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MILITARY SANITATION AND HYGIENE

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BY

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WITH TWENTY-ONE ILLUSTRATION

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PREFACE

'War tries the strength of the military framework. It is in peace that the framework itself must be formed.'—NAPIER: *History of the Peninsular War.*

As its title implies, this is not a work on general sanitation and hygiene, but a book dealing with the subject of military sanitation and hygiene from the point of view of those whose duty it is to assist in keeping all ranks fit for the supreme test—namely, the test of war.

During recent years all branches and ranks of the Army have evinced an increasing interest in all matters connected with the prevention of disease, and the reduction that has taken place in preventable sickness may, to a great extent, be attributed to this cause.

The fighting value of the soldier is so intimately associated with the prevention of disease and the maintenance of physical efficiency, that the writer feels no apology is needed for the publication of the present handbook, the aim of which is the furtherance of the public good.

During his service in the Army the writer has been much impressed by the interest that combatant officers* and the rank and file have taken in the lectures and 'talks' on sanitation, hygiene, and preventive medicine, delivered from time to time by the medical branch of the Service. The many questions asked on such occasions have indicated the lines on which the present compilation is based.

* Company officers teach their men elementary sanitation during their winter training.

Herein have also been embodied all available orders regulations, and other matters of interest, official and otherwise, bearing on the well-being of the soldier.

The medical inspection of troops in barracks is first considered, as therein lies the most important factor in the detection of disease. The sanitary inspection of barracks is next discussed.

The whole environment of the soldier is then taken up and considered in detail, commencing with military barracks: their site, construction, interior economy, warming, ventilation, lighting, and other arrangements are in turn commented on.

A complete chapter is devoted to the important subjects of the disposal of excreta and sewage from barracks, particular pains being taken to render to this section its full importance.

Sanitation in camp and bivouac is next taken up on somewhat similar lines. The organization of the sanitary service in the field, duties of sanitary officers, the sanitary section and sanitary squad, arrangements at the base, are all considered, and the regulations bearing on them quoted.

Conservancy and other arrangements for encampments have a separate chapter allotted. Here particular stress is laid upon the disposal of all organic refuse, including excreta. Diagrams of the most recent and up-to-date camp latrines and urinals have been included to make the letterpress more clear.

Water supplies in camp under peace conditions and on active service form the subject matter of the next chapter. The various methods of purification of water for drinking purposes and the difficulties of providing any sort of really safe supply will afford food for thought to those who have not been on active service in the field.

In the chapter on the Food of the Soldier the various scales during peace and active service conditions are given, as well as the scales of rations found suitable in more important campaigns of recent years. A contrast is also made between the scales of rations for our own and for other Armies, and some particulars of the emergency rations of various Powers are included. In the sections dealing with the soldier's everyday rations in barracks, the inspection of meat and bread is somewhat fully treated, and the training manual of the Army Service Corps has been freely made use of as the official authority on these subjects. For the views expressed concerning the diseases affecting meat the writer is solely responsible.

Questions connected with clothing and equipment are so intimately associated with the physical efficiency and the marching power of the soldier that they are considered with due regard to details.

In the chapter on marching particular stress is laid on the fact that a man is only as strong as his heart, and for this reason its action should not be impeded by tight jackets, straps crossing the chest, or the carrying of too heavy a load while on the march. Considerable pains have been taken to render this chapter intelligible and useful to infantry officers, seeing that special attention has latterly been devoted by medical experts to the science of efficient marching. No muscular development is of any value which is obtained at the expense of an overworked heart, and the most certain method to handicap this organ, as far as the soldier is concerned, is to allow men to march in tight jackets and tightly braced-up trousers—the former compress the chest in every direction, and the latter impede the circulation by pulling down the collar-bones.

To physical efficiency a special chapter is allotted, and the subject is discussed under the headings of Personal Hygiene, Cigarette Smoking, and Physical Training. A plea for the necessity of greater attention to soldiers' teeth in barracks is put forward, with the hope that more use will be made of the toothbrush, which will to a large extent prevent barrack-room sore throat and chronic tonsillitis, both of which conditions are prone to cause deafness and consequent inability to appreciate and smartly carry out verbal orders, either on the barrack square or at the rifle range.

The subject of the collection of sanitary intelligence is taken up in the last chapter. Although of great importance, it is a matter rarely thought about until reports have to be written, which is, unfortunately, often at short notice, and perhaps in out-of-the-way places. The general principle adopted in these pages is to give the sub-headings of sanitary reports on various subjects, so that the reports themselves can be easily filled in. The lines followed are mainly in accordance with the Regulations for the Army Medical Services.

The handbook concludes with an Appendix, in which are embodied specimen examination questions on sanitation and epidemiology in their application to military life which have been set to officers of the Army for promotion to next higher rank. The passing of an examination in these subjects is now compulsory for all branches of the Service.

Finally, it may be stated that, while every attempt has been made to bring the text up to date, it is hoped that the errors of commission will not outweigh those of omission. The writer is conscious of having spared neither time nor labour in endeavouring not only to compile, but also to verify, all information used, for the interpretation of which he bears responsibility. Criticism of higher authority is in no place intended. Indication of possible errors or oversights will be thankfully welcomed.

E. B. K.

8, Milward Terrace, Bray,
Ireland,
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CHAPTER I

THE MEDICAL INSPECTION OF TROOPS IN BARRACKS—THE SANITARY INSPECTION OF BARRACKS

ONE of the most important routine duties which the Medical Service of the Army is called on to perform is that of educating the British soldier in the essentials of personal hygiene and barrack sanitation. From the moment a recruit enters the Army the conditions of civil life are left behind, and a new régime—that of living under discipline—prevails. The starting-point of all hygienic and sanitary education in the Army begins in the recruit, and he should be thoroughly instructed in all matters relating to elementary hygiene and sanitation from the day he joins the Service, for it must be borne in mind that the habits he learns in barracks will be carried in his mind on service in the field. If a regiment has a 'chief' strict as to the details of sanitation, not only of his barracks and its environment, but also of the personal hygiene of his men, he may rely on it that his unit will be 'fit' and in good serviceable condition when put to the test of war. If, on the other hand, barracks and the rank and file are found neglected in these matters, such a condition of affairs will never tend to improve on active service, but rather get worse, and such a unit will invariably break down and become non-effective from enteric fever or other fell dirt disease. To preserve physical efficiency, every regiment should be medically inspected from time to time as thoroughly as possible. Unless such an inspection is thorough, it is useless.

MEDICAL INSPECTION OF TROOPS.

The medical inspection of troops in barracks is provided for in Regulations in the following terms :

'The officer in medical charge of effective troops will also inspect the men under his charge monthly, and satisfy himself that their personal hygiene has been attended to. He will recommend to the Officer Commanding, verbally or in writing, whatever he may consider necessary for protecting the health of the troops, whether as regards the abatement or removal of local causes of disease, or as to any alteration of diet, clothing, drills, or duties' (*vide* 'Regulations for the Army Medical Service,' paragraphs 135 and 141).

The end and object of such inspection is mainly to see if the men are 'fit,' and that they are looking after their personal hygiene—*i.e.*, keeping their teeth, feet, and underclothing clean—and that no infectious, contagious, or other disease is present. It is not uncommon to find cases of skin diseases, such as itch, or venereal disease, or even incipient consumption, at these inspections amongst men who, for some reason of their own, do not wish to report sick. Such diseases, if undetected, may play havoc in a barrack room or even in a regiment. To be in a position to weed out such centres of infection it is manifestly essential for a commanding officer to insist that his company commanders should parade their men at as full strength as possible, and that absent men be noted on nominal rolls for medical inspection at some later period. The important point about absentees is that these are often the very men who, for reasons best known to themselves, do not wish to be seen by their medical officer, and these are often the men who are suffering from some infectious or contagious trouble. Officers' servants, mess-waiters, and others in out-of-way employment in offices and other places, should also have attention directed to them. Other important men that should be inspected are all newly-joined recruits, men who have returned from off furlough, and those who have been discharged from hospital during the interval that may have elapsed since the last monthly inspection.

The best way to aid a thorough medical inspection of a unit is to do away with the supposed and, it is maintained, impossible inspection of a unit *as a whole unit* by one medical officer on one day. Even if mustered to full strength on parade, the task of proper inspection is too much. Every unit is divisible: if artillery, into sections; if infantry, into companies; and if cavalry, into squadrons. Let the sub-units parade, one for each day's inspection, and let the inspection be thorough and searching, and let their sub-unit commanders be present to look on. Have a nominal roll, and mark off each man seen, and let the absentees come up for inspection the next or following days. By this means a regiment or other unit can be given a clean and true 'bill of health.'

The day and hour for medical inspection should be carefully selected to suit all parties concerned. The day chosen should not, if possible, interfere with duty or recreation, and the hour fixed should not delay meals. Climatic conditions such as undue exposure to sun, rain, and wind should be considered; therefore select an empty barrack room, drill hall, or sheltered shed, in cold or inclement weather. Having arranged the time and place, the medical officer should make a small allowance for each company, to avoid keeping the men waiting in a semi-dressed condition. The men should be paraded with their jackets off; shirts and vests should be fully opened in front and rolled back sufficiently wide to show as much of the chest as possible. Shirt-sleeves should be rolled up high on the arms. Trousers should be rolled up above the knee, and boots and socks off, the latter being laid on the ground in front for further inspection, if necessary, as to cleanliness, fit, and repair. Boot inspections are essential, as the *interior* of the boots, if not kept clean, interferes with the marching power of the wearer. Feet inspections are very necessary, their first benefit being cleanliness. If men expect feet inspections they will 'take time by the forelock' and prepare for them. Bunions, corns, and ingrowing toenails, which lead to men breaking down on the march, should be looked for and pointed out to the regimental chiropodist for alleviation. The inside of the ankles should be glanced at for itch, a common site in Army life. As the medical officer walks by, the men should pronate and supinate their forearms, so that both aspects may be seen; boils (often found on the forearm amongst mounted troops) should not escape notice. A general glance at each man's hair, ears, face, teeth, and chest, carried downwards to the forearms and feet, occupies but a few seconds. Tinea versicolor (due to the continuous wearing of flannel shirts next the skin) should be looked for on the front of the chest. The front rank is then ordered to march one pace forwards, and the medical officer should walk back again behind it and inspect the back of the men's legs for varicose veins, and take a general glance at the head and neck for boils, and also at their clothing as to its fit, and whether trousers are too tightly braced up, etc. Shirt inspections are also important, as there is sometimes a tendency for men to wear rubbishy cotton, or even flannelette, shirts instead of the regulation 'grey-back.' The former varieties are quite unsuitable for service work, and are dangerous when wet, or when worn in the tropics under khaki drill. On the relationship that should exist between a medical officer of a unit and its commander there is little to comment on.* The medical officer is the official medical adviser to the officer commanding in all matters appertaining to the health and sanitation of the unit. He should be in close touch with all matters tending to the health efficiency of the troops under his immediate medical charge, and keep a special eye on any of the weaker recruits, satisfying himself that they are not being unduly overworked with drill, gymnasium, etc. He should also ascertain that the men have proper recreation, indoor and outdoor, as such advantages keep the men from liability to contract venereal disease.

It is also very necessary to remember that if hygienic and sanitary measures are to be efficiently adopted in the Army, help from *every* available source must be enlisted. Regimental officers can in this respect give very great assistance, and their presence at medical and sanitary inspections is always most desirable. Although a medical officer by regulation only inspects the men of his charge *once* a month, it is the duty of regimental officers to personally supervise the cleanliness of the person and teeth of their men, the condition of their clothing—socks, boots, etc.—and the monthly medical inspection in no way relieves them of this responsibility. Regimental officers have now to pass an examination in sanitation and

* Field-Marshal Sir Evelyn Wood, V.C., writes: 'I am convinced, from my experience of thirty years as a General, that the army doctors should be regarded not merely as healers of sick and wounded, but as trusted staff officers, to advise their chiefs how to guard the troops against the originating and spreading of disease, and thus maintain the number of effectives in a campaign. This will result not only in the increasing of fire effect, but will raise immensely the fighting value of the troops, and will incidentally enable us to reduce the costly and cumbersome hospital establishments and transport' (*The Saturday Review*, 1908).

hygiene before promotion, and their knowledge of these subjects should allow them to carry out a great part of the sanitary details of their unit.

SANITARY INSPECTION OF BARRACKS.

Officers in medical charge of effective troops will, in accordance with the King's Regulations (paragraph 986),* visit every portion of the barracks, including the married quarters, at least once a month, to examine their sanitary condition, reporting to the officer commanding if they are not kept in a proper state of cleanliness. Notes will be kept in the Sanitary Diary (A.B. 39) of all such examinations, and record embodied of any defects noticed, and representations made, either verbally or in writing, as may be necessary. The results of such representations will be noted.

Chapter XII., p. 318, is intended to serve as a guide to medical officers in the preparation of special sanitary reports.

Ventilation, Lighting, Limewashing, etc.—The inspecting medical officer should satisfy himself that every barrack room, guard room, and detention room is suitably lighted and provided with sufficient means of ventilation; that the beds and bedding are freely exposed to the air; that the married soldiers' quarters, all regimental institutions, kitchens, wash-houses, lavatories, urinals, and latrines, are suitably ventilated and lighted; and that the walls and ceilings of barracks or quarters are properly limewashed.

Cubic Space per Man in Barracks.—The regulation cubic space in barracks and guard rooms at home stations for each man is 600 cubic feet in permanent buildings and 500 cubic feet in huts.† The windows of

* *Vide* also 'Regulations for the Army Medical Service,' paragraph 134 *et seq.*

† For more detailed information, see Chapter II., pp. 26-28.

every barrack room will be opened sufficiently to allow of free ventilation, and will be kept open as far as the weather and season admit (King's Regulations, paragraph 1003). In opening windows for ventilating purposes, the window sashes should be raised and lowered equally to admit of full entrance of fresh air. All barrack room windows should be opened *as a matter of routine* in fine weather daily before the room is evacuated by the men for their first parade after reveille, and as often as possible during the day if the weather permits.

The number of men each room can accommodate should be recorded on a special Army form (A.F.K. 1251).

Food and Cooking.—From time to time the inspecting medical officer should examine the quality of articles of food and drink used by the troops, and also ascertain whether the cooking is satisfactory and sufficiently varied.

Water-Supply.—A medical officer should also satisfy himself that the quality and amount of drinking water are good and sufficient, and that the arrangements for the distribution of the water are satisfactory.

Inspection of Schools.—Visits should be frequently made to the schools at times when the children are present, to see that their studies produce no injurious effects on their health, and for the purpose of ascertaining that due regard is given to ventilation,* lighting, and warming, as well as to the general sanitary state of the schoolrooms and their surroundings. Note should be taken of any conditions that are likely to exercise an adverse effect on the health of the children, and representations should be made as circumstances demand. Special attention should be paid to the inspection of the children's teeth, and the use of the toothbrush enforced. The children's ears,

* When children go out to play, and when they go for their midday meal, all the schoolroom windows should invariably be opened, weather permitting.

hair, eyesight, tonsils, etc., should all be examined, and advice to the parents given if necessary.

Sanitary Recommendations.—Copies of all written recommendations made under the foregoing paragraphs will be forwarded to both the Principal Medical Officer and the Officer Commanding concerned.

Infectious Disease.—See Chapter XI., p. 297.

Inspection of Barracks by the Principal Medical Officer.—A periodical inspection of barracks is made by the Principal Medical Officer and also by the Administrative Medical Officer of the command or district concerned. These inspections are attended by: (1) An officer, not below the rank of Captain, to represent the Officer Commanding the station; (2) a representative of the Commanding Royal Engineer Officer; (3) the Medical Officer; (4) the Quartermaster (K. R., 987).

CHAPTER II

MILITARY BARRACKS

Considerations affecting the site of barracks—Selection of site—Aspect—Formation of sites—Subsoil drainage—Treatment of old sites—Hut barracks—Permanent and temporary hut barracks—Warming—Cubic space allowed at home and abroad—Permanent barracks—Arrangement—Intervals between buildings—Surface channels—Foundation of buildings—Damp-course—Hollow brick walls—Floors—Ventilation of floors—Ceilings—Doors—Barrack rooms—Scales allowed for accommodation—Half-battalion and company system—Cleanliness of barrack rooms—Ablution rooms—Bath and lavatory accommodation—Scales for same—Dining rooms—Cleanliness of dining rooms—Cookhouses—Cleanliness of cookhouses—Wash-up rooms—Larders—Beer cellars—Guardrooms—The guardhouse—The guard detention rooms—Married quarters—The water supply of barracks—Scale—Water mains—Means of distribution of water—Water cisterns and pipes—The warming of barracks—Stoves and stove-pipes—Coal-boxes—Hot-water system of warming—Ventilation of barracks—Scales of floor space and cubic air space for barracks and Army schools—Methods of ventilation employed in barracks—Inlets and outlets—Air shafts—Louvres—The lighting of barracks—Windows—Artificial lighting—Military hospitals—Slaughter houses.

BARRACKS are dwellings built to contain a large number of healthy men living under discipline. The old plan of 'barrack square' surrounded by buildings has been abandoned, as it cut off the greatest possible amount of air. The barrack blocks are now arranged in column or échelon, end on to the prevailing wind.

CONSIDERATIONS AFFECTING THE SITE OF BARRACKS.

Selection of Site.—The selection of a suitable and sanitary site for the construction of barracks for military occupation is a matter of the utmost importance.

1. It should be open and freely exposed to fresh air, but at the same time protected from cold, bleak winds.

2. It should be fairly elevated, the surrounding ground being a dry, porous soil, having a fair fall to facilitate natural drainage. The subsoil or ground water should be deep and of a constant level.

3. It should be away from low-lying, marshy land (favourable to fogs and mists), stagnant water, and other insanitary areas.

4. Gravel, sand, chalk, limestone, and sandstone strata, as a rule, form good sites; loams, marl, and clay, unless well drained, are not satisfactory; shallow gravel, or sand overlying clay, reclaimed or made ground, and alluvial areas, are all bad.

Aspect.—At home stations, in order to obtain uniform exposure to sunlight, long-inhabitable blocks should, whenever possible, have their lengths running north and south or S.E. and N.W.; this is especially important when there are several parallel blocks. Larders, milk stores, kitchens, and clerical offices should face north, or, failing this, east. The best aspect for living rooms is from south-east to south-west, but the advantage of a good view from the windows should not be lost sight of. In stations in lower altitudes where there is *too much*, rather than too little, sunlight, the direction of prevailing winds is usually the chief factor in determining the aspect. When buildings are in exposed positions, care should be taken, if possible, to place the entrance doors on the more sheltered side of the building. It may be occasionally necessary to protect the entrance by a porch with a door at the side.

Formation of Sites.—Care should be taken never to reduce this to a dead level, but to leave sufficient fall for the surfaces to shed water readily, and for the gutters to act without excessive deepening. When possible, the excavation and filling should about balance. Terracing can often be employed with advantage in order to avoid steep falls. The embankments should allow for settlement. The natural soil should be removed from the actual sites of the buildings, and the portions beneath the floors should subsequently be sealed with a layer of cement concrete.

Subsoil Drainage.—It is very important from a sanitary point of view that the level of the subsoil water should be some distance below the surface of the ground; if not, it should be artificially lowered by proper drainage.

Treatment of Old Sites.—When a new building intended for habitation is to be erected on the site of an old building, the surface earth over the whole site of the new building should be dug up for a depth of at least 12 inches and removed, the portions beneath the floors being subsequently sealed, as above described.

HUT BARRACKS.

Hut barracks are used in some stations, being cheap and healthy. In war they are better than tents for winter-quarters. When used for a permanency, the sides are usually built of brick. Docker huts, as used by the German Army, have proved satisfactory for our troops in this country. These huts are portable, being built in sections, having a wooden or iron framework, covered with felt, lined with canvas, ventilated by windows, cross-louvres, and ridge ventilators, and, as a rule, they should not accommodate more than twenty-four men. The ground for a hut should be cleared, levelled, and drained, and the huts arranged *en échelon*, each being raised above the ground to a sufficient height to allow a man to crawl under to clean out 'dead cats, rats, and tins,' that may collect there, or else this space between the floor level and the ground should be wired in with strong galvanized open-meshed netting. Warming is best carried out by open grates. As open fireplaces necessitate brick chimney stacks, sometimes stoves are used in their place in temporary huts to save expense. At home stations *not less* than 500 cubic feet, with 50 square feet floor space, should be allowed for each man, while abroad from 500 to 850 cubic feet and from 50 to 70 square feet floor area should be provided per head.

PERMANENT BARRACKS.

The Arrangement of Barracks.—Barrack buildings should not be so scattered as to waste sites or to involve undue labour of the troops in keeping roads, etc., in order; but they should be designed and arranged to render extension possible, if so required, in the future. Latrines, cookhouses, etc., should be, as far as possible, to leeward as regards prevailing winds. Barrack blocks should be arranged together and close to the parade ground, the latter measuring at least 150 by 100 yards, with a drill shed, convenient for shelter and instructional purposes. Dining halls, canteens, recreation rooms, institutes, coal stores, etc., should all be arranged convenient to the barracks. Married quarters, with laundry and drying ground, should be located well away from the single men's quarters.

Intervals between Buildings.—The distance between all rows of habitable buildings should not be less than twice the height of the loftier of the two adjacent buildings from the ground floor to the eaves, and the ends of the spaces between the rows should be kept open, to insure proper circulation of air.

Surface Channels should be of cement concrete or hard bricks, laid on 5-inch cement concrete. Surface channels should be kept away from the walls of buildings, and their edges should not project above the surface of the ground.

Foundations of Buildings must be taken deep enough to be unaffected by frost. In the United Kingdom foundations in *clay* will usually be safe if the trenches are dug 4 feet deep; in other kinds of earth subsoils 3 feet may be sufficient. Surface or subsoil water should be drained away from any proposed foundations. In ordinary military buildings it is usual to build direct on a concrete bed, which is brought up to within 6 inches of the finished ground line.

Damp-Course.—All walls of buildings should have a damp-course. In buildings intended for occupation, the damp-course should consist of a $\frac{3}{8}$-inch layer of asphalt; for other buildings, two courses of slate in cement should suffice. When asphalt is not available, a good substitute is bituminous damp-proof cloth, or 3-pound sheet lead is occasionally used, but this is only admissible when building in cement, as lime mortar eats away the lead. The best level for a damp course is from 6 to 9 inches above the finished level of the surrounding ground, but in buildings intended for occupation it should, in the case of solid floors, butt on the inside against the concrete of the floor; but in the case of wooden floors with an air space below, it should be below the under-side of the wall plate. Hence, it is often convenient in the case of hollow walls to have the damp-courses of the inner and outer skins at different levels.

