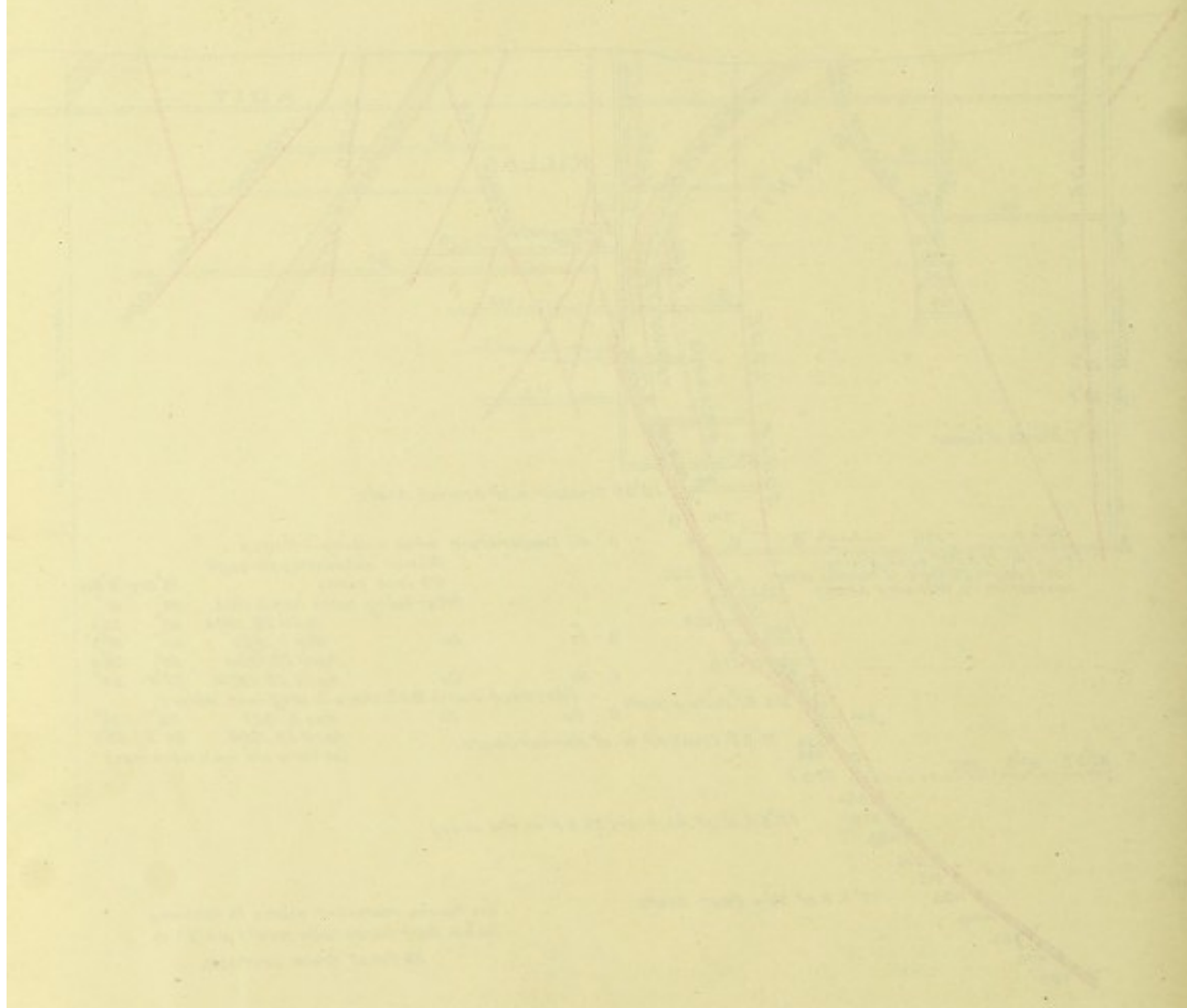


Plate II
DOLLOMATE MINE

TRANSVERSE SECTION AT ENGINE SHAFT



Scale 1 inch = 10 feet

4

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R E P O R T

TO THE

SECRETARY OF STATE FOR THE HOME DEPARTMENT

ON

THE DIAGNOSIS OF ANKYLOSTOMA INFECTION,

WITH

Special Reference to the Examination of the Blood,

BY

A. E. BOYCOTT, M.B., B.Sc.,

FELLOW OF BRASENOSE COLLEGE, OXFORD, AND GORDON LECTURER ON EXPERIMENTAL
PATHOLOGY IN GUY'S HOSPITAL.

Presented to both Houses of Parliament by Command of His Majesty.



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EXPERIMENTAL PATHOLOGY IN GUY'S HOSPITAL.

GORDON LABORATORY,
GUY'S HOSPITAL,
March 23rd, 1904.

SIR,

I HAVE the honour to submit to you the following account of the enquiry which I have made into the diagnosis of the presence of Ankylostoma, with especial reference to the use of blood examinations for this purpose. The investigation has been directed for the most part to a consideration of methods of diagnosis as applicable to a considerable body of men rather than to individual cases, with the object of finding out how a mine may be examined for the Ankylostoma in the simplest way which will afford sufficiently reliable results.

The means of diagnosis at our disposal may be grouped under three heads:—

- I.—General inspection of the employees for cases of anæmia.
- II.—Microscopical examination of fæces.
- III.—Examination of the blood.