Hollow Brick Walls.—These are more expansive, less strong, less lasting, but warmer and more damp-proof than solid wall. Hollow brick walls should consist of a $4\frac{1}{2}$-inch skin of brickwork on the outside, then a $2\frac{1}{4}$-inch air space, and inside this the main body of the wall, which varies according to constructural requirements. No communication should be made between the hollow space and the outer air; all ventilating shafts, etc., must be closed off, and the interior must be kept free from mortar and rubbish. The space should be ventilated from the inside to keep it dry.

Floors.—The floors commonly used in barrack buildings are usually $1\frac{1}{4}$ or $1\frac{1}{2}$ inch deal boarding. Small areas of teak may be used with advantage at places where there is usually most wear, *e.g.*, at entrance door and in front of fireplaces. In cases where there is a likelihood of damp penetrating the floor, the lower surface should be covered with a bituminous (pitchy) composition. In the case of ground floors, joists and wall-plates should not be built into the walls, owing to the risk of dry rot. *A concrete seal under wood floors* is necessary to prevent the ground air and damp from rising within buildings. It is necessary to seal the surface of the ground below all ground floors of wood, except in cases in which a layer of concrete forms an integral part of the flooring. This is effected by providing a layer of cement concrete about 4 inches thick (on the rammed surface of the ground, or on hard filling when required), with the finished surface of the concrete *above* the ground level outside. When floors are made of stone, cement concrete, or asphalt, they should be laid with a current or slope, so as to shed water. The flooring of a passage should slope gently towards the entrance, and passages generally should slope away or past the doors of boarded rooms, Ground floors of stone or concrete should rest on not less than 4 inches of hard dry filling, laid on firm ground, and the surface of the floor should be above the level of the damp-course.

Ventilation of Floors.—Strong cast-iron gratings, or air-bricks with wide perforations, should be provided at frequent intervals for free through ventilation of joists supporting ground floors, the surfaces of which floors should be kept at least 1 foot above the ground outside. Upper floors should also be ventilated.

Ceilings.—All ceilings should be plastered and finished plain, without cornices.

Doors should as a rule open inwards, except in the case of churches, schools, theatres, etc., where the possibility of a panic in case of fire has to be provided against. Doors of soldiers' closets should be hung self-opening by fixing the hinges slightly out of the perpendicular.

Barrack Rooms.

The authorized accommodation scale of barrack-room blocks for a regiment of *cavalry* is for 16 N.C.O.'s and 475 men (including the band), each squadron to be quartered separately, and the band kept distinct, with a room for band practice. A battery of *artillery* has barrack blocks allotted for 3 N.C.O.'s and 155 men ; a company of Royal Garrison Artillery has barrack blocks for 139 men, plus 3 N.C.O.'s, and a company of Royal Engineers for 3 N.C.O.'s and 167 men. A battalion of *infantry* has barrack blocks for 13 N.C.O.'s and 714 men (including the band). Each company should be quartered separately, and the band also kept distinct, with a room for band practice. The best barrack blocks are those comprising only two storeys, their only drawback being the difficult question of night urinals. Basements, when present, should not be utilized for habitation, owing to their liability to damp ; and barrack rooms should not be situated over stables unless the site area is restricted, in which case special sanction is necessary Barrack blocks are now constructed to meet the requirements of what is termed the 'half-battalion' or the 'company system,' the latter being considered the better arrangement, as one Captain is responsible for the housing of his entire company and its interior economy. Each block is a two-storeyed building, with a central staircase, containing two small rooms, each occupied by a N.C.O., and four large living rooms, each containing twenty-four soldiers. The size of each living room should allow not less than

600 cubic feet and 60 square feet of superficial area (floor space) being properly allotted—*i.e.*, of definite shape—to each man. Not less than 6 linear feet of horizontal wall space per man is necessary. The height in a room over 10 feet should not be included in calculations, as it is considered 'dead air space.' All barrack rooms should have windows placed in the opposite walls to allow of through ventilation. The window space should equal 10 per cent. of the floor space, each window being 2½ feet broad and 6 feet high. Thus along one outside wall six beds will occupy a 36-feet space, in which will be three windows, each 2½ feet broad. The beds should be placed with their heads 6 inches from the external walls, and with a passage of not less than 18 inches wide on at least one side of each bed. Not more than one bed should be in any corner, and not more than two beds between two windows. No bed must be below a window.

The chief objections found in the company block type of barracks are:

1. Difficulty of keeping heated in cold weather.

2. The presence of unequally spaced windows and the difficulty of avoiding the beds being placed too close together.

3. The absence of separate dining halls.

To overcome these difficulties, the more recent half-battalion combined barracks have been planned. These comprise two double-storeyed blocks, each housing two companies, facing each other, and communicating by covered ways with centrally placed dining rooms and a cookhouse. The barrack blocks are divided up into twelve-men dormitories, with ablution rooms adjacent. This form of barracks has proved satisfactory, and is popular with the men. Each dormitory is 36 feet long by 23 feet 6 inches wide and 10 feet 6 inches high. It has three windows, each 2 feet 6 inches wide by 6 feet high, on each side. A bed is placed in each corner, and the others in pairs between the windows. A fireplace, with ventilating inlet and outlet, is placed at the end of each room, opposite the door. Louvred ventilators are let in the walls 8 feet high between each bed. Cubicles have been tried in some barracks, but they are difficult to keep clean and are not popular amongst the men. Small rooms which accommodate five or six men are, however, popular.

Cleanliness of Barrack Rooms.—The cleanliness of the rooms in which the men sleep is a matter of importance in regard to the health of the occupants. No man should sleep in any room where food is kept. During sleep the body is in a state of lowered resistance, and in barrack rooms, when the full complement of occupants is present, the air is less pure than the outside air at night, and more so when the windows are all shut, as is prone to occur in cold weather. In such circumstances cleanliness is essential in order to avoid any additional cause of fouling of the air, which, if not kept fresh, causes 'barrack-room sore throat.'

Dust and dirt on the floor and walls are likely to contain harmful microbes, and must not be allowed to accumulate. The sweeping out of barrack rooms by an energetic fatigue party armed with brushes only causes the dust to settle on the men's beds and kit. When bed-hour comes, the blankets being shaken in process of making up the beds again circulate the dust, and 'barrack-room sore throat' occurs. If the floor is hard and smooth, dry scrubbing will suffice to keep it clean, but it will probably be necessary to wash the barrack-room floor once a week. In doing this only enough water must be used to scrub the floor and clean off the soap, and all excess of water should be mopped up as the scrubbing proceeds. The washing should be done in the morning to allow of the drying of the room before bedtime, and doors and windows must be left open, and a fire lighted, if possible, to hasten the drying. Floors are also quickly dried by sprinkling with hot sand, but this should not be employed unless the sand is brushed up without delay, as if trampled in it rapidly wears the flooring. In wet weather the washing of floors should be avoided. A damp cloth must be used to remove dust from walls, etc. Cleaning utensils must be kept in their proper recess. Mops and scrubbing brushes have often an objectionable smell, and must not be kept in the barrack rooms, but in the small room provided for them.

Ablution Rooms.

Each company block has two ablution rooms, 15 feet long, 7 feet 6 inches wide, and not less than 9 feet high. Basins are provided at the rate of 14 per cent., each ablution room having six basins

Baths and Lavatory Accommodation in Barracks.

The bath and lavatory accommodation for soldiers in barracks has undergone considerable improvements within recent years. The old slate bath, although still existent in some barracks, is now generally replaced by the modern immersion bath in some of the latest barracks. A bath for adults should be not less than 5 feet 6 inches long, and the outlet not less than 2 inches in diameter, as this not only affords a good flush for drains, but allows of quick emptying and the use of the bath by the next comer. Vitreous enamelled cast-iron baths are now very generally used for military purposes. They should not be enclosed in woodwork. The windows of bathrooms should be hung on pivots to insure ventilation. The baths should empty (through a 2-inch outlet) into surface channels in the floor, discharging as directly as possible through the wall by a stoneware or iron pipe bedded and made good in asphalt, and projecting 1½ inches beyond the face of the wall over a gully or hopper head. It is best to arrange for the discharge to be immediately *below* the grating of the gully, so as to avoid choking it with soapsuds, etc., and thus causing an overflow.

Where more or less saline water is used for baths, as is the case at Gibraltar, galvanized iron fittings are not suitable. The metal is gradually corroded, and the apertures in the sparge pipe become obstructed. Gun-metal fittings should be used.

The authorized scale for fixed baths in barracks is one bath per cent. of strength, plus one bath in each bath-house for sergeants. *Cavalry* have usually one bath-house per squadron, with one bathroom for sergeants and two bathrooms for the rank and file. A battery of *artillery*, a company of Royal Garrison Artillery or Royal Engineers, have two bathrooms for the rank and file and one for sergeants. A battalion of *infantry* have their bathhouses located in one or two blocks of buildings, eight bathrooms being provided for the rank and file and one bathroom for sergeants in each block.

Shower baths are provided in some barracks, and should be more generally adopted, as they are very suitable to soldiers, especially in hot climates; they consume less water, and there is no risk of contracting infectious or contagious diseases by their use.

The supply of *hot water* for personal washing has been greatly extended in recent years, and the provision of hot water is now generally available in most barracks. The provision of *fixed foot baths* for troops is an innovation of the general utility of which there cannot be any doubt, and it is hoped that their adoption will become general.

Dining Rooms.

The dining-room blocks of the new half-battalion combined barracks are each divided into two company dining halls, which communicate by a covered-in passage through each company wash-up room direct to the serving windows of the single half-battalion cookhouse. This arrangement not only facilitates a rapid service of the meals in a hot condition, but also allows the dining-room utensils and food remains to be kept away from the dormitories. The dining hall is provided with tables, allowing a space of 2 feet per man. The tables are usually arranged to seat twelve at each, with 4-feet serving passages between.

The introduction of the restaurant system into new barracks, where separate dining-room accommodation is provided, is well spoken of, and its advantages appear to be fully realized by both regimental officers and men. It is becoming largely adopted throughout the various stations in the United Kingdom, and where the special dining rooms have not been built, vacant barrack rooms have been frequently utilized. The principal advantages claimed for the system are:

1. That it affords a greater variety in food, combined with economy.

2. That the meals are served hot, and in a neater and more cleanly manner.

3. That the barrack rooms used as sleeping accommodation are kept cleaner, and their ventilation can be more readily carried out when not used for meals.

A regiment of *cavalry* should have dining rooms provided for 469 men (*i.e.*, 475, less 6 lance-sergeants) to dine simultaneously, with wash-up rooms, and arranged to suit squadron organization. Dining rooms should be provided with wash-up rooms for 155 men to dine simultaneously in a battery of *artillery;* for 139 men, plus 3 N.C.O.'s, in a company of Royal Garrison Artillery; and for 167, less 8 corporals, in a company of Royal Engineers. A battalion of *infantry* should have dining-room accommodation for 698 men (*i.e.*, 714, less 16 lance-sergeants) to dine simultaneously, with wash-up rooms provided.

Cleanliness of Dining Rooms.—The tables from which the men eat must be kept clean. The use of tablecloths contributes to this. Plates and basins must be supplied in sufficient quantity. The necessity of providing a supply of proper cloths for wiping utensils should not be lost sight of, thus obviating the use of soiled hand towels.

Cookhouses.

The cookhouse of the new half-battalion combined barracks is centrally situated between the two buildings allotted as dining rooms, and at either end are provided bathrooms (four for men and one for N.C.O.'s), and drying rooms one per company. These rooms, and also the dining rooms, are heated from a boiler room in the basement, which also supplies hot water for use in the bathrooms, cookhouse, and wash-up rooms. In other designs of barracks the authorized scale is one per squadron for a regiment of *cavalry*, one each per battery for *artillery*, company Royal Garrison Artillery and company Royal Engineers, and for *infantry* usually two cookhouses each for a half-battalion.

Cleanliness of Cookhouses.—These require to be kept sweet and clean, and cooking utensils, tables, chopping blocks, and all receptacles for food, should be cleaned at once after use.

Ptomaine poisoning (from decomposed animal matter) is one of the dangers to be apprehended from dirty utensils. These, as well as tea-kettles and milk-cans which are in use, must be frequently inspected to see that they are kept clean.

Wash up Rooms should be ventilated by perforated bricks.

Larders should, if possible, face the north, the east being the next best aspect. The windows should be barred, and any window not facing the north, or nearly so, should be protected from the sun by jalousied shutters or blinds. Floors should be of concrete or stone, and the walls lined 7 foot high with white glazed bricks or tiles. Through ventilation is of the utmost importance. Louvred ventilators are not required. Fresh air should be admitted near the floor line and again at the upper part of the walls; the upper panes of windows should be filled with fly-wire instead of being glazed.

Beer Cellars should be dry and well ventilated, but there should be no windows. It is necessary to insure an equable temperature, and as darkness is better than light for both wine and beer, direct sunlight, being especially harmful, should not be admitted.

Guardrooms.

Guardhouse.—This should be sited at, or close to, the principal entrance to barracks, and is generally built in conjunction with the regimental offices. The guardroom is about 24 feet long, 18 feet wide, and 14 feet high. Two detention rooms open off it, capable of being overlooked by the guardroom—one for casual detention, and the other for men awaiting trial. The guardroom affords 600 cubic feet per man, and is ventilated on the same principle as a barrack room.

Guard Detention Rooms.—These are ranged on one or both sides of a corridor. They are 10 feet long, 8 feet wide, and 10 feet high (=800 cubic feet), with one window 9 inches wide by 1 foot 3 inches high, placed at the top of the wall and guarded by iron bars. Two kinds of detention rooms are provided—ordinary and single. The proper ventilation of these is of considerable importance to inspecting officers. The *detention room* (*ordinary*) should have inlets and outlets to give 20 square inches per man. About half the inlet ventilation should be provided by 'hit-and-miss' gratings under the bed, worked from outside; the other half by inlets 8 feet above floor, two or three being over the bed. A fresh-air duct opening behind the coil should be provided when warmed by hot water, and should give 100 square inches clear sectional area, and have a 'hit-and-miss' grating at the outer end. This can be used in cold weather in place of the inlets under the bed, and in hot weather as a supplementary inlet. All inlets are to be in direct communication with the outer air, each opening being protected by a horizontal round iron bar $1\frac{1}{4}$ inches in diameter, built into the wall. An outlet flue, 200 square inches in clear sectional area, protected at its foot by an iron bar or grating, and terminated by a cowl, should also be provided. In a *guard detention room* (*single*) the foul air should be extracted from a room through a 9-inch by 6-inch (clear) flue, which should have a cast-iron grating at its foot, and lead into an iron trunk terminated by a cowl. Fresh, cold air should be admitted separately to each detention room through a traversed duct in the external wall, the opening to the detention room being in the sill of the window. The duct should be furnished outside with perforated bricks or an iron grating, and on the inside with a valve, under the control of the prisoner. In both classes of rooms warming is effected by hot water from the guardroom range, a cut-off being provided to each room when possible. A water closet and a urinal are provided outside.

Married Quarters.

Up to a few years ago the relief from overcrowding in the quarters of married soldiers was the most urgent of all sanitary requirements in barracks in the United Kingdom. Until recently a single-room quarter was the usual official allotment for a soldier's family, sometimes irrespective of the number or ages of his children. Overcrowding is now relieved generally by the provision of at least two rooms to all men married on the strength, and in the case of large families, double quarters are allotted when available. The chief defects in the old pattern of married quarters were defective ventilation of the rooms, the want of suitable bathing accommodation, and the faulty situation of the water closets. The last named was of considerable importance, as the water closets were frequently located in detached buildings at long distances (40 to 60 yards) from the dwelling rooms, which is trying during inclement weather and at night. The absence of suitable baths and lavatory accommodation necessitated all washing of the person being done in the bedrooms. It is satisfactory to note that these defects are being remedied as funds allow, and that all new quarters constructed can compare most favourably with municipal buildings of the same class.

THE WATER SUPPLY OF BARRACKS.

Water Supplies.—As a rule, the water supply to barracks in the United Kingdom is of excellent quality and sufficient in quantity, being usually obtained from the mains of the adjoining municipality. In some few stations, however, it has been found that as the municipal supply could not be relied on either chemically or bacteriologically, the drinking water has had to be boiled as a precautionary measure.

Scale.—The maximum amount of water allowed daily per head in barracks is 20 gallons for each officer, man, woman, and horse, and 10 gallons per child. The water supply of barracks is under the control of the Royal Engineers as to its source and fixtures; the R.A.M.C. is responsible for the quality of the water, and the A.S.C. for its quantity. It is laid on in most instances, but taps and cisterns in barracks are in charge of the occupants. Drinking direct from taps must be strictly forbidden. If filters are fixed, they are usually in charge of specially instructed men, who know how to cleanse and use them.

Mains.—The supply mains are usually made of cast-iron pipes, either with turned and bored or with plain spigot and socket joints, both caulked with lead, flange joints being used for connections with meters and valves and in all vertical work. In cases where the static head on the main may amount to over 250 feet, steel pipes with collar joints are used. As a protection from frost, all underground pipes should never be less than 18 inches from the surface.

Distribution in Barracks.—The supply system is either *constant*, in which case the taps and other services are directly connected with the mains, no cisterns being provided except for water closets, hot-water apparatus, boilers, etc., or *intermittent*, in which case every building is provided with a cistern with a capacity of one or two days' supply for the occupants.

From a sanitary standpoint a constant service is the more desirable.

Cisterns.—As a rule, galvanized wrought iron is the best material. Lead-lined cisterns should not be used. Cisterns supplying water closets, latrines, urinals, and slop sinks should be separate from those supplying water for other purposes. Those for drinking and cooking water should be placed where they are not exposed to foul air or other pollution. Covers of cisterns should be movable, to give easy access for examination, and in a well-lighted situation. Cisterns must be kept covered and cleaned out at intervals.

Pipes.—It is sometimes undesirable to use lead pipes for a service supply, but some municipalities insist on their use for this purpose. Lead pipes should *never* be used for soft water, which often acts on the metal and causes lead poisoning. Some waters which act on iron and galvanized iron do not act on lead.

THE WARMING OF BARRACKS.

The warming of barracks is usually carried out by ordinary fireplaces burning coal. In some buildings (hut barracks) stoves are used, and in a few instances warming by hot-water system is carried out.

Stove and Stove Pipes.—Stoves must be always placed on a base of stone or concrete, preference being given to the former. As serious fires have occurred from faulty stove flues, it should be noted that iron smoke flues, especially those of wrought iron, are a grave danger if carried through timbered floors, roofs, partitions, etc., and this practice is strongly to be condemned. In all buildings except those of a most temporary nature the flues should be taken up in brick or stonework, or else carefully insulated by the use of a non-inflammable material, such as asbestos sheeting, to prevent any chance of ignition of surrounding timber.

Coal-Boxes.—These should not contain anything but coal, wood, and dry paper for kindling. Men are prone to put into them fruit peelings, sweepings, etc., and very soon they become receptacles for all sorts of dirt, unless a rigid rule is enforced. When no fires are used, the coal-boxes should be turned upside down.

Hot-Water Systems.—These may be required either for warming or for the supply of hot water, or for both purposes. There are two distinct types, viz. : (1) closed or high-pressure, and (2) open or low-pressure. The former is suitable for both warming and hot-water supply. In large systems special combined apparatus may be used, or there may be a separate boiler for each purpose.

VENTILATION OF BARRACKS.

Ventilation of barrack buildings is intimately connected with considerations of cubic space, with the system of warming and the method of lighting. Further, the conditions may vary materially with climate, position, and aspect of buildings, character of occupation, and the number and habits of occupants.

To maintain a standard of purity in the air of an inhabited room, 3,000 cubic feet of fresh air, taken from a pure source, is required per inmate every hour ; and it is essential in order to avoid discomfort that the foul air should be extracted and the fresh air evenly diffused without causing draughts, which are usually felt if the rate of movement exceeds 3 feet per second. In practice, however, the air of a room cannot be completely changed more often than three times in the hour without causing inconvenience to the occupants. In some climates the necessity of avoiding either undue cooling or excessive moisture causes some difficulty. The best of all ventilation is open windows, and for this reason the position and design of windows are of the utmost importance. In large rooms with flat ceilings lofty windows, with the upper lights arranged to open, are the most satisfactory. Sometimes it may be desirable to provide for the admission of fresh warm air by inlet ventilators behind radiators.

Although the cubic space allotment per head may be apparently ample, the scale of superficial area allowed to each man must not be forgotten. Lofty barrack rooms possessing great width may possibly give each individual his full complement of cubic space and superficial area, yet it may so happen that his bed may be too close to that of his neighbour, which is an objectionable feature, and one likely to facilitate the rapid spread of infectious disease. In 1908 the standards of barrack-room space were accordingly remodelled, and the table on p. 28 shows the scales now in force.

In barracks where separate dining rooms are provided not less than 6 feet linear wall space should be allowed for each man.

The cubic space of a barrack room must be—

(1) Sufficient to admit of a change of atmosphere frequent enough for health without causing draughts, and

(2) Sufficient to reduce to a negligible quantity the danger from temporarily impeded ventilation.

The floor space must be—

(1) Adequate for the convenience of the occupants and the kind of work to be performed in the room, and

(2) Sufficient to admit of adequate cubic space being provided without unduly increasing the height of the room.

TABLE SHOWING MINIMUM FLOOR SPACE AND CUBIC SPACE PER BED PROVIDED IN BARRACK ROOMS FOR BRITISH TROOPS.

Stations.	Permanent Buildings.		Wooden Huts.	
	Floor Space.	Cubic Space.	Floor Space.	Cubic Space.
Home Stations.	Square Feet.	Cubic Feet.	Square Feet.	Cubic Feet.
Great Britain, Ireland, and Channel Islands ...	60	600	60	600
Stations Abroad.				
Scale A (sub-tropical): Bermuda, Cape Colony, Cyprus, Gibraltar, Jamaica (Newcastle and Up Park Camp), Malta, Mauritius (Curepipe and Phœnix), Sierra Leone (Mount Aureol and Tower Hill), Egypt, Hong Kong (except Victoria), Natal	60	720	60	720
Scale B (tropical), equivalent to former Scale D: Ceylon, Hong Kong (Victoria), Jamaica (Port Royal), Mauritius (Port Louis), Sierra Leone (King Tom), Singapore	80	1,000	75	850

From this it will be seen that floor space is the important element of cubic space, and, speaking generally, it may be accepted that in ordinary barrack rooms any addition to cubic space gained by increasing the height above 12 feet is of but little value; and this is especially the case if the tops of the windows are much below the ceiling line.