I.—*General Inspection.*

In the first place, I would lay great emphasis on the fact that many of the individuals who harbour the parasite in their intestines do not present any objective signs of disease, nor do they complain of any symptoms of illness. On the contrary, they will appear on ordinary examination, and will profess themselves to be, in perfect health. Yet it is these healthy "worm-carriers" who constitute the greatest danger of ankylostomiasis as a place disease; they have, indeed, greater powers than those who are actually

ill of carrying infection from place to place, owing to their very healthiness and ability to work. It is true that in any large collection of infected men a certain number of individuals will generally be found who are pale, complain of shortness of breath, and show the other symptoms of anæmia. But this is not invariably the case. In the course of my investigations I visited a tin mine in Cornwall where no history of any illness like ankylostomiasis in any underground worker could be obtained, nor could I myself find one who was anæmic on superficial examination. Yet in several samples of fæces from this mine I found *Ankylostoma* eggs, and the blood examinations indicated that about two-fifths of the men were probably infected. It is well-known, too, that many men, whose blood is found on accurate examination to be of deficient quality, do not appear to be at all anæmic on casual inspection.

It is then useless, when searching for *Ankylostoma* in a mine, to give any weight to the absence of cases of anæmia among the men, though the presence of such illness would of course be very suggestive.

II.—*Microscopical Examination of Fæces.*

Before an absolute diagnosis of *Ankylostoma* is made, it is necessary to identify the characteristic eggs of the worm in the stools; and a mine may be examined for the presence of the disease by obtaining fæces from a number of the men and submitting these to microscopical examination. Results of a very definite character are thus obtained at once. There are, however, several practical objections to this method:—

- (a) It must be remembered that the men are not under control in hospital, and that the samples are furnished by their goodwill alone. While paying the highest tribute to the willing way in which the great majority of the miners who have been asked to do so have assisted in the enquiry by performing what cannot be to them a pleasant task, I have no doubt that many refusals will often be met with. This is especially to be expected in places where there are no cases of actual illness in which the men's active interest may be aroused.
- (b) In any case, it takes at least several days to obtain a sufficient number* of samples of fæces.
- (c) There is a great opportunity for fraud, unless the stools are passed under supervision; this is done in Westphalia, but would hardly be possible in this country.
- (d) The microscopical examination is simple, and in most cases where eggs are present they are in such numbers that they are found at once. It is, however, necessary to search for a long time and on more than one occasion, before giving a definite verdict that eggs are absent.
- (e) There is no doubt that a certain number of cases occur in which, though worms are present in small numbers (as proved by autopsy), the eggs are not found by direct microscopical examination of the stool. Nor are eggs found till about a month after the larvæ have entered the bowel. The results obtained by this method of examination are not therefore absolutely infallible.

Instead of obtaining stools directly from the men, one may collect portions of any fæcal deposits which may be found underground. I have recently

* What proportion of the total number employed underground constitute a "sufficient number" is difficult to say. In most cases, however, where the worm has gained a footing in a mine, a large proportion—often nearly the whole—of the men are infected. The proportion, no doubt, varies with the suitability of the conditions (temperature, moisture, etc.) for the abundant growth and spread of the larvæ; it will be lower in cool and dry than in hot and wet mines. If these conditions are not unfavourable, an examination of 10 per cent. of the men, taken at random, will probably give a very good idea of the frequency of infection. Scattered cases, however, might easily be missed in this way.

examined a large number of such specimens, and find that valuable results may be in this way obtained. Most of the objections mentioned above cease to apply when this method is used, but some other difficulties arise—

- (a) In the first place it is a grave objection that the individual origin of each specimen is unknown.
- (b) If circumstances are favourable, nearly all the *Ankylostoma* eggs present will have hatched out into larvæ. The empty eggshells are practically invisible, and it is impossible to identify the larvæ with certainty. A few dead eggs remain for a long time in such a condition that their nature is clearly seen, but they may be so few in number, in a stool which previously contained an abundance, as to require a very prolonged search to find them.
- (c) Animals foreign to the human intestine enter the faecal deposits from the earth. I find that certain small nematode worms, which have their natural habitat in moist earth, are very often present; their eggs and larvæ in some cases are not at all unlike those of *Ankylostoma*, and might easily cause confusion.
- (d) It is not always an easy matter to obtain any number of specimens underground, and it is to be hoped that in the future it will be impossible.

III.—*Examination of the blood.*

The examination of the blood which I have investigated is made as follows* :—A small drop of blood is obtained by pricking the subject's finger; this is smeared on glass in a thin film, rapidly dried and, after appropriate treatment with certain dyes, submitted to microscopical examination.

The blood consists of a clear fluid (plasma) in which float a number of minute relatively solid bodies (corpuscles). These latter consist of (a) red corpuscles, which contain all the red colouring matter (hæmoglobin) of the blood, and to which the blood owes its colour and opacity; and (b) white corpuscles (leucocytes), free from any pigment and much less numerous than the red corpuscles. Of these white corpuscles there are present in human blood at least six varieties, which are in practice distinguished from one another mainly by the capacity of their various parts to stain in different colours with various dyes. The variety which is of greatest moment in the present connection is one which is characterised by containing in its substance a number of large round granules; these show a special affinity for the aniline dye "eosin," which stains them a bright red. They are on this account known as "eosinophile leucocytes." When they are present in excessive numbers, an "eosinophilia" is said to be present. It is this increase which constitutes the change in the blood which is present in most cases of *Ankylostoma* infection.

The method of blood examination which I have described is obviously unable to tell us the total number of white corpuscles in the blood, since no definite measured quantity of blood is taken for examination. We can only ascertain the relative proportions of the several varieties; this is readily done by enumeration under the microscope. In normal blood the eosinophile leucocytes commonly form from one-half to about four per cent. of all the white corpuscles; any figure under five per cent. may be regarded as normal. A result between five and ten per cent. raises a suspicion that some abnormality is present, the probability that such is the case increasing rapidly at about eight per cent. Any figure above ten per cent. is distinctly abnormal. It must be understood that these figures refer to individual cases. If in a large series the average is five per cent., there is clearly something amiss, though individual cases of six or seven per cent. are not very rare in persons who are apparently

* The method is described in detail in Appendix A.

quite normal. In the following account of my results, the blood test is called negative when the percentage of eosinophile leucocytes is less than five, doubtful between five and eight, and positive when over eight.

MINERS AT DOLCOATH.

—	Number of Cases.	Negative.	Doubtful.	Positive.	Over 20 per cent.
Known to have eggs of Ankylostoma in stools.	57	Per cent. 3.5	Per cent. 5.3	Per cent. 91.2	Per cent. 29.8
Taken at random*	87	3.3	1.3	95.4	35.6
Total	144	3.4	2.9	93.7	33.3

The cases of ankylostomiasis recorded in the literature bear out the conclusion which may be drawn from these figures, viz., that the great majority of cases show a marked increase in the eosinophile leucocytes. The reaction is, as a rule, best marked in individuals who have been recently infected; and may be much diminished or absent in those who have reached the stage of marked anemia, or have harboured the parasite for many years: that is, it is best marked in just those cases where there are no other signs to suggest infection. I have also been able to ascertain two other important details:—

- (1) The eosinophilia does not always disappear on the expulsion of the worms, and is thus of indefinite value in estimating the efficacy of treatment.
- (2) The eosinophilia may appear in the blood shortly after infection, and some time before eggs can be found in the stools.

It will be necessary in the next place to consider shortly the other causes of similar changes in the blood. These are:—

- (1) True paroxysmal asthma.
- (2) Certain skin diseases.
- (3) Intestinal and certain other parasites.
- (4) Miscellaneous and undetermined causes.

While, however, other causes give rise to an eosinophilia of only a slight degree (5 to 10 per cent.), or in a comparatively small proportion of the cases suffering from the given affection, Ankylostoma produces a high degree in more than half, and some degree in more than 90 per cent. of the cases. In some instances very high figures are reached.† On the other hand, no increase at all is, as a rule, caused by the presence in the bowel of the common tapeworms (*Tænia*), threadworms (*Oxyuris*), or whipworms (*Trichocephalus*), and it is the exception to find an eosinophilia with any but certain acute skin diseases of a severe character. It is, however, necessary to bear the other causes of the peculiar blood condition carefully in mind when examining men for Ankylostoma.

No other cause for the blood condition except Ankylostoma could be found at Dolcoath, but it was possible that it might be due to some other factor of place, occupation or the like. Accordingly, I undertook the examination of

* It should be explained that we have found Ankylostoma eggs in the stools of every regular underground hand at Dolcoath whom we have examined, and there is every reason to suppose that practically the whole of the men are infected.

† Of the 144 cases here recorded, nineteen are over 30 per cent., of which four are over 50 per cent., one reaching the extreme figure of 73 per cent.

blood films which I obtained from the men at a series of other mines. These comprised :—

- (1) Tin dressers at Dolcoath working entirely on surface.
- (2) Underground workers at :—
 - i. West Kitty : quite cool ; tin.
 - ii. Levant : very hot (76° to 93° F.) ; tin, copper, and arsenic.
 - iii. Talk o' the Hill and Birchenwood : 72° to 80° ; coal.
 - iv. Snailbeach : 65° to 68° ; lead and zinc.*

At none of these mines could any cases like ankylostomiasis be seen or heard of, nor could any traces of the worm† be found in the faecal deposits obtained from underground, of which some 90 were examined.

The results obtained from all these places are so similar that it is unnecessary to set them out in great detail. The next table summarises the figures :—

Mine.	Number of Cases.	Negative.	Doubtful.	Positive.
Levant	41	36	2	3‡
Talk o' the Hill ..	40	38	2	0
Snailbeach	42	38	4	0
Other mines	33	30	3	0
Total	156	142	11	3

When we compare these figures with those of a body of men infected with *Ankylostoma*, the contrast is very marked :—

—	Number of Cases.	Blood Examination.		
		Negative.	Doubtful.	Positive.
Infected	144	Per cent. 3·4	Per cent. 2·9	Per cent. 93·7
Not infected	156	91·0	7·0	1·8

These figures also show that the eosinophilia found at Dolcoath is not produced by (1) the neighbourhood of Camborne, (2) working underground, (3) working in a tin mine, (4) working in a hot tin mine, or (5) working in some other metals.§

Two other tin mines in the Camborne district (East Pool and Agar United, and South Crofty) were also investigated by the blood test and by examination of faeces obtained underground. There is a considerable exchange

* The faecal contamination of the metalliferous mines was very bad ; it was less noticeable in the coal pits.

† A single case of infection was picked out at West Kitty with the help of the blood examination ; the man had just returned from the Mysore mines, where doubtless he had become infected.

‡ These cases were re-investigated ; two were found to be due to the presence of large numbers of round worms (*Ascaris*) ; in the third case no explanation could be found.

§ Only tin is now worked at Dolcoath.

of men between these mines and Dolcoath, and, though no cases of actual illness could be found, evidence of a moderate amount of *Ankylostoma* infection was obtained by the discovery of eggs (four times in 23 samples). The blood test gave the following results:—

	Number of Cases.	Negative.	Doubtful.	Positive.	Over 20 per cent.
		Per cent.	Per cent.	Per cent.	Per cent.
	62	41.9	21.0	37.1	8.0

These mines are cool (62° to 68° F.), and the conditions underground are not very favourable for the free growth and spread of the larvæ.