Recent investigations on the subject of barracks and health in the French Army show that—

(1) Disease rarely originates in barracks, be they old or new, and that it is generally introduced from outside.

(2) Disease once introduced spreads according to the condition or otherwise of overcrowding, irrespective of the age and construction of the barracks.

(3) The space between barrack sleeping cots is the most important requirement in barrack hygiene.

(4) The modern tendency is to reduce cubic space and superficial area of the sleeping room, in order to provide dining and recreation rooms. This tendency must be regarded as one of the great evils which medical officers will have to combat.

In **Army Schools** the authorized floor and cubic space is as follows: In *adults' and older children's schools* not less than 15¼ superficial feet and 200 cubic feet per seat. In *infants' schools* not less than 11 superficial feet and 140 cubic feet per seat.

Methods of Ventilation in Barracks.

As a general rule, *every* room intended for habitation or occupation, whether of short or long duration, should be independently ventilated, and separate means of ventilation should be provided for passages and staircases. In the special case of barrack rooms, guard detention rooms, schoolrooms, and stables, the amount of inlet and outlet ventilation is regulated according to fixed rules; but in other cases it is largely a matter of judgment, according to the use to which the rooms are put, varying from the relatively small needs of officers' quarters and stores to the large requirements of gymnasia, schools, recreation rooms, canteens, tailors' shops, etc.

Inlets.—Doors, windows, etc., when insufficient, must be supplemented by special inlets, usually taken through the walls, and furnished on the outside with movable perforated gratings, and on the inside with louvred frames or valves, giving partial mechanical control over the ingress of air. To avoid draughts from the incoming air, inlets should admit the air in an upward direction, the openings being at a height of at least 6 feet from the floor, and where more than one inlet are required they should, if practicable, be in opposite walls.

Outlets.—Adequate exits must be provided for the escape of vitiated air. Chimney flues are natural outlets, and may suffice. Outlets, in addition to the flue from fireplaces, should be provided, having not less than 1 square inch clear cross-sectional area to every 60 cubic feet of room space. Inlets should together have the same cross-sectional area, and should be fixed 8 to 10 feet above floor level.

Outlet ventilation for single-storey buildings or upper-floor rooms may be arranged for by ridge ventilation or by wooden trunks, carried up through the roof from the ceiling, preferably from above the gas lights, if such exist. Outlet shafts in brickwork or masonry should be rendered in cement, and carried, where practicable, near smoke flues—between two, if possible—to aid the up-draught. Outlets should be close below ceiling level and always be at a distance from the air inlets of a room where these exist, and when both are in the same chimney stack, the openings should be as far apart as possible. Fixed louvres should be placed at the foot of the outlet shaft, except when over a bed (a position which should as a rule be avoided, on account of down-draughts), in which case a mica or other flap ventilator may be used. The upper end of the shaft should terminate in a horizontal passage right through the stack, between the necking and cap, with apertures fitted with air bricks. This passage, which may serve more than one outlet shaft, should be of such a size that the air bricks on either side will give a clear outlet area equal to the aggregate cross-sectional area of the shafts.

Air Shafts.—These should have smooth sides with rounded-off angles, be as short and as nearly straight as possible, and be provided with removable gratings at their outer ends to keep out birds, etc. These gratings should be large enough to allow of their interstices giving the full required area of the duct, and should admit of easy cleaning and always be kept free from dust and dirt, which not only contaminate the air, but also impede its free circulation.

Louvres.—Where fixed internal louvres are used they should be set 'up cast' to the room at an angle of 45 degrees, the upper edge of each louvre just covering the lower edge of the one above, so that the incoming air may be directed towards the ceiling. External louvres should be set, half covering, at an angle of not less than 60 degrees. In exposed positions louvres will not keep out driving rain or snow, and steps must be taken to prevent the drift causing damage.

THE LIGHTING OF BARRACKS.

Windows.—The amount of window space required for a room depends on its size, proportions, situation, and use. In fixing the size and position of windows it must be remembered that, apart altogether from the necessity of giving enough light, direct sunshine and light are essential to health, cleanliness, and cheerfulness, and that windows should also be arranged with a view to giving through ventilation, whenever possible. At the same time, as too many windows make a room cold by lowering the temperature of the air generally and by tending to produce cold draughts, the amount of window space should be restricted to what is necessary for light. In ordinary rooms this may be taken as 1 superficial foot to every 100 cubic feet of space in the room, assuming that buildings are not put closer together than twice their height from the ground floors to the eaves. Various circumstances may render slight variations desirable. Upper-floor windows and those with no buildings opposite them might have rather less window space. If buildings are too close together, or if they are built of dark stone, red or dark-coloured brick, or, again, if barracks are located in smoky towns, more window space might be allowed. This is especially the case if the windows are covered by a veranda. The window space at home stations, however, should never fall below eleven-twelfths of a superficial foot for every 100 cubic feet of space, and would rarely exceed fourteen-twelfths. In workshops, kitchens, sculleries, pantries, wash-up rooms, cookhouses, bathrooms, ablution rooms, water closets, and lavatories, it is almost impossible to give too much light. Rooms that are lofty in proportion to their depth from the window wall, rooms with windows on two sides, especially on opposite sides, rooms with white or light-coloured walls and paint, are all more easily lighted than rooms with the opposite characteristics. In rooms where the windows are not all in the same wall preference should be given to the walls which face south-east to south-west, except in such cases as require north light—*e.g.*, drawing offices, etc. In hot countries, where plenty of air is desirable, with subdued light, the use of verandas and wood louvres is best. As a rule, windows should be carried up as close as possible to the ceiling line. In exposed positions double windows may be necessary The top of outside sills in barrack rooms should be 3 feet above floor level. Window-sills should be 'grooved' underneath, so as to prevent rain running down the walls below.

The Artificial Lighting of Barracks.

The artificial lighting of barracks, as a rule, leaves much to be desired. In some stations oil lamps are still in use, although in many cases either gas or electric lighting is provided. Where gas is used, the tendency has been to replace the old pattern gas-burner by the modern incandescent type. In some of the older barracks defective lighting is due to choking of the pipes from long use, and consequent insufficient pressure of the gas.

MILITARY HOSPITALS.

For the proper treatment of the sick a first-class sanitary environment is essential. Abundance of pure air of a suitable temperature, as well as sunlight, are of the first importance. Hospital wards should provide 1,200 feet of cubic space and 85 square feet of superficial area for each patient at home, and in the tropics (excluding India) 1,500 feet of cubic space is usually authorized. In India the scale varies from 1,630 cubic feet of space in the hill stations to 2,400 cubic feet in the plains, and 120 square feet of floor area in both these localities. Military hospitals in peace time are usually constructed on the basis of treating 3½ per cent. of the normal garrison as in-patients. The ward blocks rarely contain more than two storeys. The largest wards are 80 feet long, 24 feet broad, and 14 feet high, and contain not more than twenty-two beds. Polished floors should always be provided if possible. The beds are arranged in pairs between the windows, with a single bed in each corner. The space between the windows should not be less than 9 feet, and for the corner bed half this. The space for windows between each couple of beds should not be less than 4 feet 6 inches. Thus there is a minimum total wall space of 6 feet 9 inches per bed, and the breadth and floor space given allow 7 feet 1 inch. Ventilation of wards is similar to that prescribed for barrack rooms, but the dimensions are doubled in the cases of special inlet and outlet shafts. Warming is effected by hot-water pipes or large ventilating grates. Special separate annexes, opening by swing-to doors off the ward, are provided for (1) a hot and cold bath and lavatory, (2) water closets and urinals, (3) slop sink and wash-up room, (4) small kitchen, and (5) room for nursing orderly.

Wash-down water closets are provided at the rate of 14 per cent. Special dining-rooms should always be provided for the use of the patients, so that no meals shall (unless unavoidable) be taken into the wards.

In large military stations special hospitals are provided for infectious diseases. The ward blocks of these are always separately located, and not more than one storey high. The number of beds which each ward is capable of accommodating is recorded on A.F., K 1251, and this number will not be exceeded without sanction.

At home stations the superficial area and cubic space allowed per bed is:

	Floor Space. Square Feet.	Cubic Space. Cubic Feet.
For permanent hospitals, light-case wards	65	900
,, ,, ,, ordinary wards	85	1,200
,, ,, ,, infectious wards	144	2,000
For detached wooden huts, all wards ...	70	800

At stations abroad a special scale is authorized for each command, except the scale for infectious wards, which is the same as that for home stations. When hospitals are not fully occupied, the sick will be distributed so as to allow, as nearly as may be, the amount of space above specified to each occupant.

SLAUGHTER HOUSES.

The walls and floors of slaughter houses should be rendered impervious, blue Staffordshire bricks being used for the floor. Blood, when not collected for manufacturing purposes, should not be discharged into the drains, or they will become offensive. To get over this difficulty all blood must be collected in impervious receptacles, and, as an additional precaution, the official grating, with bars three-eighths of an inch apart, should be fixed to the mouth of the gully trap by a chain or lock to prevent coagulated blood being placed in the trap by the workmen. Blood after removal should be destroyed in destructors. A small well-ventilated room, in which the carcasses can be hung during the process of 'setting,' should be provided, and it should be situated on the cool side of the building.

CHAPTER III

THE DISPOSAL OF EXCRETA AND SEWAGE FROM BARRACKS

General remarks on water closets, latrines, and urinals—Scales authorized for barracks—Varieties of water closets employed—Hopper closets—Testing a hopper closet—Valve closets—The 'dry method' of removal of excreta—Earth closets—Latrines—Urinals—Night urinals—Cleansing of urinals—Ashbins—The drainage system employed in barracks—Underground drains—Foul drains—House drains—Traps—The dipstone trap—The siphon trap—The junction of drains—Disconnecting manholes—The ventilation of drains—Flushing of drains—Storm-water drains—Subsoil drains—Testing drains—The smoke test—Other tests—Method of inspecting drains—The drainage of hospitals—Methods of sewage disposal—Clarification methods—Screening—Sedimentation—Precipitation—Liquefying or solution by bacteria—Oxidization methods—Surface irrigation—Land filtration—Contact beds—Percolating filters—Standards for purity of a sewage effluent—Some military methods of sewage disposal.

ALTHOUGH the water-carriage system of excreta removal is now generally adopted in barracks at military stations in the United Kingdom, yet the dry earth and pail method is still in vogue at many of the older barracks, particularly those in the northern and western commands. The objections to dry-earth closets are well known, and their replacement by water closets of the 'wash-down' type is being gradually carried out as funds allow, so that the abolition of the earth closet is now only a question of finance. The older pattern trough latrines have also been condemned on sanitary grounds, and are being gradually replaced by modern water closets.

Water closets, latrines, and urinals in barracks are in the charge of the troops in occupation, and are kept clean and flushed* by them. They should be conveniently sited, so as to be readily accessible, but detached from barrack blocks, separate closets and urinals being arranged for night use only near the barrack rooms, but disconnected by ventilating lobbies. Compartments should be provided for sergeants in the closets belonging to the block for the rank and file, but with separate entrances. All entrances should be screened. Concrete platforms for ashbins may be placed at the ends of these blocks. Floors of closets and urinals should be of cement concrete currented to doorways, and that of each compartment at least 5 inches above outside floor level in the case of closets, and in urinals it should be currented to surface channels.

In barracks one of the chief sanitary essentials to be aimed at is to keep flies out of the latrines and urinals. The best disinfectant is a 2½ per cent. solution of crude carbolic acid in water. Perchloride of mercury is not suitable for troops, as it is poisonous, and may lead to dangerous results.

The water closets (or latrines) and urinals are provided in the following proportional scale to the strength of single N.C.O.'s and men living in barracks: Water-closet or latrine seats at 6 per cent., plus one in each block for sergeants; urinals at 4 per cent., plus one in each block for sergeants. *Cavalry* have usually one block per squadron, each containing ten seats and one urinal for rank and file and one seat and one urinal for

* The necessity of periodically flushing all water closets in empty quarters, especially in the summer months, should not be lost sight of.

sergeants. A battery of *artillery* or a company of Royal Garrison Artillery or Royal Engineers have one block per unit allotted, each containing nine seats and six urinals for rank and file and one seat and one urinal for sergeants. An *infantry* battalion has usually one block provided per two companies, each containing eleven seats and seven urinals for the rank and file and one seat and one urinal for sergeants. *Night urinals* are provided adjacent to barrack rooms at the rate of one or more per company, troop, or section, according to the arrangement of the barrack rooms, each being fitted with one urinal stall. Water closets adjacent to barrack rooms on the same scale as night urinals, each being fitted with one 'wash-down' water closet.

WATER CLOSETS.

These are of two classes, valve closets and hopper closets: the latter are the more suitable for barracks, chiefly because of their simplicity; the former are an abomination, and very little used now. The old pan closets had mechanical means of keeping the water in the pan and are obsolete.

Hopper Closets.—This class consists of closets which have no intricate working parts to get out of order, but comprise only a pan and a trap, either separate or combined, the latter being the better. The essentials of a good hopper closet are—

1. It should be as little complicated as possible.

2. It must be constructed of impervious material throughout. The best are glazed, white or brown, porcelain.

3. It should retain water in the pan before and after use to act as a seal. There should always remain in the pan sufficient water for the direct reception of excreta. This water should be a good and fair height to cover the excreta; it should be sufficiently deep, but not deep enough to cause splashing.

4. It should be self-cleansing, so that the contents of the pan are entirely cleared out by a 2-gallon flush through the trap, so as to leave nothing but water in the trap. Self-cleansing implies a good flush, but the shape of the pan is also an important factor; it should have a straight back and no obstruction between the fall of the excreta and the water seal.

5. The pan should be of such a shape, without projections, as not to be fouled when used; it should be strong and firmly fixed, and not boxed in by woodwork. The seat should be hinged.

6. It must have a good water seal, the seal of the trap being from $1\frac{1}{2}$ to 2 inches.

7. It must have a good flush of an adequate amount of water, at least 2 to 3 gallons, and must come from a proper height: 6 feet is convenient, as the cistern can be readily inspected for repair, etc. The flush pipe should be not less than $1\frac{1}{4}$ inches diameter, and come direct from the cistern, without undue bending: each right-angle bend takes off half the velocity of the water. The water should pass away after each flush; the reverse is one of the defects of the 'wash-out' closet. The cistern should be of the syphonic flushing pattern, discharged by pulling a chain.

The hopper closet retains the water in the chamber by a bending on the discharge pipe. The long hopper closet is defective, because it does not flush itself sufficiently. The short hopper is better: it has a vertical back, a sloping front, and a rim flush. The 'wash-out' pattern of short hopper closet is not as good as the 'wash down,' because the water flush loses part of its power against the floor of the basin, and so does not clean out and seal properly. In the 'wash-out' closet the excreta rests first on the ledge, and then is washed out by the flush. It does not hold up sufficient water to prevent smell, and the bottom of the pan becomes soiled. Also the edge of the pan ledge tends to become soiled, the flush is not so effective, and it is not self-cleansing.

In the 'wash-down' the flush goes *straight* down and drives excreta out through the trap. It should not be boxed in, but should have a hinged flap seat to allow of thorough scrubbing. It should be placed against the outer wall of the compartment. In the case of indoor water closets having tile or wood floors, sheet lead should be fixed under the apparatus. All water closets should, however, have concrete floors, if possible. Seats for

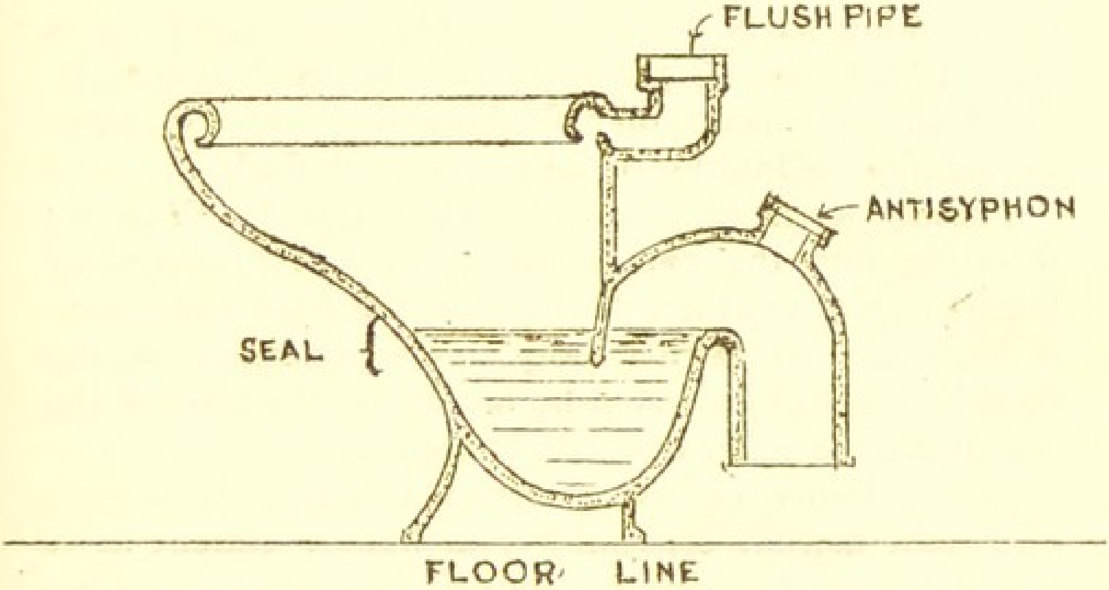

FIG. 1.—'WASH-DOWN' CLOSET, WITH BASIN AND TRAP IN ONE PIECE AND OVAL BASIN WITH STRAIGHT BACK.

adults should be 1 foot 6 inches high, and for children 1 foot 2 inches. The flushing cistern should allow of a *continuous* strong flush of 2 gallons, and to effect this it is usually 4 feet above the pan. Proper ventilation is essential. Rooms containing water closets should have their doors self-opening, with a clear 6-inch opening between top of door and frame, and 12-inch opening below bottom of door and floor. A continuous course of air bricks should be arranged in rear of wall of each compartment at a level of 6 feet 3 inches above floor, and all covered passages to closets should be exposed to cross draughts to ventilate them.

Closet seats must be cleaned as often as necessary. It is essential that they should be dried after being scrubbed, in order to avoid giving the men any excuse for not sitting down and so fouling the seats. A supply of proper water-closet paper is equally important. Such matters are apt to be forgotten. All classes of water-closet apparatus, including their traps, should be made of incorrodible material, and should admit of ready access to every part. They should be as simple and have as few working parts as possible. The trap should be as close to the pan as possible, and the flush should be rapid and by means of a flushing rim, so as to scour thoroughly the interior of the pan at each flush.

Testing a Hopper Closet.—This can be done by throwing into the pan small corks and crumpled-up latrine paper, and then discharging the flush and seeing if they are all carried away. The efficiency of the flushing rim can be tested by powdering the sides of the pan above the water line with lampblack.

In all forms of water closets the trap is a most important matter, especially with hopper closets, as it forms the only disconnector between the soil pipe and the interior of the building. In order that the trap may not become foul, it is necessary that it should not only be self-cleansing, but also smooth and incorrodible—*i.e.*, either of glazed stoneware, lead, or iron lined with lead, enamel, or glass. Of equal importance is the connection of the trap with the soil pipe or drain, which should be both water-tight and air-tight. Other joints on the branch connecting the trap with the soil pipe should be water-tight, air-tight, and accessible in all cases, and outside the building when possible.

It should be noted that as all closet pans become more or less encrusted with urine deposits, especially at the outgo neck and in the traps, it is desirable that they should be occasionally cleaned with 'spirits of salts' (commercial hydrochloric acid) on a cloth fastened to the end of a stick.

Valve Closets.—The pan should be of good size, oval in plan, with a 3-inch outlet at the bottom, the sides of the upper half being vertical, or even slightly recurved. It should have a good flushing rim to flush the whole of the pan, and with especial force the parts most likely to be fouled—viz., the front and the part just at and above the permanent water line. The overflow should be several inches below the water line, and the opening to it should be by perforations in the side of the basin about ½-inch diameter, and so formed and placed as to be easily cleaned and flushed at each discharge. The opening and overflow pipe should be large enough to carry off water from the pan more quickly than the flush can supply it, and the pipe should be trapped and connected with the valve box, which should be as small as possible, with no corners to collect fæcal matter, and of such a shape as to be thoroughly washed out at each discharge. The closet trap should be low enough for the discharge valve to work clear of the surface of the water in it. The flushing apparatus should be fitted with a copper bellows regulator, to prolong the flush after the handle is lowered, so as to fill the pan about half full, and the flushing pipe should be at least 1¼ inches diameter. Valve closets may be obtained with square slop-tops.

The old-fashioned *pan closet*, with container, is a very insanitary closet, and should be at once condemned.

Latrines.—Where latrines are used, they should be of the continuous pipe pattern, with syphonic discharge. They must be flushed at stated intervals. Fæcal materials collect in water, and float there until the flush comes. This is offensive, and a good promenade for flies. These troughs crack, and fæcal material oozes out. If circumstances permit, trough latrines, however, should not be used. Separately flushed water closets are now generally adopted in all new barracks.

'DRY METHOD' OF REMOVAL OF EXCRETA EMPLOYED IN BARRACKS.

In this method the excreta are retained in the closets for a longer or shorter time, pending arrangements for their removal. During this period we must prevent smell, decomposition, and infection. Dry earth or ash will effect these three objects if carried out at once. If enteric infected fæces are exposed for even a short time, the bacilli may infect barracks. The dry-earth system is excellent for a small community, but full of danger to a large one, as everything depends on the personal equation, and this danger is bound to increase with every addition to the community. The dry-earth system may be unavoidable under the following conditions :

1. Absence of sufficient fall.
2. Scattered condition of the buildings, requiring long branch drains, which will not cleanse themselves.
3. Absence of skilled expert staff to look after the drainage system.*

Earth Closets.—These are sometimes used in barracks, and the pails are emptied by contractors. The contractor should be directed to put a 'double charge' of earth in each pail when he replaces it. When it is necessary to use earth closets, the apparatus should take the form of a simple plank seat laid on bearers, from which it can be raised and scrubbed daily. A pail a little larger than the hole is provided, and its rim should fit *close* up under the seat. A plentiful supply of dry finely pulverized earth should be kept in a box; a scoop should also be provided. Automatic mechanical contrivances for depositing the dry earth in the pan should be avoided, as they are apt to get out of order. In deal-

* In stations abroad the use of dry earth is being in many instances abolished, a solution of cresol in water being used in its stead.

ing with earth closets it should be strictly impressed on all concerned that it is every man's first duty to *cover* his excreta *immediately* with fine earth.

URINALS IN BARRACKS.