It appears from the results which I have given that the blood test is one which attains a considerable degree of accuracy. It is necessary now to consider certain points in its practicable application.

The time occupied in making an examination of a mine by the blood film method is certainly not more than that necessary to obtain and examine a corresponding number of specimens of faeces. It is true that the method requires more experience and skill than the direct microscopic examination of the stools, but sufficient familiarity with the necessary technique and with the microscopic appearances of blood corpuscles is not difficult to acquire. The preparation of the films alone is very simple, and they can be easily sent for examination to those who are more familiar with microscopical work. Under favourable circumstances it is possible to obtain blood films from 10 per cent. of 400 or 500 men in 20 minutes, and the preparation and examination of these specimens can be completed within 24 hours. The bulk of the specimens is small, and a large number can be carried in the pocket; they can, moreover, be kept in good condition for at least several months if immediate examination is for some reason inconvenient. The actual enumeration of the white corpuscles (such as I have carried out in all the specimens which have been examined for this inquiry) is laborious, each specimen taking about half an hour, sometimes much longer. In but few cases, however, is it necessary to do this and so find the exact percentage of the eosinophile leucocytes; a rapid general examination will suffice to tell in nearly every instance whether they are present in normal or in definitely increased quantity. Positive results take a little longer (in microscopical examination) than in the direct examination of faeces, but negative results are reached much more rapidly. There is in this method no chance of fraud, since the specimens are obtained directly by the examiner from the subject, and there is little or no difficulty in persuading men to allow their fingers to be pricked.

There are, however, two serious drawbacks to the method. In the first place, as has been already mentioned, it is of very uncertain value (so far as is at present known) in ascertaining whether an infected subject has been freed from the worms by treatment. Secondly, it cannot yield evidence of *Ankylostoma* infection of a character so positive as would justify the immediate administration of anthelmintic treatment. In every case an *absolute* diagnosis can only be made by finding eggs in the stools. But the method is not designed, nor is it proposed that it should be used, for this detailed examination of individual cases; it is rather a simple, and I think an accurate, way of investigating a large number of men easily and quickly to see if a suspicion of *Ankylostoma* is thereby raised of sufficient strength to justify the troublesome process of obtaining specimens of stools from a number of men. If specimens of blood from 10 or 20 per cent. of the underground men fail to reveal any cases of an increase in the eosinophile cells, it may be assumed that the mine is free from any extensive infection. If, on the other hand, any cases of eosinophilia are met with, the individual source of each blood sample is known; and further investigation of each positive case is then made to see

whether the abnormality is due to the *Ankylostoma* or to one of the other causes of eosinophilia. It will be readily seen that the method is most superior to the primary examination of faeces in cases where there are no cases of *Ankylostoma* infection in a district.

The results which I have already obtained deal mainly with the signs which the presence of *Ankylostoma*, taken as a whole, produces in the blood. A number of details, such as the relation of the blood condition to treatment, and the peculiarities due to individual idiosyncrasy, still require elucidation.

During the progress of the investigation, I have received invaluable assistance from the management of all the mines which I have visited, and from other gentlemen too numerous to mention. I desire, however, to draw your attention specially to the services rendered by Mr. J. C. Cadman, Inspector of Mines in Staffordshire, Dr. C. S. Jago, of St. Just, Mr. R. A. Thomas, of Dolcoath, and by my laboratory assistant, J. R. Clark: without their assistance the enquiry would have been hardly possible. Six of the blood examinations were made by Dr. S. G. Scott, of Leeds.

In Appendices I have described in detail the method of blood examination which is recommended for this purpose, and have also given a short account of two matters of interest which have come under my notice.

I am, Sir,

Your obedient Servant,

ARTHUR E. BOYCOTT.

The Right Hon.

ARETAS AKERS DOUGLAS, M.P.,

H.M. Principal Secretary of State for
the Home Department.

&c., &c., &c.

APPENDIX A.

PREPARATION AND EXAMINATION OF BLOOD FILMS.

There are many different ways in which a microscopical examination of the blood may be made. The following has been recommended because the process is simple, and is capable of giving excellent results under unfavourable circumstances.

*I. Materials required.**

For the preparation of the specimens of blood, one only wants :—

1. Large (*e.g.* "Number 4") straight triangular surgical needles.
2. Glass slides, 3 × 1 inches, of thin white glass, with ground edges. The quality known as "Number II." is suitable; the cheaper varieties are unsatisfactory.

For the staining of the films there will be required :—

3. Two glass sample tubes, $3\frac{1}{2} \times 1\frac{1}{4}$ inches, with corks.
4. Jenner's stain in powder, as prepared by Grüber.
5. Pure methyl alcohol (Merck's "pro analysi").
6. Distilled water.

The glass slides must be thoroughly cleaned before use. After washing with soap and water, wash thoroughly in clean water under the tap, and then carefully dry and polish with a dry cloth. A small label ($\frac{3}{4} \times \frac{1}{2}$ inch) should then be fixed at one end. They must be kept free from dust; this may be conveniently done by storing them in small envelopes, one dozen in each, which are very convenient to carry to and from the mine, &c.