Owing to their offensive smell if neglected, urinals should always, when possible, be located in the open air. A perfect urinal should be of non-porous material, with a very smooth surface, should possess no angles or parts that cannot be easily scrubbed, and should provide for the immediate dilution or washing away of urine. The best materials for construction are glazed stoneware and slate; the former is the better, as the surfaces, being curved, are less liable to foul, and are more easily cleaned. It is best to have a channel common to all the stalls, with an outlet at the end. Urinal stalls are usually made 24 inches wide from centre to centre. Indoor urinals should be of glazed stoneware or porcelain, and should be trapped as close to the urinal as possible. Enamelled iron urinals are unsuitable for soldiers, as the enamel becomes easily chipped, and then the iron corrodes and leads to further scaling of the enamel. Galvanized iron and other metals are also bad, as urine corrodes and destroys them. Cemented urinals are porous, and stink. Gun-metal should be used for the metal gratings of urinals.

Night Urinals. — The proper sanitation of night urinals is always a difficult problem. Urine tubs are provided for night use in some barracks, and are placed in a passage outside the sleeping rooms. The place where the tubs stand should be raised 4 inches above the floor, and furnished at their edge with a stone step. This and its surroundings must be kept well cleansed; the whole, so far as possible, made of concrete* (in the newer bar-

* These places are sometimes asphalted, and then *tar must not be used* as a coating.

racks), and may be coated with tar or limewashed. There must be no smell, and the tubs should be removed each morning to a fixed place outside barracks and filled with water, which should stand in them all day. The tubs are tarred inside periodically.

The provision of night urine tubs in barracks is condemned on sanitary grounds, as they lead to pollution of the floors and walls of the passages during micturition, or in the subsequent conveyance of the tubs when full. Hence these tubs are being gradually discarded, and properly constructed night urinals of the municipal pattern, connected with the drainage system, provided in their stead. These should be locked up during the daytime.

Cleansing of Urinals.—All slate urinals should be cleansed daily with crude petroleum, applied by a painter's brush or rag. Care should be taken that no excess of oil is allowed to remain in the urinals, as it is prone to collect in the traps and choke them. The oil, besides preventing fouling by corrosion, keeps away smell and flies. Glazed stoneware urinals may be kept 'sweet' by the same means, but intermittent flushing is generally provided for; this should be strong, copious, and short, rather than a prolonged dribble. The allowance of water for urinals in barracks is 48 gallons per stall per day, 1 gallon being discharged every half-hour when in use, and the remainder being available for hand flushing and swilling purposes. The gutter and floors and drain channels of all urinals must be cleansed daily by swilling down and flushing with water, and a birch broom freely used.

ASHBINS.

Portable bins are best, the bins, with their contents, being frequently removed, and clean empty ones left in their stead. All bins should stand on cement concrete platforms under shelter, and be provided with lids.

The official ashbins should be reserved entirely for *dry* rubbish, such as ashes; while wet refuse from kitchens and the men's dining tables should be placed in separate bins provided for this purpose. The receptacles for barrack refuse are in charge of the troops. Contracts are made for the disposal of some kinds of refuse, such as vegetable parings and ashes. Rules as to such disposal are made known locally, but from the sanitary point of view it is important that all putrescible refuse should be at once removed from barrack rooms, and that the ground around the receptacles should be kept scrupulously clean.

THE DRAINAGE SYSTEM EMPLOYED IN BARRACKS.

Sewage may be broadly described as water that has been used, and is therefore impure. The object of drainage is to convey this impure water by sanitary means to some place where it will not affect public health. In barracks it is generally advisable to have separate systems of drainage for sewage and storm water, for the following reasons:

1. The number and size of the foul drains are thereby reduced.

2. The extra size required for a system of combined drains carrying sewage and storm water greatly diminishes their self-cleansing power when only sewage is flowing.

3. There is little advantage in admitting storm water into sewage drains for flushing purposes, because in hot, dry weather, when they most require flushing, no storm water is available.

4. The traps of gullies which receive storm water only are very liable in dry weather to become unsealed by evaporation, thus allowing a dangerous escape of foul gas if they are connected with the sewage system. But it is always desirable that storm-water gullies which are liable to be fouled should be connected with the foul-drainage system.

Drains are of two main classes, overground or surface drains, and underground drains ; the former are open surface channels for the conveyance of storm water, and the latter are closed pipes for conveying either storm water, sewage, or subsoil water. All underground drains should be laid, as far as possible, in straight lines, and at even gradients from point to point.

Underground Drains.

These are of three kinds :

I. *Foul-water or sewage drains*, for the conveyance of sewage or sewage mixed with storm water.

II. *Storm-water drains*, for the conveyance of rain water only.

III. *Subsoil drains*, for carrying off subsoil water only.

I. **Foul Drains.**—These receive the contents of latrines, urinals, baths and sinks, and at certain points manholes are made for their inspection and cleaning. They are in charge of the Royal Engineers, but are sometimes opened, inspected, and flushed by soldiers under Royal Engineer supervision.

Foul drains are provided with traps and ventilating shafts to allow foul air from the drains to escape above the windows, and to prevent it from entering the building. These require attention by troops to keep them efficient and clear from obstruction. All *foul drains* should be watertight, and, if possible, self-cleansing, accessible for inspection and cleaning, possible of ventilation, but at the same time foul air resulting from ventilation should not be allowed to escape anywhere that it can affect public health. Foul drains should never be directly connected with the appliances which furnish sewage, except in the case of water closets, latrines, slop sinks, and urinals, all of which should have traps of their own, and their discharge pipes should be led as directly as possible to the outside of the building in which they are situated, and be connected with the underground drain, or

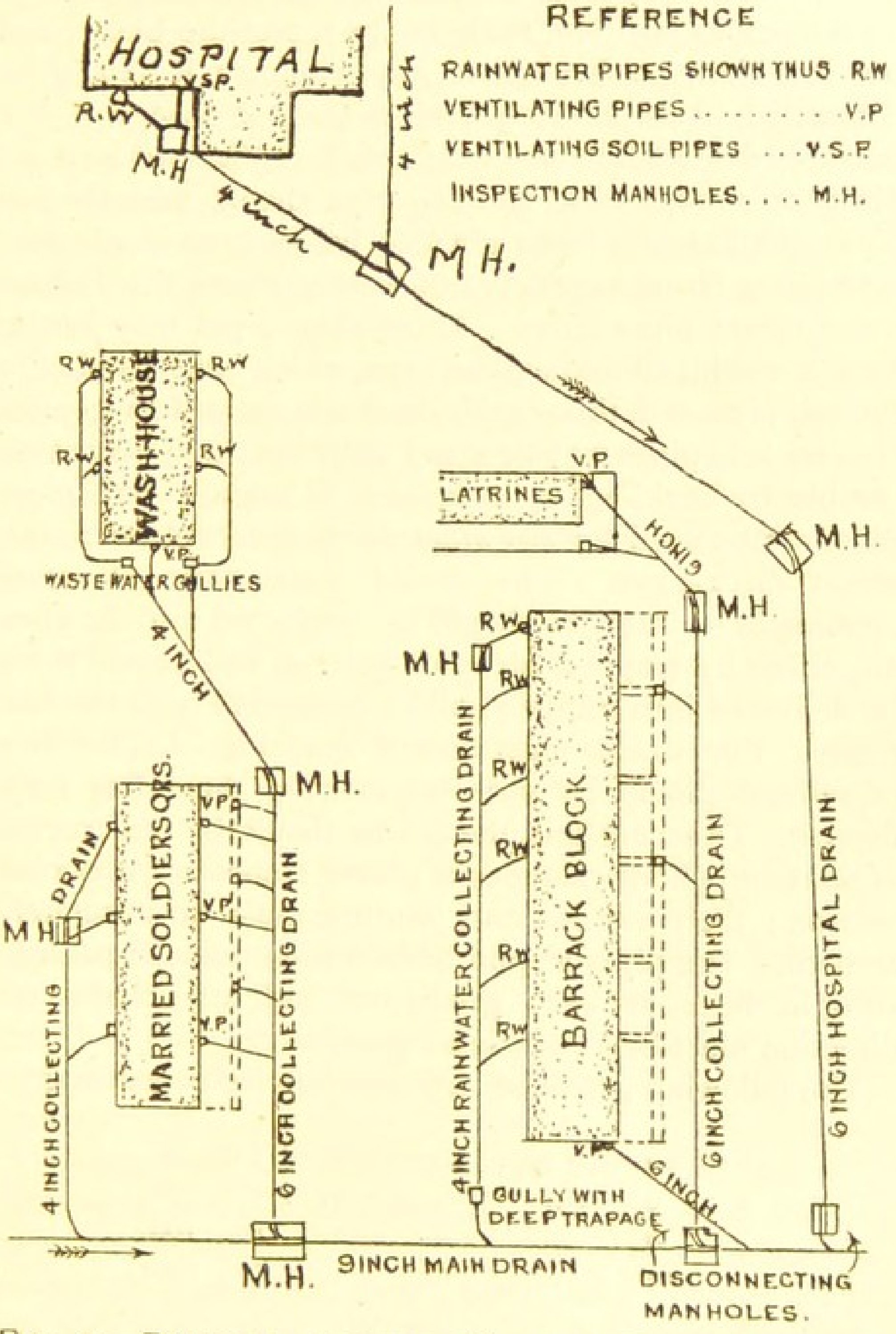

FIG. 2.—DIAGRAM SHOWING BRANCH, COLLECTING AND MAIN DRAINS OF A MILITARY BARRACKS.

with a soil pipe in the open air. The soil pipe should be carried vertically up (without any reduction in its diameter, and without any bend) as a ventilating pipe, with its open end (protected by a cage, to hinder birds nesting in it) in an innocuous position, such as the top of the house, and not less than 10 feet above any window; it should be connected below, directly and *without a trap*, with the untrapped head of the house drain. Where closets on different storeys exist, one soil pipe should take the soil pipes of all closets in a right line below it, an antisyphon pipe being let in to prevent unsealing where the various water-closet pipes enter. Antisyphon pipes may join to form a combined antisyphon pipe, which runs parallel to the soil pipe. On the south side of a house or in a tropical country lead pipes may be acted on by heat, and may cause trouble by buckling, by expansion of metal. Soil pipes must not be used for *any other purpose* except for water-closet discharges. The fouled water from all other appliances or interiors should be conducted into the open air, either by trapped pipes or gutters, and should there be delivered into trapped gullies connected with the foul drains. Foul drains must be self-cleansing—*i.e.*, the flow of sewage should be such as to keep them free from deposit. To secure this, the drains should be constructed of straight cylindrical pipes of glazed stoneware, concrete, or iron; their interior and jointing must be absolutely smooth. The pipes should be laid from point to point in straight lines at even gradients, and any change of direction must be as gentle as possible.

The following gradients are generally self cleansing:

For a 4-inch pipe,	a gradient of	1	in	40.
,, 6 ,,	,, ,,	1	,,	70.
,, 9 ,,	,, ,,	1	,,	100.
,, 12 ,,	,, ,,	1	,,	150.

These gradients give a velocity of about 3 feet per second when the depth of the sewage is one-quarter the diameter of the pipe. The smaller the diameter of the pipe, the greater the velocity of the flow, and the more effectual is the self-cleansing; but no branch drain should be less than 4 inches in diameter, and no drain receiving the discharge from a kitchen scullery, stable gullies, or set of latrines, should be less than 6 inches in diameter. Where drains have self-cleansing gradients, few barracks require a larger outfall than a 9-inch pipe for the conveyance of sewage only. To distinguish foul drains from storm-water drains, the iron covers of all manholes, etc., should be legibly marked with the words 'Foul Drainage,' etc.

Drains should never pass under a building, if possible. When this is unavoidable, iron pipes of heavy quality should be used, specially coated or glass-glazed inside, and laid in cement. The same kind of pipes should be usedfor drains passing close to buildings ; if iron pipes

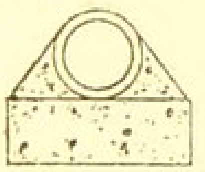

FIG. 3.—DRAIN LAID ON AND PACKED WITH CONCRETE.

are not used for the latter, they must be cased in concrete to avoid leakage.

House Drains.—These are composed of earthenware or iron pipes, not less than 4-inch diameter. They should be laid in straight lines, and require a certain gradient ; the smaller the bore of the pipe, the steeper the gradient required.

The spigot end of the pipe fits into the socket end, and the sewage flows in the direction of socket to spigot. The angle of junction between house drains should not be over 30 degrees ; if over 45 degrees it must be eased off with a bent piece. Wherever a change of direction occurs in a house drain, there must be access for inspection and cleaning purposes allowed. This necessitates a *manhole*. House drains must be laid in a bed of cement, otherwise there is danger of 'sagging.'

4

Traps.—The object of these is to prevent foul air getting from the sewer back into the house.

A trap is a pipe bent to a certain shape, so that it holds water in its lumen, and thus prevents the passage of gas.

The *dipstone* or *mason's trap* is a useless trap, as it gets blocked and impedes the flow of water, etc., along the drain.

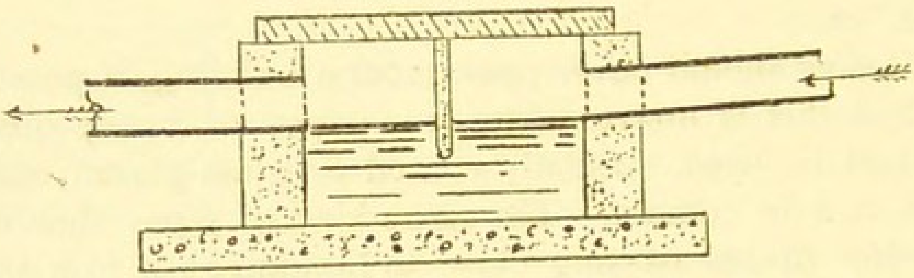

FIG. 4.—DIPSTONE OR MASON'S TRAP.

By bending a pipe and thus forming a *siphon trap*, what is required is obtained—namely, a water seal. To overcome friction, the fall is made more steep than the rise (cascade action).

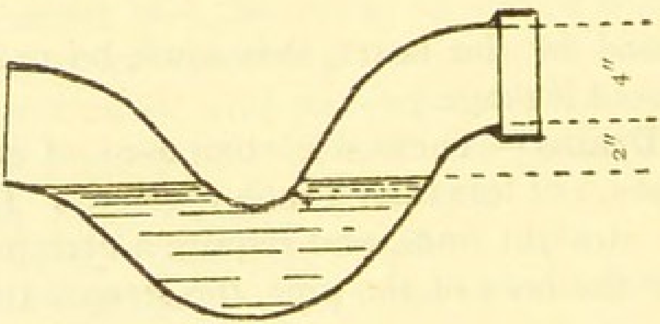

FIG. 5.—CASCADE TRAP.

The only danger is that suction from negative pressure below may suck out the water seal, or pressure of gas from below may force through or ooze through the seal. All these defects are remedied by ventilation of the drain below. There are two places in a house where traps are absolutely necessary—one at the water closet, between it and the soil pipe, and another between the house drain and the sewer. Each branch drain should have a trap at its upper extremity, or else a ventilating pipe. A branch drain starting from a storm-water gully should have a trap, with a water seal at least 4 inches deep. A good

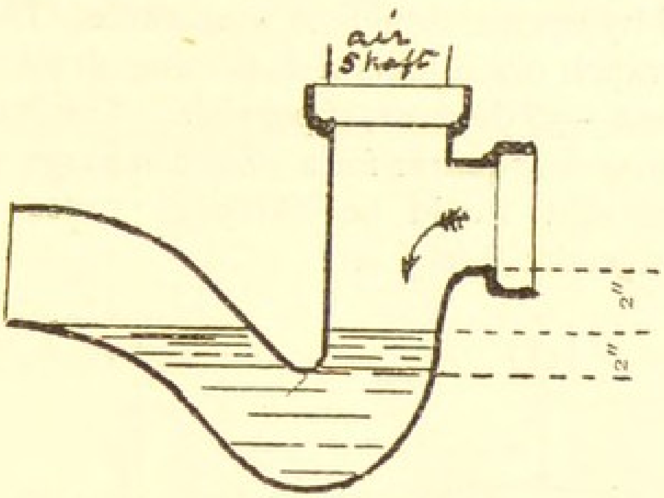

FIG. 6.—BUCHAN TRAP.

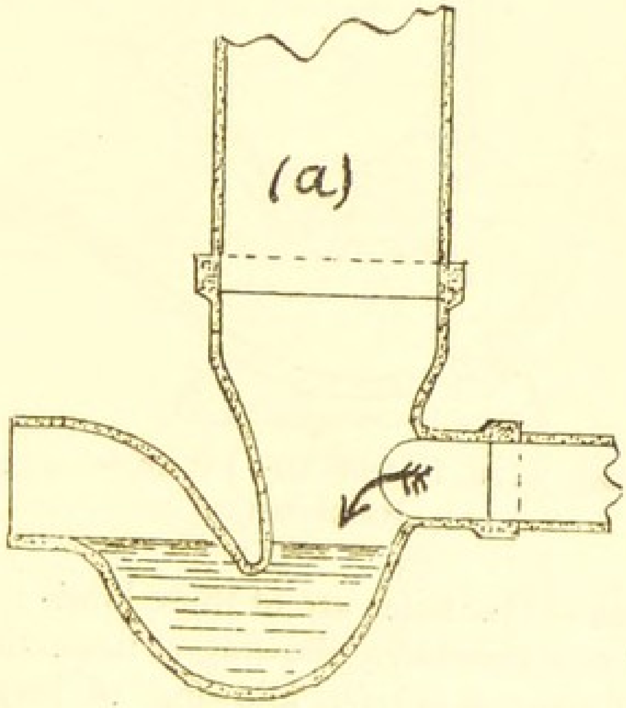

FIG. 7.—DENT AND HELLYER'S TRAP WITH FRESH AIR INLET.

(*a*) For inspection and fresh-air inlet.

trap must be of impervious material, self-emptying, cleansing, having a *cascade action*, and running out with easy gradient.

In a foul-drainage system every trap must be easily cleaned and easy of access.

Junction of Drains.—All important junctions should be formed by open channels in a manhole. The angle at which a branch drain joins a collecting drain should be an acute one—30 degrees, if possible. The junction in a manhole may be squarer for a slow discharge than for a rapid one, that would be likely to cause splashing, which is objectionable.

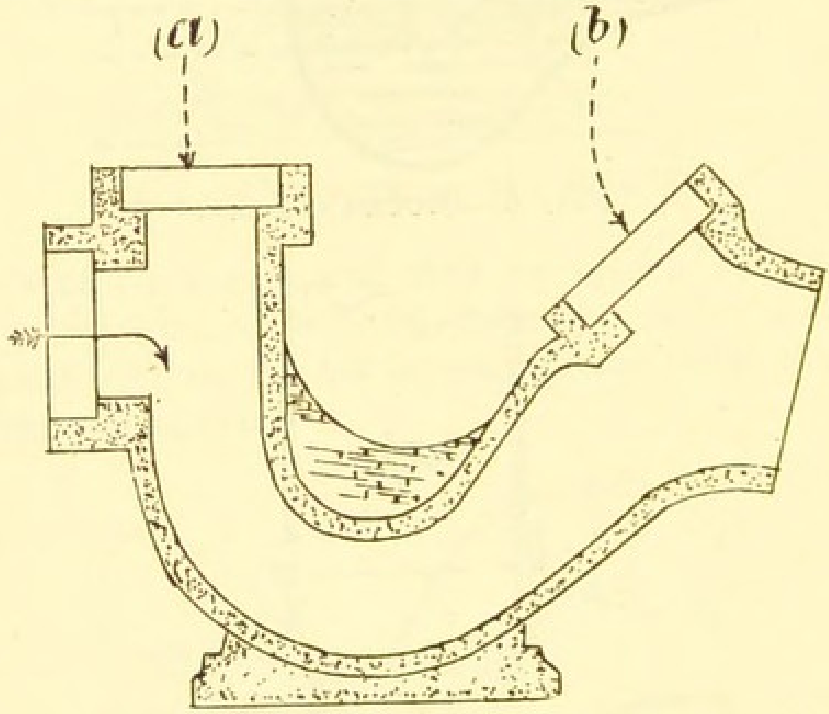

FIG. 8.—TRAP WITH FRESH-AIR INLET (*a*) AND CLEANING BRANCH (*b*).

Manholes.—Manholes are of three kinds :

1. *Inspection manholes*, allowing of inspection.
2. *Ventilating manholes*, allowing of inspection and ventilation.
3. *Disconnecting manholes*, allowing of inspection, ventilation and disconnection.

Disconnecting Manholes.—Each foul-drainage system must be 'disconnected' from the outfall by a disconnecting manhole ; in addition, the system, if extensive, should be cut up into two or more sub-systems, each insulated by its own disconnecting manhole. A manhole is an opening for cleaning out drains and for inspecting them; there are three kinds—inspection, ventilation, and dis-

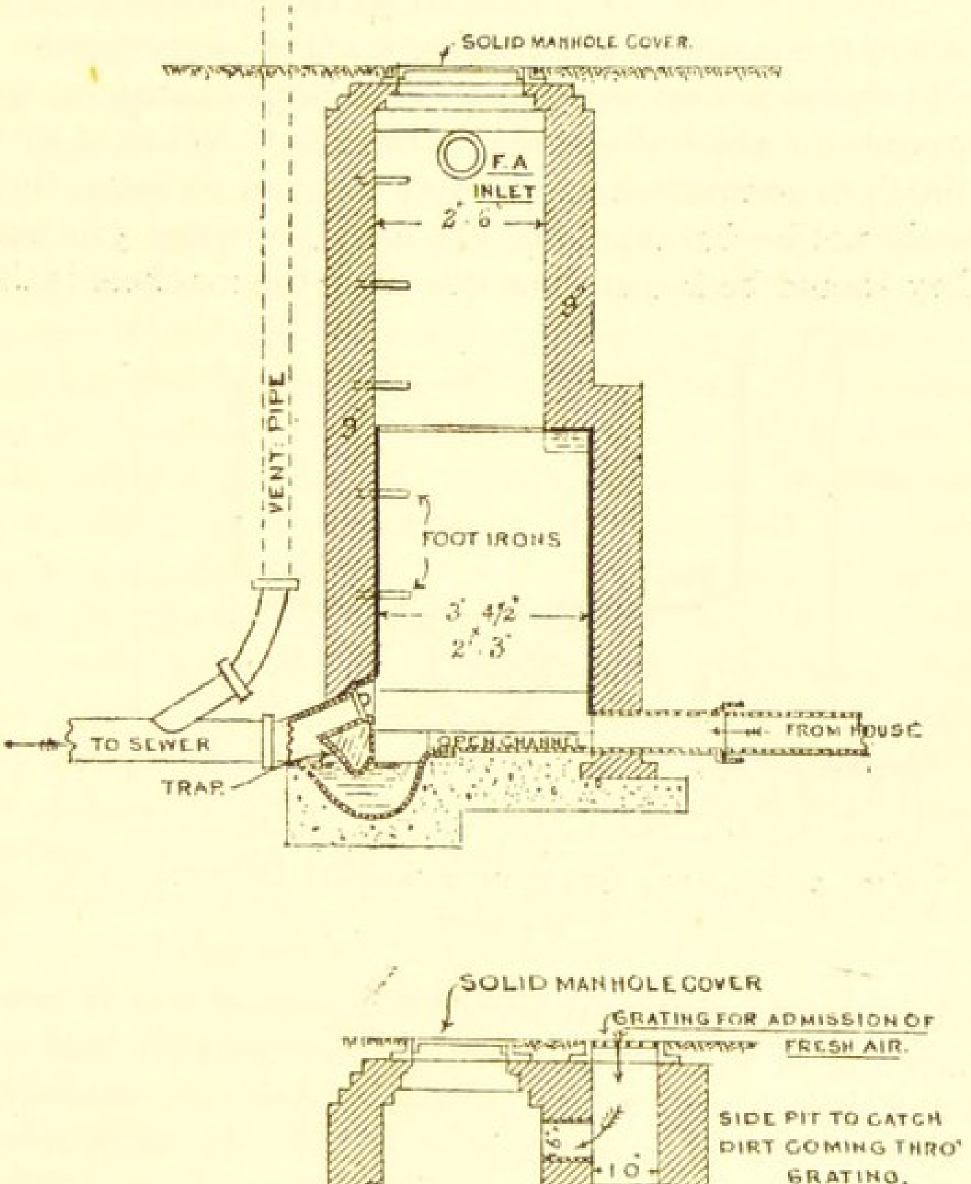

FIG. 9.—DISCONNECTING MANHOLE.

connecting. The disconnecting manhole has two lids—an outer flat iron cover, with vertical flanges generally sealed with putty, and is protective. The inner lid is dome-shaped and fits into a groove; its purpose is to seal the air in the manhole. The moisture in the warm air of the manhole condenses on the inside of the cold metal dome, and runs down as water into the groove and seals it. This will not, however, work satisfactorily in the tropics, where heavy mineral oil must be used. The walls of the manhole are of brick rendered impervious.

Manholes are constructed of sizes proportionate to the purposes for which their uses are intended. When of such a depth as to make it necessary for a man to enter, they should not be *less* than 3 feet 4½ inches by 2 feet 3 inches. They should be larger than this when the manhole is the

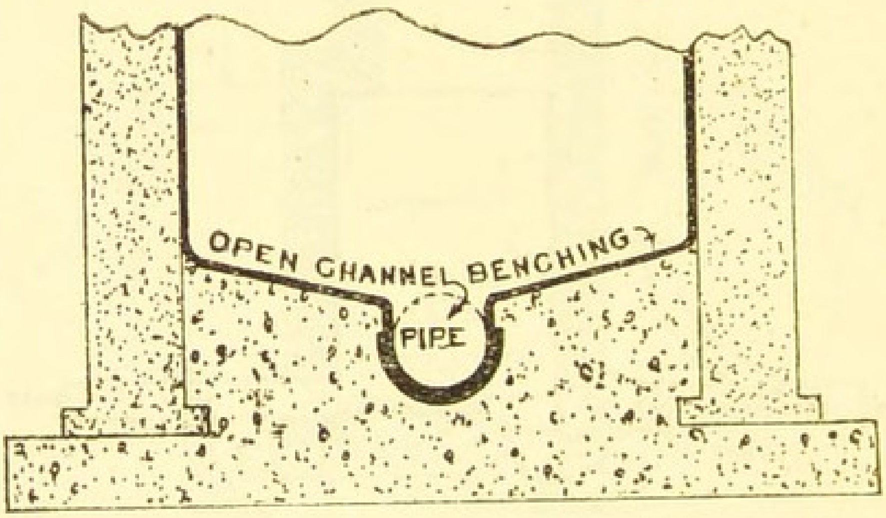

FIG. 10.—CROSS SECTION THROUGH BOTTOM OF A MANHOLE.

meeting point of several branch drains or of two or more collecting or main drains. Metal foot irons are inserted at one side to allow a man to descend and ascend easily.

The bottom of a manhole is a drain, the walls being sloped (*benched* with concrete) to allow of this. The *ventilating pipe* is let into the side; its function is to admit air into the manhole and not to let gas out. This is effected by a mica flap valve. The *disconnecting trap* consists of an ordinary trap with a *cleaning eye;* the latter is not part of the manhole, but fitted with a well-fitting metal cap for the purpose of cleaning the sewer.

Disconnecting manholes should be located where they will not cause nuisance or danger, and they should be limited in number as far as possible, being only necessary at points where there is either a change of direction or gradient, these being the points where inspection and cleaning are mostly required.

Ventilation of Drains.—This is necessary to provide for the escape of air and foul gases compressed by sudden discharge of sewage, which, if not allowed free escape, will unseal the traps or be absorbed by the trap water, and be given off as a danger to health. Ventilation of drains is effected by means of ordinary road ventilators or else by low-level fresh-air inlets and high-level outlets, or a combination of the two. Every important drain should be in communication with the open air at both ends. The size of a ventilating pipe should never be less than 3 inches in internal diameter, or 4 inches if it is fixed against a lofty building. Crooked or long drains require a larger ventilating pipe than straight ones. The outlets of ventilating pipes should be in safe positions, as they are a grave source of danger to people working or sleeping in their immediate vicinity. Their outlets should be as high as possible, and at least 10 feet above all windows or fresh-air inlets, and, if possible, at least 15 feet distant (horizontally) from the outlet of any chimney opening or ventilating shaft on account of the risk from down-draught. Ground ventilating pipes should never be less than 15 feet above ground, and well away from occupied buildings.

Flushing of Drains.—It depends on the gradient given to drains, and also on the likelihood of blockage—*i.e.*, fæcal matter, paper, stable matter, etc.—whether flushing is necessary, but even when not essential it is advisable to provide facilities for flushing at the head of every drain. In some cases automatic flushing tanks are provided, but they are wasteful of water and uncertain in their action. The best means of flushing is to use a fire hose.

II. **Storm-Water Drains.**—These are surface drains that carry off the rain water. They run into 'gully traps' covered by iron gratings. These drains are under the care of troops, and the silt which runs into them has to be removed periodically. Storm-water drainage should be conveyed as much as possible in surface channels. Underground storm-water drains should be self-cleansing, accessible for inspection and cleaning—if neglected they become foul—and so arranged to prevent anything except water entering them. The storm water is admitted into

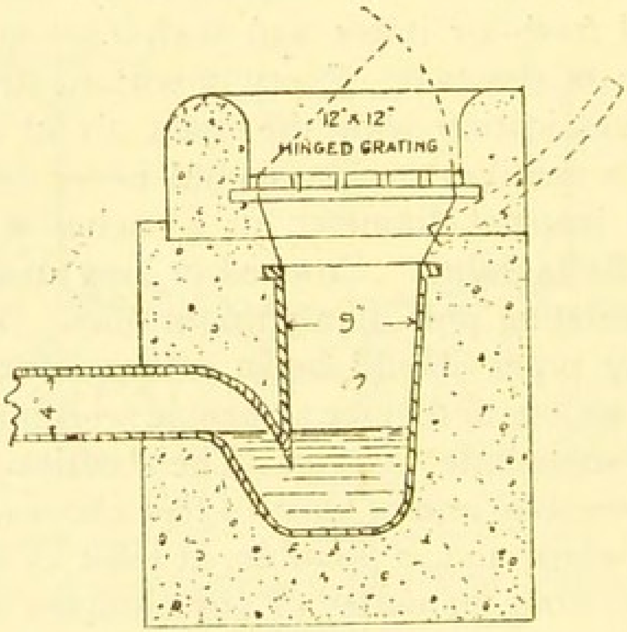

FIG. 11.—SILT GULLY ENCASED IN CONCRETE.

drains by means of trapped gullies, which should have silt pits easily cleaned out. Surface gullies near doors, especially those of married quarters, etc., where it is likely that slops may be emptied, should be connected with the foul-water drains, and not with the storm-water system. Manhole covers, etc., of storm drains should have the words 'Storm Drains' cast on them to distinguish them from the foul-drainage system.

III. **Subsoil Drains.**—From a sanitary point of view it is very important that the subsoil water should be some distance below the surface of the ground, and that its level should be kept constant. Subsoil drains become necessary where the ground-water level is near the surface. The ground-water is carried away by constructing subsoil drains 4 to 6 feet deep. The necessary number of these and their distance apart will depend on their depth, on the slope of the ground and the nature of the soil. With a depth of 4 feet they may be from 20 to 27 feet apart in stiff clay, 30 feet apart in heavy soils, and 40 feet apart in light or gravelly soils. They should not be laid under buildings, but carried round their sites. The pipes for lateral drains should be ordinary agricultural pipes without collars, and not less than 2 inches diameter. The collecting drains receiving the laterals are of the same kind of pipes, from 4 to 6 inches in diameter. Gradients should be 1 in 80 to 1 in 100, and not less than 1 in 200. Silt pits, manholes, and means of ventilation should be provided.

Testing Drains.—The testing of all foul drainage works from their lowest to their highest point is essential. When the work is in progress it is necessary to insure and prove that it is well done, that the drains and manholes are watertight, and that soil pipes, ventilating pipes, and connections with apparatus are watertight and airtight.

For underground drains, either new or already in use, the best method of testing is the water test.

For house drains, soil and waste pipes, and connections with apparatus, the best method is the smoke, vapour, or air test, because the water test may cause too much pressure.

All new drains should be tested to ground-level with water before being covered in. This is done by plugging the lower end of the drain and filling the pipes with water, the upper end being brought to ground level by fixing into it a vertical pipe. Branch drains should, if possible, be tested simultaneously. It is provided in the Regulations for the Army Medical Service that the Administrative Medical Officer of the district will detail a medical officer to be present when the tests are made, and the medical officer will certify as to the tests applied, their date, and the results. It must be borne in mind that as stoneware pipes and their joints may absorb moisture under the pressure of water testing, while some of the joints will 'sweat,' a small amount of subsidence of the water may be expected, and that such limited subsidence must not, therefore, be taken as implying bad workmanship or defects. Besides this, subsidence of the water may be due to leakiness of joints. If this be the case it will be visible to the naked eye, or may be ascertained by feeling under each joint, and will be indicated by uniform rate of subsidence. Absorption by pipes and joints will not be visible after a short interval. Sweating of pipes and joints will be visible, and accompanied by slight but continuous subsidence of the water. In testing drainage works, manholes should be tested separately by plugging all inlets and the outlet, and filling them up with water to the level of the rendering. In *testing old drains*, where the main drain has no manholes and has ramifying branches, the smoke test should first be applied. If this gives no bad results, openings should be made at convenient places, and the water test applied as above described. If the results are bad, the drain should be renewed.

The Smoke Test.—The nose of the indiarubber outlet tube is packed tightly into the mouth of the drain with clay or wet rags. Windows and doors are closed, as well as all tops of soil and ventilating pipes, after the smoke has had time to circulate. Smoke leaking from rat-holes and fissures, etc., will point to defects in the drain.

Other Tests.—These comprise the use of oil of peppermint, oil of aniseed, asafœtida, or other pungent essences to test soil pipes and their connections, so that leakage, if present, is detected by smell. Peppermint is mixed with hot water and poured from the top of the soil pipes ;

but if other essences are used which are not volatile oils, hot water is not required.

Method of Inspecting Drains.—Each *manhole* should be opened and examined to see whether the sides of the sloping surfaces at the bottom are fouled. If not fouled, there can have been no stoppage and the drains have worked well. All *traps* should be free from deposit, thus showing that they have been continuously self-cleansing. *Drains* should be flushed and the flow watched at each manhole—*e.g.*, a dirty flow shows that the drain is foul or contains sediment, and a slow flow shows that the drain is partly choked. A bull's-eye lantern is convenient for examining the drains between manholes.

Drainage of Hospitals.—No sewage from a hospital should pass through the drains of a barracks. Each hospital should have an independent system of its own, which should discharge through a disconnecting manhole, either to a separate outfall or else into the outfall drain from the barracks, below the disconnecting manhole which insulates the barrack drainage.

METHODS OF SEWAGE DISPOSAL.

The end and object of all modern scientific disposal of sewage lies in its oxidation by germs. This is best done by filter beds of different kinds, because sewage cannot be oxidized *en masse;* and if spread on ground or let flow untreated into the sea or rivers, it kills all forms of life—fish, vegetable, etc.—by abstracting oxygen.

Modern sewage purification may be divided into two main stages—(A) clarification and (B) oxidation.

By *clarification* the solid suspended matters are got rid of by screening, straining, and the various methods of treatment in tanks (sedimentation, precipitation, and liquefying or bacterial biological tanks).

By *oxidation* processes the effluent from the clarification tanks (which contains dissolved impurities and finer matters in suspension) is still further purified by treatment either on land by (*a*) the Broad irrigation method; or (*b*) by land filtration method; or (*c*) it may be passed through another system of filter beds, which may be either (i.) contact beds or (ii.) percolating filters.

The above-noted methods may be summed up as—

A. The Clarification Methods.	B. The Oxidation Methods.
1. Screening.	1. Surface irrigation.
2. Sedimentation.	2. Land filtration.
3. Precipitation.	3. Contact beds.
4. Liquefying (solution by bacteria).	4. Percolating filters.

It will thus be seen that each of the two stages of purification, (A) and (B), may be effected by either of four distinct methods, and in practice we find a combination of two or more of these is made to suit the special *local* circumstances and constitution of the sewage under consideration. The essentials of each of the different methods may be briefly defined.

A. The Clarification Methods.

1. **Screening.**—This is a mechanical means of catching, by a grid made of iron bars, or perforated metal sheets, or plaited woven wire, all the coarser matters which may be found in sewage, such as old shoes, sticks, rags, corks, straw, and garbage. These large solids are removed, to avoid blocking the more delicate means of purification which follow.

2. **Sedimentation.**—This is also a purely mechanical process, and does not involve either chemical or biological change in the resulting effluent. The sewage is let flow very slowly through, or let stand in, sedimentation tanks, whereby the coarse and less fine solid matters in suspension sink to the bottom as 'sludge' by the force of gravity. This method is not much used alone, but it forms an important factor in septic tanks.

3. **Precipitation**.—As this effects the same object as sedimentation, and as it is much more efficient, it is more frequently adopted. The sewage has chemicals (lime, alum, or sulphate of iron, etc.) added to it, and these minerals produce a heavy precipitate with various sewage substances. The sewage is let flow very slowly through tanks, or let stand, and, the precipitate falling, carries finer suspended matter down with it and forms sludge.

4. **Liquefying or Solution by Bacteria**.—This is another clarifying process by which finely suspended organic matter is acted on by the anaerobic biological putrefying action of bacteria. Septic tanks on the Exeter system are used in this process, and are suitable for a weak domestic sewage, but in many cases they may become overworked, and then their main action becomes sedimentation.

Remarks on the above Four Clarification Processes.—The best of the four methods just described is that of *chemical precipitation*, and is recommended as such by the Royal Commission on Sewage Disposal. Its chief drawback, however, is the question of *sludge disposal* The best method of disposing of sludge is to compress it into cakes and sell it for manure. This is done at Kingston-on-Thames, Colchester, etc. Other methods of sludge disposal are: Ship to sea and dump (expensive, wasteful, and dangerous); compress it and bury in the ground, or spread over surface of land, allow to dry, and dig in (worst method of disposal); or burn it (efficient, but costly and wasteful, for it is thought some attempt should be made to make use of its manurial value).

B. The Oxidation Methods.

1. **Surface Irrigation**.—The sewage is run on land on which crops are grown; the ground may be drained with underground drains (intermittent filtration), or irrigation channels alone may be employed. Surface

irrigation of land is now considered an obsolete method of *primary* treatment for sewage, but irrigation may be used as a secondary method of disposal after the sewage has been treated by any of the filtration methods.

2. **Land Filtration.**—Sewage is run over land reserved exclusively for the purpose, and crops are not grown at the time of spreading. A larger quantity of sewage can be dealt with by this means than is the case with surface irrigation. The land, after being treated, is given a rest, and after a time it is broken up, and crops are grown. Sewage is again run on after the crops have been removed.

3. **Contact Beds.**—These are masonry tanks, not more than 4½ feet deep (as they have to fill and empty in a fixed time, limited to an hour each way). The tanks are filled with small pieces of broken stone, flint, gravel, clinkers, etc., according to local economical conditions.* The plan devised for working is as follows: (*a*) The sewage is let run into the tank or tanks (as there is usually a series) for one hour; (*b*) the tank is then allowed to stand full for two hours; (*c*) empty in one hour; (*d*)

* A special form of slate contact bed is employed at Devizes (a good account by Major Stammers may be found in the *Journal R.A.M.C.* of November, 1908, p. 522 *et seq.*). Slate contact beds have not got the credit they seem to deserve from some authorities (Royal Commission of Sewage Disposal, for example). The chief points concerning the Devizes tank are: (1) Depth 4 feet, composed of slates in layers varying from 18 inches by 6 to 9 inches, and ¼ inch or so thick, separated 2 inches apart by means of stone distance pieces. (2) The top layer acts as a screen, and cylindrical orifices are left at regular intervals, by which any deposit can be flushed out by a hose. (3) The tank takes two to three hours to fill, rests for two hours, and is allowed two to three hours to empty; all work regulated by hand; no automatic gear to go out of order. (4) The process is chiefly aerobic. A similar tank is at present under trial by the Army authorities at Bordon (Aldershot command).

remain empty and get a rest for four hours; the whole cycle taking eight hours to complete, after which the process is started again. The eight-hours cycle must be regular both in order and in timing. The action aimed at is—

(*a*) *Filling.*—One hour. Sewage takes up oxygen from the zooglœa layers on the stones, and also from the previously oxidized sewage remaining behind in the interstices of the contact bed.

(*b*) *Standing Full.*—Two hours. Only the surface sewage is oxidized by the atmosphere; no action in the deeper layers except that caused by anaerobes.

(*c*) *Emptying.*—One hour. Friction set up by contact bed settling down breaks dust off the opposing surfaces of the clinkers, etc. This dust is indirectly proportional to the hardness or softness of the materials used for making the bed, and as it eventually clogs the bed, the harder the clinkers, etc., of which it is made, the longer can the bed be used without renewing or cleaning out.

(*d*) *Standing Empty.*—Four hours. This is the so-called 'resting period,' but in reality it is essentially a working period, as the zooglœa scum on the clinkers, broken stone, etc., of the contact bed is actively oxidizing the sewage particles left in contact with it in its interstices, and this sewage in turn helps to oxidize the sewage let in during the filling period of the next cycle.

The efficient working of a contact bed is thus due to the action of oxidation, chiefly brought about by *aerobic* bacteria; and contact beds are capable of purifying sewage at a more rapid rate than a corresponding area of land, either by irrigation or land filtration. In practice it is found that with stronger or more concentrated sewage more contact beds are necessary, so that it may be necessary to use secondary and tertiary contact beds, with finer clinkers or stone material to again treat the effluent produced by the previous bed.

4. **Percolating Filters (Streaming Filters).**—These are filled with the same kind of materials (clinker, broken stone, etc.) as are used for filling contact beds, but the process of oxidation (aeration) is *continuous* instead of being intermittent, and consequently, being in continuous action, they are capable of dealing with a far greater quantity of sewage. As the one essential is gravity, they cannot be used in a flat country without great expense, as fall is necessary. The sewage is distributed over the surface of the filter in finely divided streams, so that it trickles through the filter bed in the thinnest possible streams, and thus oxidation takes place by *aerobic* bacilli of the zooglœa layers acting in a plentiful supply of oxygen derived from atmospheric air. There is no cycle of filling, standing full, or resting, as occurs in contact beds. To get over the difficulty of fine distribution, many forms of mechanical feeders,* etc., are employed, as well as splitting up the filter beds into a series of small, narrow, deep channels. In a hilly country sewage can be dealt with readily by this method, and streaming filters 1,000 feet long may be employed.

All things being equal, the streaming filter is a better and quicker method of sewage disposal than the contact-bed system. An approximate estimate of the quantity of

* Automatic rotary distributors are of various patterns—*e.g.*, (1) action dependent on 'Barker's mill principle' (a number of perforated iron pipes attached to, and radiating from, a central pillar, through which the sewage is supplied, the holes being all on one side of the pipes; the reaction of the escaping jets causes the distributor to rotate and discharge the sewage over a circular area of the filter bed); (2) fixed troughs for small installations; (3) fixed pipes and sprays; (4) power-driven distributors, where pressure (fall) is insufficient for automatic working, or where rectangular filters are used.

sewage that can be dealt with per acre under English conditions is given by Raikes* in the following figures :

	Gallons per Acre Daily.
Surface irrigation	3,000 to 15,000
Land filtration	20,000 to 100,000
Contact beds	400,000 to 800,000
Percolating filters	1,000,000 to 2,000,000

Remarks on the above Four Oxidation Processes.—Cost and efficiency are the chief important questions. If materials for contact beds and percolating filters cannot be obtained locally, it may be more economical to treat sewage by any of the other methods. Sedimentation is cheap, but by itself is ineffective. Precipitation is costly, as chemicals have to be provided and the sludge has to be got rid of. Selling sludge for manure, even when it is possible to get buyers, can only be done at a great loss. The biological method of treatment by liquefying in septic tanks may possibly cause a nuisance by offensive smell (putrid gases, etc.).

Again, sewage varies greatly in its composition and dilution. Very diverse congredients are met with, from trade wastes to the concentrated urine of a cavalry barracks. The latter seems to render liquefying or septic tanks methods unworkable, probably from the excess of benzoic and hippuric acids present, which apparently act in some antiseptic way. Or, again, storm water from barracks and paved channels in cavalry stables may suddenly flush out a septic tank installation and render it useless, if not otherwise provided for by a separate system of pipes. The question of what is to become of the sewage afterwards has also to be considered, as well as the position of the drinking-water supplies. A good sewage effluent may be readily distinguished from a bad one by noticing its effects on

* 'Sewage-Disposal Works.' By Hugh P. Raikes. Constable and Co. 1908.

vegetable life in the vicinity of its discharge, especially green weeds, grass, etc., which, if of a grey colour, points to sewage fungi, only found in a bad effluent. Sewage effluent should also be free from smell and colourless, and after shaking up in a bottle for one minute all bubbles should disappear in three seconds. The chemical tests comprise an estimation in parts per 100,000 or grains per gallon of the solids in suspension and solution, albuminoid and free ammonia, nitrates, nitrites, and oxygen absorbed. The following figures, showing the average composition of samples taken from the untreated sewage of thirty-six English towns, as recorded in the first report of the Rivers Pollution Commissioners, are of interest :

Solids in suspension (parts per 100,000) :		
Organic	20·5	
Mineral	24·1	
Total	44·6	
Solids in solution (parts per 100,000) ...	72·3	
Total solids		116·9
Chlorine		10·6
Free ammonia		6·7
Albuminoid ammonia (estimated by taking of the organic nitrogen)		·63

The *standards* for purity of the effluents of sewage after treatment vary so widely that the final decision of the Royal Commission must be considered.