II. Preparation of films.

The finger is most convenient; it should be fairly clean, and must be dry. Stab quickly into the pulp of the finger with a new, sharp needle, resting the subject's hand on some firm object. Hold the needle short in the fingers so that the point does not reach the bone (this would give some subsequent pain). If the blood does not flow, squeeze it out with gentle pressure. To a small drop (about the size of half a pea) apply one of the glass slides, close to the label,—this must be done directly the blood flows out. Lay the slide flat and place the end of a second slide touching the drop of blood on the side nearest the label. The drop will at once spread out laterally, when the second slide, held obliquely and inclined away from the label at about 45°, is drawn steadily along the surface of the first. The pressure must be so adjusted that a thin, if possible uniform, film of blood is left behind as the drop is, as it were, dragged along the glass. This film should be so thin that a large part of it dries in a few seconds,—but extremely thin films made in this way are not good for the examination of the leucocytes. It is important that the film should dry quickly—drying may be accelerated by waving about in the air; and when films have to be taken underground, the face or return air should be avoided, since in the damp air drying takes place very slowly. If most of the film is not dry in less than half a minute, it is too thick to be of much use, and a second specimen should be obtained. The slides may finally be returned to the envelopes and thus carried away, the name of each man being written on the label when his specimen is taken.

Films made in this way will keep in good condition for several months at least. It is, however, of the greatest importance that they should be kept quite dry.

III. Staining.

Dissolve 0.75 gramme (10 grains) of the solid Jenner's stain in 100 cubic centimetres (3 ounces) of methyl alcohol in a clean dry bottle, which must be kept closely corked. Put about 25 to 30 cubic centimetres of this solution into one of the sample tubes, which is also to be kept tightly corked, except when actually taking slides in and out. Place two of the slides with films back to back in the sample tube, the labels being of course above the fluid. After $2\frac{1}{2}$ to 3 minutes (*by the watch*), remove them and wash them in a vessel (a beaker or tumbler is convenient) of distilled water by waving them backwards and forwards five or six times. Then dry the back and ends of the slides with a cloth, tilt them on end to drain and allow the film to dry; this may be hastened by gentle warmth.

* All the materials here mentioned may be obtained from Messrs. A. Gallenkamp & Co., 19, Sun Street, Finsbury Square, E.C.

Instead of distilled water, which may not be at hand, clean rain water may be used. Ordinary tap water spoils the film. If, however, a few drops of dilute acetic acid are added to a tumblerful of tap water, excellent results may be obtained. The exact amount of acid necessary varies with different waters, and must be determined by experiment beforehand: the mixture should give only a very faint acid reaction with litmus paper.

The same tube of staining fluid, with occasional additions of a few drops of fresh solution, should suffice to stain at least 200 slides.

IV. Examination.

It is better, in all cases at first, and always with inferior films, to use an oil-immersion lens. This is best done without a cover glass, the oil being placed directly on the film. With a high ($\frac{1}{4}$ or $\frac{1}{2}$ inch) dry lens, it is necessary to mount the part of the film which is to be examined with a drop of Canada balsam solution and a "Number 1" cover glass. After some practice, good films, if well stained, may be satisfactorily examined unmounted with a $\frac{1}{2}$ inch objective.

The eosinophile leucocytes are stained very conspicuously by this method: the nucleus (commonly bi-lobed, less often irregular in shape) is rather dark blue, while the rest of the cell is crowded with large round refractile bright red granules.

In counting the leucocytes, the slide should be moved along steadily, no part being examined more than once. This is of course best done with the aid of a mechanical stage. During this process a count (on paper) is kept of each leucocyte seen, the eosinophile cells being put down separately. The percentage of eosinophile cells can thus be readily ascertained. In the films which I have examined for this enquiry, 500 leucocytes have in each case been counted and classified; two or even one hundred will, however, give fairly accurate results. For practical purposes it is, moreover, seldom necessary to make an actual numerical estimation at all.

V.—General Remarks.

Much time is saved if the requisite number of men can be collected before the preparation of the films is begun. Where such exists, the changing house is very convenient.

Men with boils, abscesses, or the like, should be excluded, or a note made of the presence of these conditions. The changes which they produce in the blood are such that the percentage of the eosinophile corpuscles may be greatly diminished even in the presence of some cause (such as *Ankylostoma*) which normally produces a considerable increase. For similar reasons, men should not, as far possible, be examined when they are suffering from any acute illness, nor shortly after a hearty meal.

APPENDIX B.

CONDITION OF LEVANT MINE, ST. JUST.

The present workings of this mine are to a large extent under the sea; the ventilation is very imperfect and the temperature very high, rising from 71° F. at the bottom of the downcast shaft to 90°–93° in large areas of the deeper workings. The levels, ladders, etc., are wet and muddy, and the fecal contamination extensive. A considerable number of men have returned to work here in recent years from infected districts abroad, and I was aware that a few men from Camborne, who were actually known to harbour the worm, had been employed underground. I visited this mine, therefore, in the expectation that *Ankylostomiasis* would be found to be prevalent. Such, however, was not the case. Nothing like *Ankylostoma* could be found in any of the fecal deposits which were examined, and no history of any suggestive illness among the men could be obtained. Forty-one specimens of blood were examined; they were all negative with the exception of three. These men were re-examined and samples of their stools obtained on two occasions, but they were not infected with the worm. *Ankylostoma* thus appeared to be entirely absent from a mine which seemed to be most favourably situated for its introduction and spread. The reason for this was, on further investigation, found to lie in the nature of the water which permeates the mine. Some of this flows in from the land and is ordinary spring water, but most of it is derived from the sea by leakage through the roof into the upper levels. Seven samples of water from different places were examined. The salinity varied from 0.94 per cent. of salt on the eastern (landward) side to 3.0 per cent. in the adit water; the other samples gave percentages of 1.8, 2.28, 2.42, 2.44, and 2.72 of salt.* Samples obtained from other, inland Cornish mines gave:

* Seawater contains 3.4 per cent. of salt.

East Pool 0.009 and 0.018; South Crofty 0.023 and 0.013; Dolcoath 0.09 per cent. of salt. I find that a 2.5 per cent. solution of salt quickly kills young *Ankylostoma* larvæ. The infection has, in this way, been prevented from spreading in the mine; there is practically no doubt that it must have been introduced on several occasions.