The Commissioners suggest a standard requiring the following estimations :

1. The suspended matter. (This is not to exceed 3 parts per 100,000.)

2. The amount of atmospheric or dissolved oxygen absorbed in 24, 48, and 120 hours. (This should not exceed ·5, 1·0, and 1·5 parts per 100,000 respectively.)

According to Dr. Thresh, the estimation of the oxygen absorbed from the dissolved air in twenty-four hours is almost invariably sufficient to determine whether the effluent is satisfactory or not, but he prefers the older and simpler test of estimating the amount of oxygen absorbed by the effluent in three hours from an acid solution of potassium permanganate at 98° F.

Messrs. Gallenkamp and Co., 19, Sun Street, Finsbury Square, E.C., put up a small cabinet for testing effluents, whilst Messrs. Burroughs and Wellcome make a similar cabinet in which the reagents are chiefly in the 'solid' form. Both cabinets have been approved by Dr. Thresh, and contain full directions for applying all the requisite tests for determining the quality of a sewage effluent.

When sewage is to be dealt with by land treatment instead of by bacteria beds, the relation of these areas to human habitations, prevailing winds, etc., has to be taken into account. The area of land required for distribution of sewage will depend on the character of subsoil and level ground water and position of the sources of drinking-water supplies. Engineering difficulties will also have to be considered, and for this purpose it is most essential that an engineer of repute should be consulted from the very first.

SOME MILITARY METHODS OF SEWAGE DISPOSAL.

Installations for the treatment of sewage by biological methods are employed at many of the military stations in the United Kingdom. These installations may be divided into two classes :

1. Those without septic tanks.
2. Those with septic tanks.

The latter may be subdivided into :

(*a*) Installations in which the tank effluent is directly subjected to land treatment.

(*b*) Installations in which the tank effluent is screened before its final disposal on land or into a stream or river.

Examples of (1) exist at the Curragh, Blackdown, and Deepcut Barracks. At these stations the crude sewage is passed through double contact beds before its application to land, and so far the results have been fair. At Deepcut the large amount of stable matter contained in the sewage has caused some trouble.

Septic tank installations have given better results at the smaller stations—*e.g.*, Devizes, where the volume of sewage is small and its flow comparatively uniform. The principal difficulties in the management of the large installations have arisen in connection with regulating the flow of sewage through the septic tank, more particularly at garrisons containing an undue proportion of mounted troops. The sudden and temporary increase in the volume of sewage due to the introduction of storm water is found to produce a 'scouring' effect within the anaerobic chambers, which appears not only materially to interfere with bacterial action within the septic tank, but, in addition, causes derangement of the system by clogging the filter beds with the untreated solids held in suspension in the tank effluent. To prevent this, it has been found advisable in some instances to exclude storm water as far as possible by providing a separate system of surface drainage. A somewhat similar defect, although in a less degree, has been caused by the liquid waste from the cleansing of stables, scrubbing of floors, etc., which takes place at certain hours of the day in barracks.

In some stations (Lichfield, Ewshott, and Bulford) the septic tank effluent is directly applied to land, with satisfactory results. Where sufficient land is available and the condition of the tank effluent is a matter of secondary importance, this system possesses many advantages, but is obviously unsuited for general application. Biological treatment of sewage, to be satisfactory in military practice, requires knowledge and experience on the part of those immediately responsible for its carrying out. Specially trained intelligent men, with a permanency of tenure, are necessary for the proper supervision of biological installations.

The Allahabad System.—The general means of the final disposal of excreta adopted in India for military barracks is one of *shallow trenching*, known as the Allahabad system. The night-soil (excreta, etc.) is removed from barracks in Crowley filth carts, each containing sixty gallons; removal usually takes place by night, when for sanitary reasons if it were removed by daylight much insanitary soiling of the roads from spillage would be avoided. The contents of these carts are taken some two miles from cantonments, and disposed of as follows: An area of 80 square feet is excavated, 16 feet long, 5 feet broad. Three inches of the top surface of this area are removed, and the soil placed at one end. The subsoil below the area thus excavated is well pulverized to a depth of at least 9 inches. The contents of the Crowley cart are now tilted into the centre of the trench, the fluid matter (urine, etc.) soaking into the loosened soil. The solid matter is now spread out over the area, and the three inches of soil previously removed replaced on the top of the excreta and hammered down. After a short time grass or other seed is sown over the trenches, and it is cropped annually. In five years' time the areas so treated are again used for fresh trenching. Strict supervision is necessary to ensure that this system of trenching is properly carried out, as it is open to the following grave dangers:

(*a*) That the trenching grounds afford breeding grounds for flies, and that they stink.

(*b*) That the trenches become infected with excreta from enteric fever cases, 'carriers,' ambulant cases, etc.

(*c*) That the surface covering of the trenches becomes washed away by heavy rain, is uncovered by birds, or by the evolution of putrefactive gases.

The system has, therefore, nothing to recommend it, save that in some stations no other method of disposal is available.

CHAPTER IV

CAMP SANITATION

The organization of the sanitary service in the field—Duties of sanitary officers—Personnel of the sanitary service—The regimental sanitary organization of field units—The sanitary organization on the lines of communication—The sanitary section—The sanitary squad—The sanitary organization at the base—The sanitary inspection committee—Encampments—Rules for the selection of the site for a camp—Military considerations affecting the selection of the site for a camp—Sanitary considerations affecting the selection of the site for a camp—Salubrity of site—Tents—Various kinds of tents—Rules for pitching—Scale for accommodation—Sanitation of tents—Huts—Bivouacs—Shelters — Tentes-abris — The interior economy of a camp — The distribution of troops in camp — Fatigues — Grass fires — Sleeping arrangements — Straw mats — Changing the camping ground—Sanitary inspections.

THE medical service of a force in the field has four distinct functions :

(1) It is concerned with the preservation of the health of the troops and the prevention of disease ;

(2) With the professional treatment and care of the sick and wounded ;

(3) With the replenishment of medical and surgical supplies and equipment ; and

(4) With the collection and evacuation of the sick and wounded from the theatre of operations.

It is with the first of these functions that the scope of the present chapter is concerned.

ORGANIZATION OF THE SANITARY SERVICE IN THE FIELD.

Prevention of disease, preservation of health, and the study of sanitation are incumbent on every member of a field force ; their importance cannot be overestimated.

The Director of Medical Services is the supreme responsible adviser to the Commander-in-Chief of the field force on all medical and sanitary matters. His representatives — administrative and senior medical officers—are similarly the advisers to the commanders (General Officers and Brigadiers), to whose headquarters they are attached ; likewise the medical officer of a unit is the responsible local adviser to the commander of the unit to which he is attached.

The commander of every unit and formation is responsible for the sanitary condition of the quarters and area occupied by his command, and for the carrying out of all measures necessary for the preservation of health of those under his command. He is also responsible for seeing that each officer, soldier, and follower observes all sanitary orders, and that good order and sanitation prevail in the quarters and area under his charge, irrespective of the period for which the latter may be occupied. He is also responsible for seeing that, on vacation of such quarters and area, they are left in a sanitary condition.

DUTIES OF SANITARY OFFICERS.

A sanitary officer, who also acts as assistant to the administrative medical officer, is provided in the war establishment of each division of the field army. Subject to such other instructions as he may receive, the duties of a sanitary officer are as follows :

1. Exercise general supervision over the sanitary condition of all places occupied by the troops of the command to which he is attached.

2. Watch the health conditions of billets, camps, bivouacs, and posts, and at once investigate the cause of any unusual prevalence of disease among the troops or inhabitants.

3. Advise on the measures which should, in his opinion, be taken to protect the health of the troops, and report on the adequacy of the arrangements already made for that purpose.

4. Advise, from a sanitary point of view, on the selection of sites for camps and bivouacs, and on questions relating to the sanitary condition of towns, villages, or buildings about to be occupied. To this end he should accompany the staff officers charged with the selection of these places.

5. Advise regarding the purification and distribution of water for drinking and other purposes, latrines and urinals, burial of the dead, and disposal of refuse and carcasses of animals, etc.

6. Impress on commanders of units and on officers in medical charge of troops the imperative necessity of attaining the highest possible sanitary standard, both in camp and on the line of march, and bring to the notice of superior authority any neglect of sanitary measures possible under existing circumstances.

THE PERSONNEL OF THE SANITARY SERVICE.

This comprises:

1. The regimental sanitary organization of field units.

2. The sanitary organization on the line of communications.

3. The Sanitary Inspection Committee.

The Regimental Sanitary Organization of Field Units.

The sanitary service of field units is organized upon the principle that every unit, through its commander, is responsible for its own sanitation and for the proper sanitary condition of any area which it may occupy. For this purpose each unit is provided with a regimental sanitary detachment, made up partly from the ranks of the unit itself and partly from the Royal Army Medical Corps. The *unit* provides one N.C.O. and a certain number of men, according to the strength of the unit (eight for regimental units), for sanitary duties. The duties of these men are to act generally as sanitary police, in order to prevent soil pollution, and, in detail, to supervise :

1. The preparation and care of latrines and urinals, including the filling in of the same with soil and the marking of old sites.

2. The systematic collection, removal, and disposal of refuse, by burning or otherwise.

3. The construction of ablution places and the disposal of waste water.

4. The sanitation of cooking places, horse and mule lines, and slaughtering places in the area occupied by the unit.

The Royal Army Medical Corps provides the following personnel : one N C.O. and four men for an infantry battalion, one N.C.O. and two men for a regiment of cavalry,* etc. These men are responsible for the following duties :

1. The daily supervision of the water supplies, and their purification for drinking purposes by boiling, filtration, or the addition of chemicals, as may be directed.

2. To take charge of all apparatus and stores connected with the water supplies of the unit, such as water carts and chemicals used for the sterilization of water, etc.

3. The supervision of the use of disinfectants in camp or quarters, as may be necessary.

4. The care of the sick of the unit until they are removed to hospital ; the immediate removal and segre-

* *Vide* 'Field Service Manual' or 'War Establishments' for the various arms of the service.

gation of all cases of infectious disease, and, if necessary, of 'contacts.'

The medical officer of each unit is responsible to its commander for the efficient performance of the work of the regimental sanitary detachment. The commander is responsible that all ranks of his unit render a loyal and intelligent assistance to the regimental medical officer in the performance of his sanitary duties, and that the efficiency of his unit is not impaired through neglect of, or non-compliance with, sanitary rules.

The sanitary responsibility of a division in the field may be thus indicated in tabular form :

- Each division.
  - G.O.C.
  - A.M.O.
    - Each brigade.
      - G.O.C.
      - S.M.O.
        - Each unit.
          - (*a*) One medical officer.
          - (*b*) One N.C.O. and eight men of unit, dealing with disposal of refuse, excreta, and acting as sanitary police, etc.
          - (*c*) One N.C.O. and four specially trained R.A.M.C. men, dealing with water supply (new filter cart), disinfection, and sick.
  - Sanitary specialist.

The Sanitary Organization on the Lines of Communication.

The sanitary service on the lines of communication is organized on a more permanent basis than that for field units, and for purposes of sanitary administration the lines of communication are divided into sanitary districts and posts. As a rule the base, railhead, and any specially important area will constitute separate sanitary districts, these being under the direct sanitary control of a specialist sanitary officer. The sanitary service responsible for each district or post comprises either a *sanitary section* or a *sanitary squad*, the personnel of these being provided by the Royal Army Medical Corps, and each nucleus supplemented by such hired civilian labour as can be procured.

Sanitary Section.—This is commanded by a Captain or subaltern of the Royal Army Medical Corps, and comprises the following N.C.O.'s and men of the same corps: 2 staff sergeants or sergeants, 2 corporals, 20 privates, and 1 batman—total, 26. A sanitary section is allotted to each base and to each railhead.

Sanitary Squad.—The personnel of this comprises one sergeant and five men of the Royal Army Medical Corps. A sanitary squad will be required for each road or railway post on a line of communication, and two sanitary squads for each advanced depôt. Sanitary squads will be attached to sanitary sections as required, and their mobilization will be carried out by officers commanding sanitary sections.

The duties of a sanitary officer in charge of a district are analogous to those of a medical officer of health, and include:

1. The supervision of food and water supplies.
2. Questions connected with the disposal of sewage and refuse.
3. Disinfection and all measures necessary to prevent the introduction and spread of infectious disease.

The sanitary responsibilities of the administrative commandant of a section or post are analogous to those of a commander of a unit (see p. 74).

The duties of a sanitary squad are as follows:

1. To execute skilled work in connection with disinfection; the provision of pure water, including its collection, storage, and distribution; the construction of incinerators, etc.

2. One or more of the sanitary squad will be specially detailed to supervise the work of permanent fatigue parties employed for conservancy or other duties in connection with sanitation.

3. To act as sanitary police. For this purpose the N.C.O.'s and men of the sanitary squad are invested with the authority of military police, and wear a police badge.

4. If a post has a railway-station under military control, the squad exercises sanitary supervision over the water supply to the troops passing through, and over the conservancy arrangements generally.

THE SANITARY ORGANIZATION AT THE BASE.

The sanitary service at the base is in charge of a specialist sanitary officer, who may, especially if the base includes a large seaport, be aided by one or more assistant sanitary officers. He is entrusted with the duties of a port sanitary officer, with a view to preventing the introduction of infectious diseases from transports. He arranges for the segregation of cases of infectious disease, and of 'contacts' when this last measure is considered necessary.

THE SANITARY INSPECTION COMMITTEE.

On mobilization being ordered a Sanitary Inspection Committee is formed, consisting of a combatant officer as president, a field officer of the Royal Army Medical Corps, and a field officer of the Royal Engineers, as members. This committee receives its instructions from the Commander-in-Chief through the Director of Medical Services. The duties of this committee are as follows :

1. To assist commanders and the Medical Service in their efforts to maintain the health of the Army, not only

by co-ordinating the work of the different military branches, but also by co-ordinating the military with the civil sanitary organization of the country or the area occupied.

2. To initiate important schemes of general sanitation, and to serve as a board of reference for the solution of sanitary problems.

3 To visit and inspect the stations occupied by troops, to advise local authorities regarding sanitary measures, and to further in every way the maintenance of satisfactory sanitary conditions, reporting to the Director of Medical and Sanitary Services any measures they consider necessary, but which they cannot arrange to be carried out locally.

4. To ascertain what sanitary appliances and materials of all kinds are required for the Army, and that an adequate reserve is maintained.

ENCAMPMENTS.

An army in the field encamps or bivouacs with the primary object of obtaining rest and food, the degree of enjoyment of which depends on security from attack by the enemy, and also on the quality and quantity of food and water supplies, and facilities of obtaining the same. Intimately connected with these factors will also be a comfortable site for the encampment, its sanitary environment, and its continuous sanitary upkeep. War, by reason of the concentration of troops or surface overcrowding necessarily connected with its operations, is opposed to the first principles of sanitation. Pollution of the soil, both by reason of surface fouling and subsoil contamination, and of the air by exhalation from men and animals, as well as the emanation of damp and underground gases from beneath the surface of the soil, are the chief factors operating against health in camps, and all these factors are intimately connected with insufficient space as a primary cause. It is pollution of the soil and water supplies which robs camp life of its otherwise healthy and invigorating conditions. The longer an army remains in the presence of an enemy, and proportionally as strategical considerations outweigh sanitary recommendations, so much the more will it suffer in loss of health and efficiency ; there is no escape from enteric fever and dysentery as a natural consequence. Attention should be judiciously directed to the ultimate effects of thus disregarding sanitary laws. To direct such attention in anticipation of such consequences is the duty of the Administrative Medical Officer, who is the responsible adviser of his General.

RULES FOR THE SELECTION OF THE SITE FOR A CAMP.

The selection of a suitable site for a military camp is always a matter of considerable importance, as three main considerations may be said to be intimately involved :

1. Military considerations.
2. Sanitary considerations.
3. Interior economy and comfort of the troops.

The order of importance of these three factors is as they are respectively quoted. In time of war purely strategical and tactical considerations are of the first importance, and sanitary considerations, in conjunction with the comfort of the troops and the interior economy of the camp, are of next moment. In the case of bivouacs and temporary camps in the vicinity of the enemy, the military requirements will probably outweigh the sanitary essentials, but the latter should be of paramount importance when camps of a more or less permanent nature have to be formed. In the important question of strategical and tactical considerations a medical officer has no official responsibility, but when detailed alone, or when accompanying any party not under the command of a combatant officer, he should bear them in mind when looking out for a suitable site for a proposed encampment. With the second consideration—namely, that of sanitary suitability—the medical officer is the official of all others who has the expert knowledge, and he bears the full responsibility. With regard to the question of the suitability of site as affecting the interior economy of the proposed camp and the comfort of the troops, a medical officer has no other than an official advisory opinion in so far as it affects the public health. The above three essentials may now be considered.

MILITARY CONSIDERATIONS AFFECTING THE SELECTION OF THE SITE FOR A CAMP.

The chief military considerations that the site for a camp in time of war should fulfil are—

1. In time of war the *site* for a *standing* camp is selected chiefly because it presents certain strategical advantages, and will thus, as a rule, be located on the lines of communication or at some other place close to railhead of a more or less permanent nature.

2. The site for a *temporary* camp is usually chosen on account of the *tactical* advantages the conformation of the ground may offer, such as:

(*a*) Favourable ground for defence in case of attack by the enemy, so that the troops can be rapidly formed up in a good position for action. This does not always involve encamping on the very position to be defended. It should also be remembered that troops should never cross one another in going to defend ground.

(*b*) Concealment from the enemy.

(*c*) Facilities of protection.

(*d*) Economy of outposts. The more compact the camp, the easier it is to defend. A scattered camp increases fatigue duties, impedes distribution of supplies, and delays the circulation of orders.

SANITARY CONSIDERATIONS.

The chief sanitary considerations the site for a camp should fulfil are—

1. Fitness of the site in point of *salubrity* as to its sufficiency, aspect, elevation, nature of soil and subsoil, shape or contour of ground, nature of cultivation, and sanitary environment. In every camp, order, cleanliness, ventilation, and salubrity *must* be ensured.

2. Water supplies, their quality, quantity, location, and sanitary environment.

3. The presence of suitable means of approach and communication (roads, etc.), and means of free passage through the camp, are essential.

Salubrity of Site.—Apart from tactical considerations, regard must first be paid in selecting sites for encampments to the *length of time* that their occupation is likely to last. The selection of a site for a temporary camp to be occupied for not more than two days as a bivouac will not always require so much attention to detail as will be the case for a camp of more prolonged duration, and the selection of the former will probably be more or less governed by military considerations, provided an efficient water supply is obtainable in the vicinity.

The best possible site for a camp is grass country, with sand or gravel as a subsoil, both of which act as a means for natural drainage. This is especially the case if the ground is level and on the summit of a rise, or on ground with a gentle slope to the east or south. A porous, dry, high ground, or the gentle slopes of hills with a gravel or sandy subsoil, on open grass, will always help drainage of a camp, but steep slopes should be avoided. Sites on granite, metamorphic, clay-slate, and trap rocks are also satisfactory unless these rock strata be disintegrated, when they are unhealthy. Limestone and magnesian limestone sites are also healthy when not marshy or waterlogged, and although the water supplies in the vicinity are certain to be 'hard,' they are good. Chalk strata by themselves, when unmixed with marl, are good, and so is the water in their vicinity. When, however, marl and chalk are found together, they usually form impermeable strata, and the soil is damp and water-logged. Permeable sandstone usually gives a healthy site. Vegetation other than grass is generally damp. The presence of an abundance of vegetation generally indicates a more or less unhealthy locality; but such places should be borne in mind in the event of water being scarce, as by digging or boring wells, or by sinking Norton's tubes in such places, water can probably be obtained. Land with a clay or marl subsoil is damp, and is unbearable in wet weather; the ground becomes a bog; men's feet, their clothing and bedding, become wet; therefore such soil should be avoided. Open wood-land, the open bank of a river, or a wide, open valley may, failing a better site, be chosen. Camps should not be too much exposed, and should preferably face north-east in warm weather, and south-east in cold weather.

An encampment should not be located in or on—

1. The summits or base of hills, damp ground, low meadows, newly-turned soil or clay. A clay soil or sub-soil coming near the surface is retentive of water and damp; it is the worst site for a camp unless well drained. Ground immediately at the foot of a slope is bad, as it receives water from the higher level, and will be damp and unhealthy. Areas at the foot of hills are not desir-able, being often damp and unhealthy unless the ground water from the high land behind is cut off from them by a suitable drainage. Marshy ground and areas in its vicinity, as well as ground covered with rank vegetation, are unhealthy. This is especially the case in the tropics and sub-tropics, owing to the prevalence of malaria and on account of the large amount of decaying vegetable matter in the soil. Irregular, hollowed-out ground, the proper drainage of which is difficult or impossible, is bad.

Land that has recently been ploughed or cleared of brushwood or is covered with rank vegetation is also to be avoided for camping grounds of a permanent type. Tilled, irrigated, damp land, made ground and areas close to villages, especially native villages, and sites adjacent to any insanitary focus, such as a graveyard, should be avoided.

The nature of the *soil* should also be noted when selecting the site for a standing camp. Clay should be shunned. Deep gravel and sand are healthy, except when on an elevation with a bad surface slope ; sand with high ground water, and alluvial soil, are to be avoided, if possible, as they are cold, damp, and usually unhealthy. The subsoil should be porous.

2. In warm climates the banks of rivers, stagnant pools and lakes, as well as land subject to flooding, especially flooding by brackish water, are unhealthy.

3. Ravines, gorges, and the dry beds of watercourses are not only unhealthy, but dangerous, being draughty and liable to flooding, for a sudden fall of rain may convert them into large streams.

4. Large woods with thick undergrowth are unhealthy. Although the neighbourhood of trees is desirable, as the shade of trees either in camp or near at hand is of great value in sheltering men and animals from the sun, it is best not to form camps under trees or in places where there is thick undergrowth. Rank vegetation shows dampness of site, and must, therefore, be avoided. Decaying vegetation, jungle and forests recently cut down, are dangerous in tropical and malarious countries.