Four of the seven samples of water from Levant contained traces of copper. There was no arsenic in any of them.

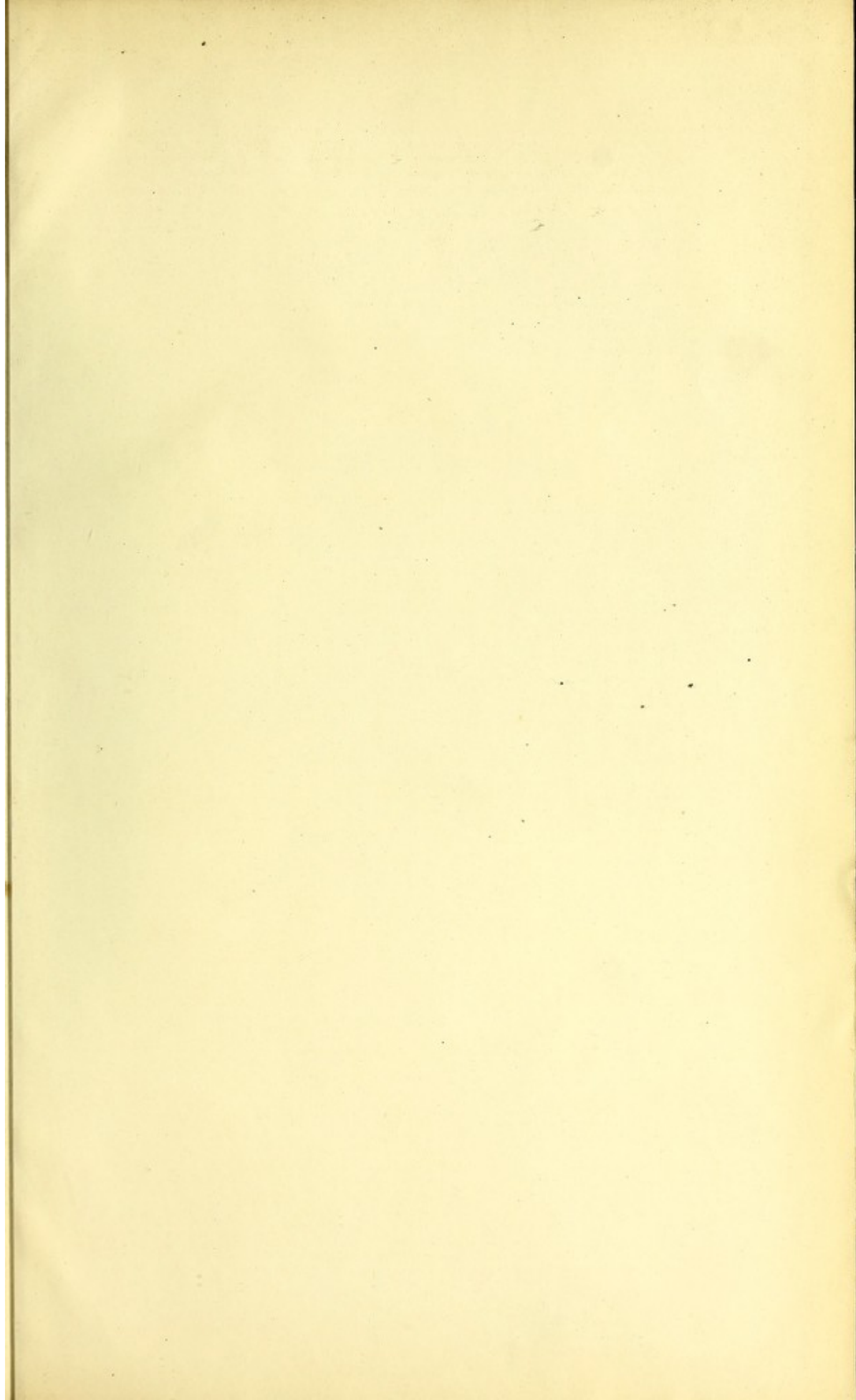
APPENDIX C.

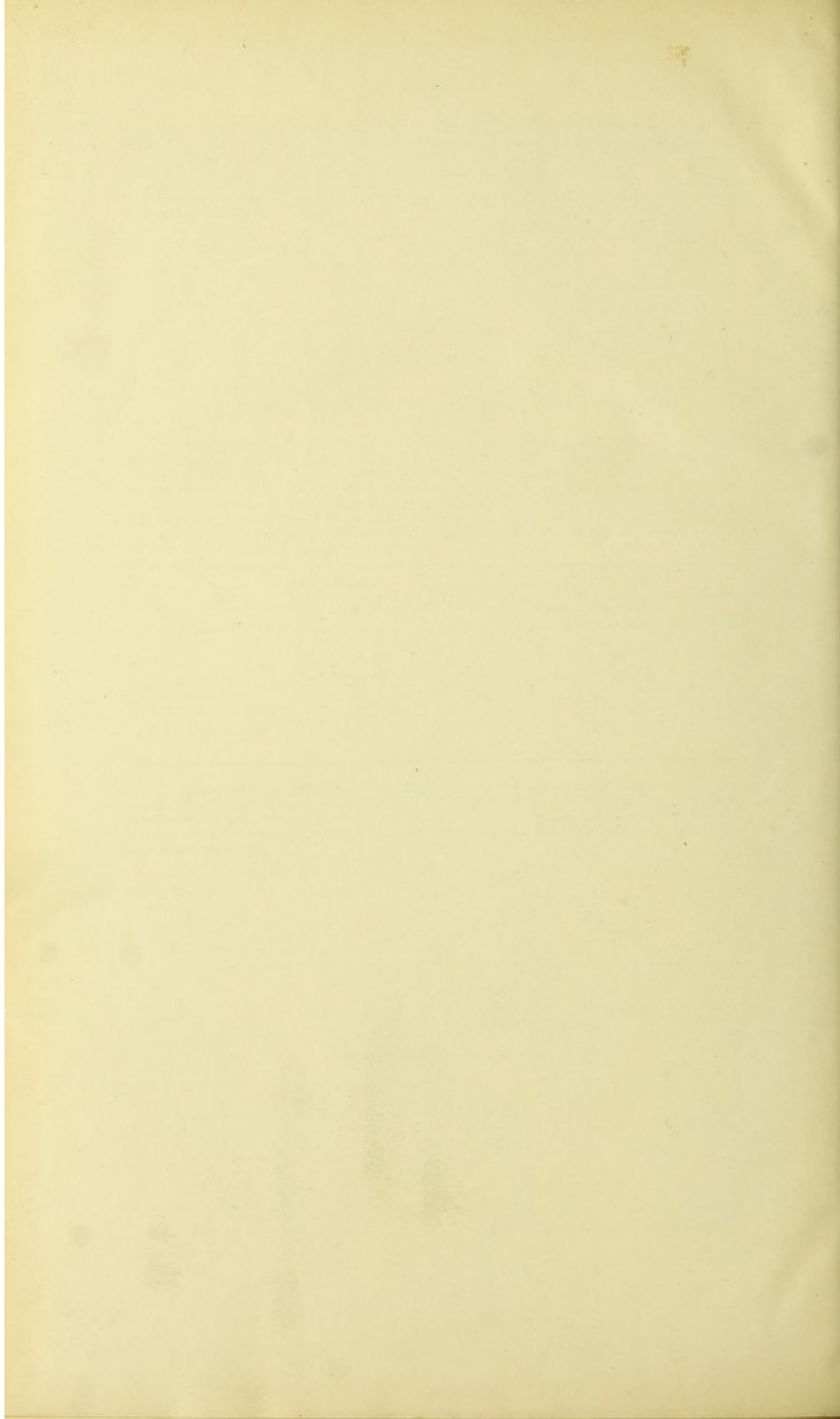
PREVALENCE OF INTESTINAL PARASITES OTHER THAN ANKYLOSTOMA AMONG MINERS.

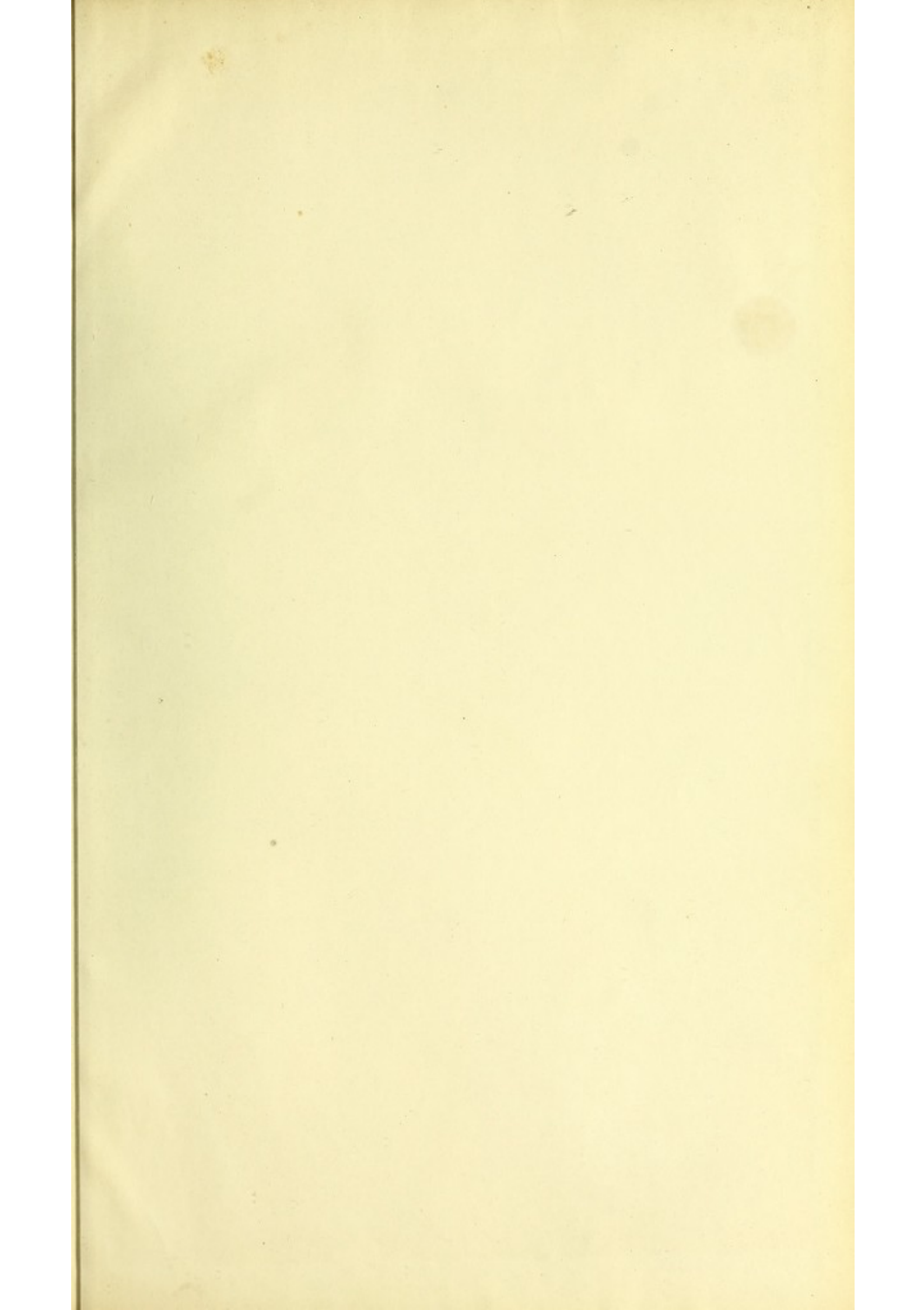
The examination of specimens of fæces obtained from various mines shows that other intestinal parasites besides *Ankylostoma* may be widely spread among the men. This is no doubt due to the faecal contamination. The life history of these other worms is roughly the same as that of *Ankylostoma*, the eggs passing out in the stools and infection taking place by others swallowing the eggs or larvæ. These other parasites are more or less harmless, but the results show how other diseases, such as enteric fever, the infective agents of which are contained in the stools, might be widely disseminated owing to the filthy condition of the mines.