5. It is most important that camp sites that have been recently occupied should be avoided, if possible ; if this is unavoidable for strategical or tactical reasons, it is always advisable to camp as far to windward as possible of the old site. Should an army be obliged to occupy for any length of time a defensive position on which an

attack is expected to be made, the camp or bivouac should be pitched in such a position as not to foul an excessively large area, as such ground may, of necessity, have to be occupied in a future advance, or possibly have to be retired upon.

TENTS.

A field-service tent should be waterproof, durable, light, portable, and easily ventilated. In the tropics it should have a double fly for use during hot and wet weather, good ridge ventilation, and a lining of black, red, yellow, or orange cloth, to keep out the actinic rays of the sun. Military encampments are always densely populated, and, when possible, should be scattered over a large area. Small tents are preferable to large ones, provided that they supply sufficient ground and air space to each occupant, as they allow of the men being distributed in small groups, and are thus less exposed to the diseases of overcrowding.

The tents used by British troops are as follows:

1. **The Bell or Circular Tent.**—These are of two patterns: single fly (weight with poles 81 pounds), and double fly (weight 112 pounds), made of duck, having three ventilators above, covered with small hoods. Six-inch eaves are provided to carry off rain water clear of the walls. Both patterns accommodate fifteen men, but in some expeditions (Abyssinian, etc.) they were issued at the rate of one to twenty men and one to twelve officers; for hospital use the fixed scale is one to four sick men. In both patterns the floor diameter is 18 feet, the height of the pole 9 feet 9 inches, and the height of the walls 2 feet 2 inches. The men lie with their heads to the walls and their feet to the pole; with eighteen men lying down, their shoulders touch. In the Suakin Expedition of 1885 the single-fly circular tents issued were found quite unfitted for the climate, and had to be changed for tents 'British Privates' (Indian pattern), as the heat increased. In the

Bechuanaland Expedition of 1884-85, notwithstanding arduous work and a temperature in the double-fly tents rising to 112° F., the troops continued in good health, and no cases of either sunstroke or heatstroke occurred, although many of the men lived in single-fly patrol tents. In the Chitral Expedition of 1895 single-fly tents proved unsatisfactory for British troops, the heat during the day-time being much felt, and chills at ni ht brought on ague, diarrhœa, and dysentery. The necessity of looping up the flaps of bell tents for ventilating purposes should not be lost sight of, on account of the very small cubic air space they provide. During the South African War cases of pneumonia occurred during the hot weather when this was not done. Later in the war, when tents were not used, very few chest complaints were noticeable, although the weather was cold.

2. **The Hospital Marquee Tent.**—This is a double-fly tent, with two poles and a ridge pole, really intended for hospital use on the lines of communication and base, when it accommodates eight sick men or sixteen healthy men. Owing to the very large surface that this tent offers to the wind, great care should be taken to ensure that the pegs are well driven into the ground, as they are prone to draw very easily. Its dimensions are 29 feet long by 14 feet wide, sides 5 feet high, and height from ground to the ridge 15 feet. Its floor area is 375 square feet and its cubic capacity 3,200 feet. Its weight, including valise, is 512 pounds. Its waterproof ground sheet weighs 145 pounds. Two ventilating openings are provided, as well as a large flap ventilator at the top. There is also a larger pattern of this marquee.

3. **The Operating Tent.**—This is a rectangular tent, with a door at each end, and is issued as part of the equipment of each British Field Ambulance. It has two poles and a ridge pole, the length of the tent being 20 feet; width, 14 feet; height, 9 feet 4 inches; height of wall (which is permanently attached to the roof), 3 feet; and

weight complete, 181 pounds. It has six ventilators in the roof and a large window at each side.

Six patterns of regulation tents are issued to British troops serving in India, viz., those for—

1. *British Privates*.—With two poles and ridge pole, double-fly. Weight, 900 pounds; dimensions, 20 by 16 by 10½ feet; ground area, 320 square feet; cubic capacity, 2,373 feet; height of walls, 5 feet 6 inches. Accommodates sixteen soldiers or eight sick men.

2. *Staff Sergeants*.—Weight, 500 pounds; dimensions, 12 by 12 feet; height of walls, 5 feet; ground area, 144 square feet. Accommodates two sergeants.

3. *General Service* (*Large*).—With three poles and a ridge pole. Weight, 160 pounds; dimensions, 14 by 14 by 7 feet; height of walls, 1 foot; ground area, 196 square feet; cubic capacity, 1,372 cubic feet. Accommodates sixteen British or twenty native soldiers, or twenty-five followers.

4. *General Service* (*Small*).—With two poles and a ridge pole. Weight, 80 pounds; dimensions, 8 by 14 by 7 feet; height of walls, 1 foot; ground area, 112 square feet; cubic capacity, 784 cubic feet. Accommodates eight British or ten native soldiers, or twelve followers.

5. *General Service* (*Staff Sergeants*).—Weight, 40 pounds; dimensions, 7 by 6 by 7 feet; height of walls, 2 feet 6 inches; ground area, 42 square feet; cubic capacity, 160 cubic feet. Accommodates two sergeants.

6. *General Service* (*Officers*).—Weight, 80 pounds; dimensions, 7 by 7 by 7 feet; height of walls, 2 feet 6 inches; ground area, 49 square feet; cubic capacity 170 cubic feet. Accommodates one officer.

All these tents are good and suitable for standing camps, etc., when available, and when transport is possible. Tents 1 and 2 are only used in standing camps. The superficial area and cubic space per head is necessarily limited on field service, but this drawback is mitigated by the fact that two to four of the occupants are almost constantly absent on duty or sick. There is, however, no doubt that the sanitary surroundings of the men would be improved if only twelve and six respectively were to occupy Nos. 3 and 4. General service tents are best used when in a standing camp. None of these tents, when closed, are properly ventilated. To remedy this defect a strip of canvas 2 feet wide, and stopping 1 foot short of each end, should be removed from the *inner* fly of double tents on either side of the ridge pole, and replaced by rope netting with 2-inch meshes, or else they might be fitted with the same means of ventilation as that described for the hospital marquee tent. In the case of single-fly tents, a window 1 foot square should be made in each half of the doors, and similarly filled with netting. These ventilating orifices could easily be closed, when required, by draw-shutters of canvas.

Tents should never be pitched in double rows, but in short lines, at intervals of 2 to 3 yards from each other. In bivouac camps there ought to be a space of 4 feet between the shelters. The main street of a temporary camp should be 5 yards from the outer line of tents, and a similar interval should separate corps units.

Tent Accommodation.—When circular tents are used the scale is as follows for each tent: Commanding officers and officers of higher rank 1 to one tent; other officers 3 to a tent; men, 15; warrant officers, 5; sergeants, 7 to each tent.

Intervals in Camp—Ten yards clear ground should be left between units, 3 yards between companies, 1 yard between squadrons, and 1 yard between the pegs of each tent.

Pitching Bell Tents.—The following points should be attended to:

1. Position of guy pegs and tent pole.
2. Radius of circle for pegs, 9 feet.
3. Pole must be perpendicular to ground.
4. Pegs should be equidistant.

5. Pegs and ropes should be in line with the seams of the tents ; runners should be halfway.

6. Mark centre of tent with peg and make circles of radii 7 feet (wall of tent) and 9 feet (pegs). Drive in four pegs at four corners. Put up tent and drive in other pegs.

7. Doors, if possible, should point to leeward.

8. Cut drains round bottom of tent walls and heap earth inside flap.*

9. Dig a hole 6 inches deep close to tent pole. If storm comes on at night, push tent pole into this to relieve strain.

In standing camps the tents should be pitched at intervals of $1\frac{1}{2}$ diameters apart—*i.e.*, a space of 20 to 30 feet in the case of general service and British privates' tents respectively.

Sanitation of Tents.†—The tent floor should be well beaten down and sprinkled with kerosene or paraffin oil to keep away flies, etc. The floor should never be

* Trenches 4 inches deep and the width of a spade should be dug round each tent, with the earth thrown up outside. These trenches should lie immediately outside the tent flies, and so placed that both the trench and the earth bank shall lie inside the pegs. The drainage from these trenches shall be such that all water flowing from them shall be led away by small drains cut in the sod to the nearest ravine or hollow in the ground. This is of great importance, not only to drain each unit's camp, but to protect it from washings, from animal standings, and other polluted ground. Each regiment should arrange for this drainage system for its own camp, and the Brigade Major or other staff officer of the brigade should arrange for fatigue parties to connect or complete the combined drainage system of his encampment. In cutting surface drains it is best to cut them with rounded bottoms, so ——∪——, and not rectangular, so ——⊔——

† The essentials of camp conservancy are discussed in Chapter V., pp. 96 to 140.

allowed to be dug out with the intention of increasing the space. Newspapers, etc., spread out on the floors of tents at meal times save the ground from being fouled. A shallow trench communicating with a larger one in the camp street should be dug round each tent for surface drainage. This should always be done, even in a camp to be occupied for only a single night. The tent walls should be looped up all round each morning on fine days, and, in the case of ridge-pole tents, such as general service tent, one side, or part of a side, should be thrown up over the ridge pole. In wet weather and at night-time only the walls of the lee side need be raised. Only one half of the door of a tent should be closed except during wet weather. Roads are always a boon in camps. Raised footpaths should be made along the sides of the camp streets, and from them to the kitchens. Paths should be marked off with stones (whitewashed for guidance after dark) in front of each row of tents. The main street in a stationary camp should be about 20 yards wide, and the side streets 10 yards wide, while there should be an interval of 10 to 20 yards between corps and units. Surface drains should be constructed freely. The larger surface drains may with advantage be paved with small stones. A surface drain should be dug to intercept and lead aside from the camp all surface storm-water from higher ground, and all depressions likely to retain water should be filled in. In stationary camps all riding and transport animals and cattle should be picketed well outside the camp perimeter. As it is impossible to move a standing camp frequently to a fresh site, the tents should be struck once a week and pitched loosely on a fresh site for a few hours to allow of the vacated sites being thoroughly aired and cleaned. Any soiled portion of a tent floor should then be dug up, removed, and replaced by fresh, clean earth, which must be well beaten down before the tents are re-pitched on their original sites.

HUTS.

When huts are constructed for the shelter of troops in a standing camp, they should be built to accommodate not more than twelve men, each man receiving at least 400 cubic feet of air space. The floors should not be dug up, ventilation should be carefully attended to, and a trench should be dug round the huts, which ought to be separated from each other by a space equal to at least one and a half times their height.

BIVOUACS.

Bivouacs are encampments without tents, and the principles laid down for the selection of the site for encampments apply equally to that of a bivouac. Napoleon preferred the bivouac to tents for men, and there can be no doubt that they are more healthy in *fine* weather, particularly if operating in a wooded country, where fires can be maintained easily. In cold weather woods are the warmest places for a bivouac. In tropical climates it is pleasanter at night to bivouac in the open. When camping or bivouacking in a hilly or undulating country, remember that the actual cold is greater in the valley than on the side of a hill. Halfway up the slope is generally the best site for comfort, as well as for military reasons. Narrow belts of wood form a good shelter screen from wind, and woods, especially pine-woods, afford good sites for an infantry bivouac; they are warm at night and cool during the day in hot weather.

The area required for the bivouac of any unit should be the same as that laid down for its *minimum* camp, and should be occupied on the same principle. One advantage of selecting fine weather for manœuvres in this country and the cool season in hot countries for active service is the possibility of bivouacking, and thus being able to cut down the transport difficulties of carrying tents, and at the same time allowing of greater mobility, forced marches, and the possibility of striking rapid blows at the enemy.

Bivouacs admit of the maximum concentration of troops, and afford the greatest facility for their rapid concentration. Under favourable climatic conditions bivouacs have a healthy influence on the troops employed if overcrowding is avoided and if the soil is not damp. The disadvantages may be summed up as:

(*a*) The occasional loss of sleep at night, either by the unavoidable noises due to animals, etc., or to the harassing sniping of the enemy.

(*b*) The danger from chills during the night and dew in the morning.

(*c*) The heat of the sun during the daytime.

When troops have to bivouac, it is essential that each man should have *at least* two blankets* and a waterproof sheet. A welcome addition would be a waterproof canvas sheet, with eyelet holes at the sides, which can be used as a *tente-abri*. The waterproof sheet and one blanket are used to lie on, and the other blanket is wrapped round the body. While bivouacking, all troops should wear flannel shirts and woollen jerseys, and under no circumstances should cotton or flannelette shirts be worn.

When there is no wind, spreading trees will keep off cold and dew. In windy weather screens made of boughs of trees, or small embankments (*sangars*), if thrown up, will act as a protection, but men must not sleep on the

* No blankets for men are included in the normal scale of war outfit, but one blanket per man will be carried when specially ordered. In units where this necessitates an addition to the normal scale of transport, the extra personnel, horses and vehicles required are shown in a note in the war establishment tables. *Vide* 'War Establishments,' section 1, paragraph 25.

damp ground caused by such excavations. On hard ground considerable comfort can be attained by loosening the soil and making a slight hollow in the ground for the hip. Dry grass, straw, or leaves can be utilized as a pad under the sleeper, or a folded blanket used as a cushion. A party of men may prepare a combined resting-place by arranging dry grass, straw, or heather, and lie in a row, using their combined blankets as coverings. Sufficient blankets should, however, be placed underneath to avoid chill from the earth. Men should never sleep below the level of the ground, but, if possible, always above it. In frosty weather sleeping between large fires or between two rows of small fires has been recommended; but unless they are kept alight all night, or should the wind change, chills may result. When only one row of fires is employed, men should sleep with their feet towards them. In very cold weather a bivouac, tent, or a hut may be kept warm by placing red, well-burnt embers of a fire in a hole or trench made in the ground, and covering them with a little dry earth or ashes. Charcoal fires in closed huts or tents cause suffocation.

SHELTERS.

Tentes-abris, or shelter tents,* can be made with the regulation army blankets † or waterproof sheets. The special service blanket is an ordinary brown-grey blanket measuring 7 feet 6 inches by 5 feet and weighing 4½ lbs.;

* Shelter tents are carried practically by all armies except our own. In the German army they are popular with the men, and well designed, besides being useful on manœuvres when it is desired to avoid billeting. The average weight of the German shelter tent is over 3 lbs., French 2¼ lbs., and American 4¾ lbs.

† Blanket shelters are articles of store. The poles are officially termed 'poles, wood, s.s. blanket.' Two poles make a set.

it is fitted with fourteen eyelet holes to enable it to be used as a bivouac shelter. Five eyelet holes are on each side (one being at each corner), and two holes are at each end. By means of a cord passed through the eyelet holes, two or more blankets can be laced together to form a shelter. This is supported by poles or sticks, each 4 feet long, and secured to the ground by a piece of cord tied at each corner and fastened to pegs in the ground. A piece of rope, stout cord, or straps across the top forms a supporting ridge, and this is carried to the ground at each end and secured by a peg. The blankets should be so adjusted that their nap slopes downwards (towards the ground), to allow the rain to run off, because, if placed facing upwards, the wet will penetrate. Four men at a pinch can sleep under a shelter composed of two blankets or waterproof sheets, and their remaining waterproof sheets and blankets may be utilized as bedding. If sufficient blankets or waterproof sheets are not available, a shelter can be formed by driving two forked sticks into the ground, with a ridge pole resting in the forks between, and branches, with their thick ends alternately upwards and downwards, placed resting against the ridge pole at an angle of 45 degrees. The screen is completed with smaller branches, long grass, heather, ferns, etc., and fastened by cord or tendrils. In making the roof, commence at the bottom, so that the upper branches, etc., will overlap the lower, like the slates of a house, and so run off rain. In South Africa the Boers made comfortable shelters in this way, and stretched ox-hides overhead as a protection against sun and rain. Before setting up any shelter, take note of the direction of the wind, and face the *back* of the shelter that way. A comfortable shelter for twelve men can be made by excavating a circle of 18 feet diameter, and piling up the earth to form a wall 2 or 3 feet high. Branches of trees stuck in this wall improve the shelter.

THE INTERIOR ECONOMY OF A CAMP.

Considerations connected with the comfort of the troops and the interior economy of an encampment include the facilities which the site affords for obtaining a sufficiency of space, good shelter, rest, water, fuel, forage, and straw, facility of approach and communication (convenience to roads, etc.).

Considerations Affecting Allotment of Ground.

1. Each unit should be kept together under its own commander.

2. Areas allotted to subordinate commanders should be defined.

3. Areas should be allotted for water, fuel, and grazing.

4. Roads should be allotted to units.

5. Each unit should have positions of its latrines, kitchens, refuse pits, and places for disposal of dead animals defined.

6. Names of prominent features of surrounding country should be freely communicated.

7. All special sanitary measures and precautions to be taken by subordinate commanders should be communicated to them.

8. When sent out to select a camping ground, a rough tracing on thin paper of the map in use should be made, and the allotment to each unit marked on it, so that each unit's position can be located or communicated.

9. The camp should be within a mile or so of the next line of march.

The Distribution of Troops in Camp.—The following rules must be observed* in distributing troops to areas, whether camps, bivouacs, or billets are used :

1. When liable to attack, infantry should be in the more exposed positions; cavalry and other mounted troops in the less exposed. Artillery, columns, and

* *Vide* 'Field Service Pocket-Book,' 1908, p. 34.

medical units should always be covered by the other arms. Depôts should be near good roads.

2. Dismounted units should be nearest the water supply. Mounted men should be near their horses, guns, and waggons.

3. Officers should be accommodated close to their men.

4. Staff and hospitals have the first claim on buildings; the former should adjoin their telegraph offices, be on main communications and easily found, and the latter should be given a quiet spot in the most sanitary position.

5. Both sides of a street should be allotted to the same unit, to prevent confusion in case of alarm.

Stones along Paths.—These add greatly to the comfort of troops in camps, especially in wet weather, and lend an air of neatness and cleanliness to the place which is very desirable. Stones should be collected by defaulters. Paths should be made in front of each row of tents, in front of the camp round each flank to the latrines, along the kitchens, etc.

Drains.—The longer a camp remains standing the more complete ought the drains to be made, whenever it is necessary to construct large ones. Bridges must be made over them opposite the intervals between the regiments. Large flat stones can be used to make a covered-in drain, or barrels, sunk and covered over with small stones and clay, well rammed in round them, answer well.

Fatigues.—As the duties in camp are often very heavy, recommendations with a view to limiting the number of fatigues, picquets, guards, and other trying duties, as much as possible, should be submitted.

Grass Fires.—In grassy countries like South Africa, etc., the danger of being burnt out should not be lost sight of. Encamp on the banks of rivers as a precaution against such a disaster; this protects the camp from fire, at least in one direction, or halt only in ground over which fire has already swept, or burn a strip of grass away with care around the camp.

Sleeping Arrangements.—If a night attack can be precluded, men should remove their accoutrements, and, when sleeping together, should always club their blankets so as to have some to lie on and the others to cover them. Too much attention cannot be paid to making sleeping comfortable. Unless men get good refreshing sleep, they cannot sustain continued work. The company officers should be most energetic in this matter, for a little trouble bestowed in collecting straw, dry grass, shavings, etc., will prevent troops awakening some two hours before daybreak, chilled with cold. There should be no stir or preventable noise in camp between 'Lights out' and 'Réveillé.'

Straw Mats.—When dry straw is available, its issue to the men will greatly increase their comfort in bivouac or camp for the purpose of lying upon. In stationary camps the straw should be made into mats, for these can be aired, and are cleaner. Each mat should be 5 or 6 feet long, to allow of one end being rolled to form a pillow, and their width should be 2 feet.

Changing the Camping Ground.—Change the positions of camps as frequently as possible. Scatter divisions, regiments, and even individual tents, when at a distance from the enemy.

Sanitary Inspections.—The sanitary officer from each division should ride round the camps of the several corps daily, to see that they are in good order, the latrines and cooking places made, and should bring to notice of officers commanding and Brigadiers all irregularities.

CHAPTER V

CONSERVANCY AND OTHER ARRANGEMENTS FOR ENCAMPMENTS

General considerations—Conservancy arrangements before occupation of a camping ground—The preparation of the ground — The disposal of organic refuse generally — Latrines—The shallow-trench system of excretal disposal —Area of ground required—Details as to the trenches—Latrine screens—Time the trenches last—Supervision—Latrine paper—Closing the trenches—The deep-trench system of latrines—The 'dry earth' removal system—Arrangements for latrines when on the march—Army regulations, etc., concerning latrines—Camp urinals—Day urinals—Night urinals—Dry urinals—The disposal of waste water—The disposal of refuse—Waste food—Kitchen water—Baths—Bathing places—The drying of wet clothing—Disposal of dead animals—The conservancy of standing camps—Improvised refuse destructor for a standing camp—Sullage water—Camps at manœuvres—The camp kitchen—The ablution place—The disposal of horse litter—Sanitary rules to be observed on striking camp—Graveyards and the burial of the dead on active service—Infectious diseases occurring in camps—Enteric fever—Dysentery—Cholera—Disinfection of tents.

BEFORE troops enter an encampment or bivouac, a concise knowledge as to the conservancy arrangements connected with the sanitary upkeep of a camp must be instilled into all concerned, and draft orders should be prepared beforehand, ready for issue, dealing with the construction of latrines, urinals, sullage-water pits, incinerators, and other means suitable for the disposal of organic and inorganic refuse. As orders in themselves are useless unless intelligently interpreted and understood, it must be impressed on all concerned that the fighting power of an army depends on its health, and that the vital power of the army depends on the strict observance by *each* individual that helps to form it, of the sanitary orders promulgated, more especially those connected with the danger of promiscuous soiling of the camp area and its vicinity by fæces, urine, sullage, or any other form of organic refuse.

CONSERVANCY ARRANGEMENTS BEFORE OCCUPATION OF A CAMPING-GROUND.

Some short time before the departure of the main body of a unit to camp, at least half the sanitary squad, under their N.C.O., should be sent there with the advance party. Definite instructions, including a rough plan, should be issued to this party by the O.C. the unit as to the position and number of latrines, urinals, urine pits, sullage and grease pits, etc., to be dug, and similar arrangements made for canteens, institutes, etc. This sanitary squad should be in addition to the actual strength of the advance party, and should only be employed in sanitary work.

The Preparation of the Ground.