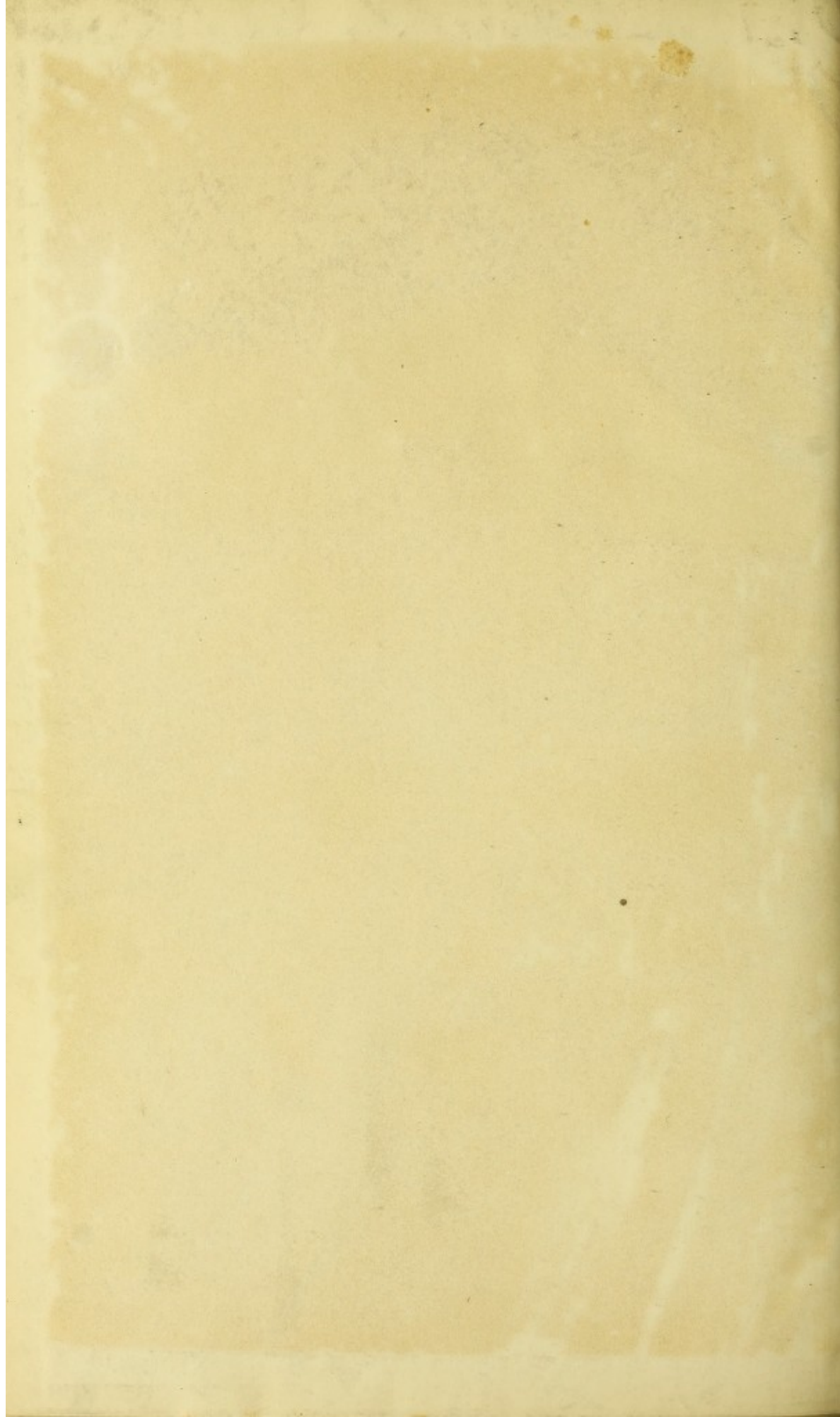
Mine.	Number of specimens examined.	Whip-worm (<i>Trichocephalus</i>).	Round-worm (<i>Ascaris</i>).	Thread-worm (<i>Oxyuris</i>).	<i>Ankylostoma</i> .
Levant	25	24	3	1	0
East Pool	23	14	9	1	4
Snailbeach	22	0	0	0	0
Various coal pits in Staffs. ...	18	0	0	0	0

There are no exact statistics with regard to the prevalence of these worms among the general English adult male population, but the figures for the two Cornish mines (whip-worms in 79 per cent. and round-worms in 25 per cent.) are undoubtedly far beyond anything found in this country. The mines examined in the Midlands were free from any worm infection.









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