The ground should be prepared before tents are pitched, and long grass, bushes, stones, and all rubbish removed. Long grass and bushes, besides harbouring snakes and insects, also make it difficult to prevent and detect fouling of the ground. Whether the camp is to be occupied for a short or long time, it is essential that the area it is to occupy should be kept clean, and this is materially aided by keeping its surface dry, so that in all camps it is necessary to cut surface channels to drain the ground and to carry off the rain water from the trenches encircling the tents. In malarious districts abroad however, it is advisable to disturb the soil as little as possible except for purposes of drainage. The surface of the ground may be hardened where necessary by the laying down of gravel, and paths may also be laid by this means, or planking used if obtainable. The floors of tents can be improved by laying down and stamping in the ashes from fires. Where a camp is dusty and water available, the roads through the camp should be watered to lay the dust. In standing camps the floors of the tents should be swept clean, and the surface sprinkled with oil to lay the dust and keep away flies. The form of a camp must be governed by the space available; enough space should be allowed between the tents to make it possible to shift every tent one tent's space forward or laterally, and thus obtain occasional airing and disinfection by the sun of the ground previously used. It is also desirable, when possible, to shift the entire camp every eight days.

The Disposal of Organic Refuse Generally.

There *must* be no delay in the incineration or burial of organic refuse. The burial of dead animals, excreta, and offal is just as important as the burial of human corpses. Scavenging is a science, and requires careful teaching. If scavenging be left to the ignorant and delegated to the control of those who think that its details are beneath their notice, epidemic disease will of a certainty result. The question of the immediate disposal of the organic refuse of camps must be ever present in the mind of a successful organizer. Fæces must always be buried in shallow rather than deep trenches, and if properly done no offence to health, eyes, or nose will occur, nor will flies or rats be attracted. Fæces should always be covered with fine dry earth as soon as they are passed, and malodorous open trenches, with excreta either partially covered or not covered at all, should *never* be permitted. Nitrification of fæces in the soil is the aim of sanitary science, and the more intimately fæces are mixed with dry soil the quicker will nitrification occur. The greater the bulk of excreta and the less intimately it is mixed with the soil, the longer will it take to nitrify, and the longer will it be a source of danger to the community. Horse dung when not burnt should be neatly made up into rectangular heaps like hotbeds and covered over completely at the top and sides with earth. The earth will prevent flies feeding and laying their eggs in the dung. Moses, from his experience of a plague of flies in Egypt, laid down sanitary directions in Deut. xxiii. 12-14:

> 'Thou shalt have a place also without the camp whither thou shalt go forth abroad. And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself (sittest down) abroad, thou shalt dig therewith and shalt turn back and cover that which cometh from thee.'

This passage means that fæces should be immediately buried if camp sanitation is to be kept perfect.

No organic or other refuse of any kind must be allowed to foul the surface of a camping ground or its vicinity. Refuse from tents, such as meat tins, bones, washings from the men's mess tins, tea-leaves, etc. must not be thrown on the ground outside the tents, as all these cause fouling, collect flies, and become a grave source of disease.

Latrines.

Before occupation of a camp by the main body of a unit, arrangements should be made, if possible, to have all its latrines and urinals ready for the troops when they march in. This should usually be carried out under the supervision of the officer in charge of the advance party and the contingent detailed from the sanitary squad of the unit. The site of the latrines should be to leeward at the rear of the camp, and the trenches should be so placed as to lie in échelon on the *outward* flank on an area not likely to be flooded by storm water from higher ground. Their location should be well away from the water supply of the camp, and at least 100 yards distant from any place to be inhabited or used by the troops either for resting, cooking, washing, or storage of food or water supplies.

Three distinct varieties of latrines for camp use may be noticed:

1. The shallow-trench system.
2. The deep-trench system.
3. The dry-earth removal system (with pails).

1. *The Shallow-Trench System.*

During recent years the shallow-trench system of latrine trenches has been extensively employed at manœuvres in the United Kingdom, and has given such good results that it will probably be universally adopted in future. It is the best all-round sanitary method of fæcal disposal, and the amount of ground required is not large. Captain R. Tilbury Brown, R.A.M.C., while Specialist Sanitary Officer of the Eastern Command, devoted considerable attention to the perfecting of this system, and his practical trials on manœuvres have stood the test of time.

Area of Ground required.—The frontage of the area of ground required for the shallow-trench system of latrines varies with the number of men who have to use them. It is usual to lay out a set of latrines for each unit, and it is necessary to dig trenches on a basis for 5 per cent. of the strength; but in practice it is found that the greater the strength, the smaller need be the percentage of trenches—for instance, 3 per cent. is usually sufficient for 500 men. Captain Tilbury Brown states : 'Calculating on the basis of 5 per cent., to obtain the frontage of ground, multiply the hundreds of men by 6 ; this gives the frontage in yards, but only holds good when trenches are dug with a 2 feet 6 inches inter-space.' If the latrines are to be located at the rear of the camp of the units, there is always enough frontage even with the minimum camping area, so that the depth only has to be considered, and the depth will vary with the number of days the camp has to be occupied. When the trenches are dug as described in the next paragraph, the depth is calculated by taking two-thirds of the number of days that the trenches are to be used, and this in yards will give the amount of ground to be trenched. It is always well, however, to allow a few yards in each direction as a margin for error, and on irregular ground or in a wood a greater area should be allowed. Separate latrines should be provided for officers: one trench for field officers, and four for the remainder will usually suffice. Trenches for N.C.O.'s should also be provided, separate from those for the men, on a scale of 5 per cent. of strength. Frontage of trenches is as follows : Two trenches require 3 yards ; four trenches, 5 yards ; six trenches, 8 yards ; and eight trenches, 10 yards. Depth as stated above.

Details as to the Trenches—(1) *Size of Each Trench.*—This should be 3 feet long, 1 foot broad, and usually not deeper than 1 foot. The space between each trench should be 2 feet 6 inches. Trenches should be arranged as far as possible in one line. The depth of each trench should not as a rule exceed 1 foot, but if the ground is limited they can be dug deeper—to 2 feet. These deeper trenches should last at least two days. Captain Tilbury Brown states that one regiment, 500 strong, had twenty-five trenches 2 feet deep; it was in camp for thirty days, and each trench lasted four days. Another regiment, 550 strong, used fifteen trenches 1½ feet deep ; each trench lasted two days ; the camp was for eighteen days, and the trenched ground measured 20 yards by 10 yards. Another regiment, 440 strong, used 10 trenches $1\frac{1}{2}$ feet deep ; each lasted two days ; the camp was for seventeen days, and the trenched ground was 20 yards by 15 yards.

(2) *Interspace.*—Two and a half feet is a convenient interval ; it allows plenty of room for another trench to be dug in it if so required later on, when ground is limited. Men using the second trench have 9 inches of firm ground for each foot to stand on, and there is an economy of space. A 3-foot interspace, while having the advantage of allowing more room between the trenches, entails a longer frontage—more than exists with a minimum camping ground, and it also requires a greater length of screens.

(3) *Methods of making the Trenches.*—Remove the sod of each trench as far as possible in one piece, and place it about 3 feet behind the trench, then evacuate the trenches until they are 1 foot deep, keeping the sides vertical. Break up the evacuated earth as fine as possible, and place it immediately behind the trench. Suppose B (see Fig. 12) is the base line of the camp, that trenches are to be dug to the rear, and that the number of men is 200, and the probable length of occupation of the camp is thirty days. Two hundred men require ten trenches (at 5 per cent.), with a frontage of 12 yards (2 by 6 ; see paragraph 1). Thirty days' occupation will require a depth of 20 yards (30 by $\frac{2}{3}$; see paragraph 1).

From B and at right angles measure off 20 yards B-C, and drive in a peg at C. From C mark off C-D parallel to the base of the camp, and 12 yards long. C-D will represent the line of the first row of trenches to be dug. From C along C-D measure off 1 foot and $2\frac{1}{2}$ feet spaces alternately, marking each of these with the spade until there are ten 1-foot spaces. To do this it will be convenient to use a stick which is 3 feet long and marked at 1 foot and $2\frac{1}{2}$ feet, or a cord looped at one end and marked by knots. From C measure 3 feet C-E. From

E and parallel to C-D mark off alternate spaces as before, and join up. This outlines the first row of trenches. The trenches will thus be arranged in parallel rows (in échelon), with an interval of $2\frac{1}{2}$ feet between

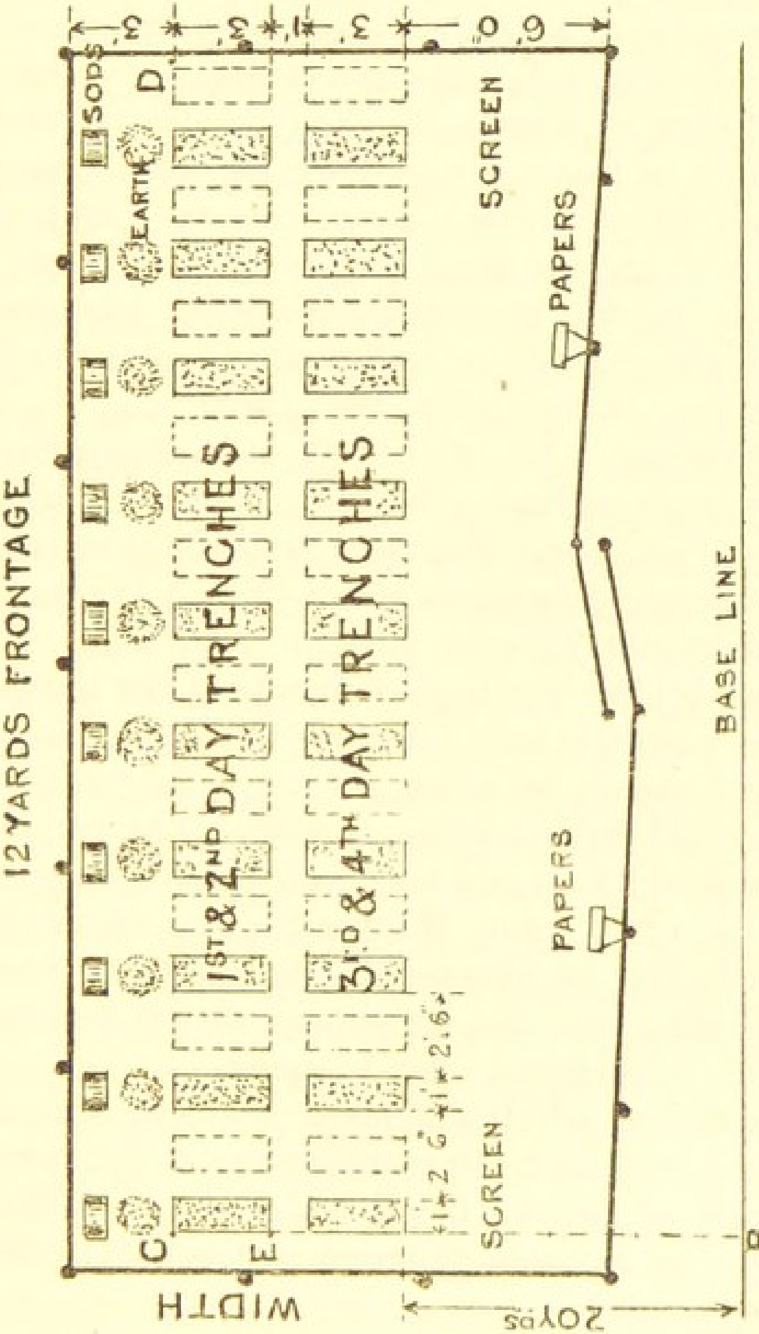

Fig. 12.—Diagram showing Arrangement of Shallow-Trench Latrines. The second and fourth day trenches are indicated by dotted lines. The dark line enclosing the trenching area represents the latrine screen.

each trench. The distance of this interspace is important, as, being limited, it makes the soldier use the trench properly, and it should not be used otherwise than in the straddle position—*i.e.*, with one foot on each side—and thus spillage of urine on the outside of the trench is avoided.

When the first row of trenches is filled with excreta to 6 inches from the surface it is closed in, and fresh trenches may be dug in the interspaces (indicated by dotted lines in Fig. 12), if ground is limited; otherwise it may be better to start a new row parallel to the first row and 1 foot in front. It will thus be noted that the first trenches will be farther away from the camp than the second row, and the third row farther away than the fourth, and so on, thus obviating the men having to walk over what might possibly be soiled ground, and carrying infection on their boots back to the camp.

Latrine Screens.—All latrines should be surrounded by canvas screens, at least 4 feet high. These are usually a Government issue, but when not supplied, they can be made out of empty commissariat oat-bags. The back of each screen should have its upright poles fixed in the ground 3 feet behind the latrine trenches, and the front of the screen placed at least 6 feet in front of the trenches. The entrance should be placed in a central position in front, and should have a 6-foot overlap. The length of screening required for 1,000 men on a 5 per cent. trench basis will be 130 yards. If twenty-five trenches are used, 70 yards will be necessary. As each new row of trenches is taken into use, the screen should be moved forward, so as to surround them properly.

In some cases an additional set of small screens may be constructed for use between the trenches for greater privacy, strips of canvas being nailed to uprights of wood, and erected between either single trenches or every two or three trenches.

Time the Trenches last.—As a rule for one day only. If space is limited and the trenches are not filled in one day, dig fewer. A trench can be made to last longer if the contents, which tend to get heaped up in the centre, are levelled down, and if the earth for covering is finely broken up.

Supervision.*—Considerable attention should be provided until the men become accustomed to use the trenches properly; they should not be used other than in the 'hunker' position—*i.e.*, straddlewise—thus preventing spillage of urine on the grass and soil at the sides of the trenches. The excreta should be covered at once by each man with some of the finely powdered soil taken from the back of each trench. Small general service shovels are best for this purpose, one being provided for every two trenches. If shovels are not available, grocers' scoops answer the purpose, or improvised articles, such as empty food tins, or scoops made of tins with wooden handles can be provided, but one per trench is required. An article of some sort should be provided, as pushing earth into the trench with the foot is undesirable and wasteful. It is found best to have these latrines properly controlled at all times by the sanitary police.

Latrine Paper should be supplied in bundles, wired at the corner to enable it to be hung inside the front screen; when used, the paper should be covered with earth to prevent its being blown about. Latrine paper can be purchased in boxes from which one sheet at a time can be delivered on the principle of telegram forms. This protects it from the weather and is economical.

Closing the Trenches.—This must be done carefully. The contents, which tend to get heaped up in the centre, are first levelled, and then they are closely packed with earth, which is hammered down as tightly as space permits. After closing, some litter, brushwood, or other dry substance should be burned over the surface to sterilize any spillage. The grass sods are now carefully replaced and firmly beaten down. The advantage of pre-

* *Vide* 'Sanitary Report, Eastern Command Manœuvres, 1909,' by Captain R. Tilbury Brown, R.A.M.C., *Journal R.A.M.C.*, vol. xiv., p. 333.

serving the large upper sod is now obvious. The covered trench is finally marked by some distinguishing mark to prevent accidents to horses, etc.

2. *The Deep-Trench System of Latrines.**

The 'deep-trench system' of latrines was formerly universally employed, but of recent years it has fallen into disuse, as being offensive and attracting flies. The system is not to be recommended, as the ground in front of the trenches, from their constant use, often becomes sodden with urine, and mud is thus carried back into camp on the men's boots. If infected by a typhoid carrier with bacilluria, this mud may cause an outbreak of enteric fever in the camp. Deep-trench latrines, *if adopted*, should be located, as regards their position to the camp, according to the rules laid down for shallow-trench latrines on p. 100. Accommodation should be provided on a scale of 5 per cent. of the troops, allowing 1 yard per man. When the camp is to be occupied for two or three days, the trenches are dug 4 feet deep and 2 feet wide ; for occupation of a week or ten days, the depth should be 6 feet and 1 foot wider. Some sort of seat or rest should be constructed for the men to sit upon ; a rail, pole, or iron pipe placed 18 inches above the ground, supported by forked posts at the ends, answers well; a back piece can be lashed on about 3 feet from the ground (see Fig. 13). The soil at the bottom of the trench before it is taken into use should be well loosened for the depth of 1 foot.

To ensure the trenches being kept in a sanitary condition, the men should be particularly instructed to throw some earth † over their dejecta before leaving the latrine,

* The 'deep-trench' system of latrines is described here as it is still mentioned in some of the Military Regulations.

† It should not be thought, however, that all sanitary requirements are complete if the contents of latrines are occasionally covered with a layer of sand or dry earth, which

for which purpose boxes of finely-powdered earth and scoops should be provided. Twice daily, an hour after breakfast and three hours after dinner, the bottom of each latrine should be covered by a 3-inch layer of finely pulverized dry earth. Sand is useless, as it has no nitrifying powers. It has been recommended also to spread the wood ashes from the cooking places about in the vicinity, particularly where men's feet rest within the enclosure. Lime is of very little use unless it is fresh, and fresh lime can hardly ever be obtained. The health and

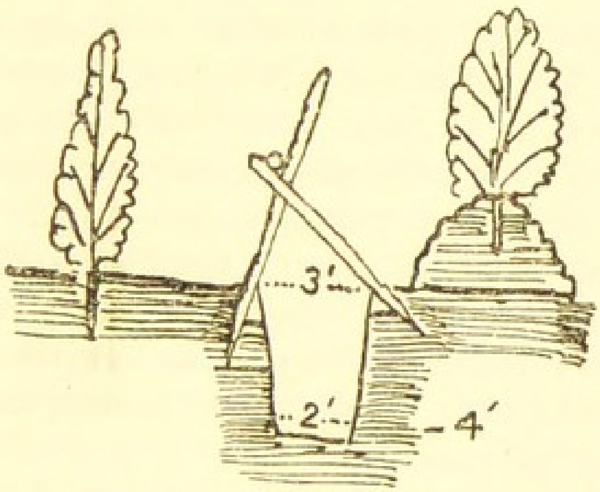

FIG. 13.—DIAGRAM OF A DEEP-TRENCH LATRINE.

comfort of everyone in camp depend upon the manner in which the latrine arrangements are carried out.

When the contents of the trench are within 2 feet of

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cannot be considered effectual when cholera, enteric fever, or dysentery is prevalent in the locality. Under such circumstances it is of paramount importance that all dejecta and night soil generally, as well as rubbish, should be destroyed by fire. Possibly small destructors could be designed sufficiently portable to accompany units; at any rate, each field ambulance might be provided with one for the disposal of the excreta of all infective intestinal cases, including diarrhœa cases, the latter being always dangerously suspicious in the field. Too much reliance should not be placed on the power of chemical disinfectants.

the surface, the trench should be closed and the earth well hammered in, a mound being left on the surface, so as clearly to mark the site. The greatest care should be taken to prevent pollution of the camp water supplies by these latrines, either directly by percolation or indirectly by surface water. Successive deep trenches cannot be made together. Lime should be freely used in front and rear as well as inside. The pole seat should be kept clean by scrubbing with hot water and soda or cresol solution.

In camps occupied for more than a single night a shallow drain should be dug on the higher side of the latrine to prevent surface water entering the trench. The latrine, if possible, should be sheltered with a light thatched roof to exclude rain. All latrine and urine trenches should be daily disinfected by burning in them a layer of dry litter, 3 or 4 inches thick. Where the ground is too rocky for deep trenching, shallow trenches must be made, and dry stable litter should be spread 4 or 5 inches thick at the bottom, so that the excreta will be deposited on top. This can be burned daily and the whole reduced to ashes.

3. *The Dry-Earth Removal System.*

In the case of standing camps, and also in camps of a more or less permanent nature used for manœuvres or training purposes, or in some cases even under war conditions, the dry-earth removal system may be adopted, the pails or buckets being cleaned and their contents removed by contractors* employed by the Army Service

* Contractors should be obliged to specify in their agreement:

1. The hours between which they will remove the refuse (usually 5 to 6 a.m. daily) so that supervision can be made possible.

2. The distance outside camp to which the refuse is to be moved.

3. Cookhouse waste food to be removed at stated times, and the receptacles not to be taken away.

Corps. In this system latrine seats are provided, and there should be two sets of buckets, to allow of replacement of those emptied nightly, so that they can be efficiently cleansed. In standing camps in India, when appliances such as buckets or earthenware pans are available, they should be invariably used, and will work well if half filled with water. Water will prevent paper blowing about, and will also keep down flies ; but if water is used, Crowley carts are necessary, and the fluid excreta must be trenched a mile or two from camp. When possible, all such buckets or earthenware utensils should stand on concrete or slabs of stone, to prevent soil pollution from urine, which, as we know, is one of the chief factors in the spread of enteric fever.

The following conditions should be strictly enforced whenever the dry-earth system is employed :

1. It is very advisable to maintain a double set of buckets and receptacles, the latter with tight-fitting covers, for each latrine, as this will allow of their being disinfected every day, a process which can easily be effected by burning in them some dry litter or dry grass over which a little oil has been poured. It is very necessary that some chemical disinfectant should be available for use in the latrines and urinals of standing camps. Probably an acidulated solution of fresh chlorinated lime (1½ per cent.) would be the best, since its cheapness, portability, and recognized powers as a deodorizer and disinfectant more than counterbalance the drawback arising from its disagreeable odour. A very little of this solution placed in the latrine and urine pans would prove a great deterrent to flies.

2. Removal should be daily, at dawn.* In India removal should be carried out during daylight.

3. When the buckets are removed, fresh clean ones,

* A small quantity of confetti, if thrown in the urine tubs at night, will often prove a useful aid to discover if it is 'dumped' in the immediate vicinity of camp.

each containing a little dry earth and lime, should be placed in position. The tops of the buckets should fit tight to the under-surface of the seats, the latter being provided with automatic falling tight-fitting lids, to exclude flies.

4. The earth should be *thoroughly* dry and fine, being sifted through a ½-inch-mesh sieve. The main supply of this earth should be kept in a covered shed to keep it dry.

5. Proper receptacles, such as boxes for the dry earth, with a scoop for each, should be provided beside each latrine seat.

6. The excreta should be removed, and either properly trenched or incinerated at least a mile away from the camp. If trenching is employed, the excreta must be covered with a layer of earth, and the surface disinfected by having a layer of dry litter 3 or 4 inches deep burned over it every day, after carefully filling in with earth when the contents are within 2 feet of the surface. This system of removal works well if *carefully* supervised, but is far inferior to the American army 'trough method,' in which milk of lime is utilized as a disinfectant, and which might with advantage be introduced into the larger standing camps. When field operations have to be carried out in a country with an Arctic winter, all excreta and garbage from a standing camp should be disposed of by cremation, because when a thaw sets in the nuisance caused by the exposed filth, which, from the frozen state of the ground, could not be covered at the beginning, would be appalling, as was demonstrated in Manchuria, and also amongst our own troops in Northern China

In wars on the frontier of India, as it is often impossible to exclude marauders from the vicinity of camp at night, and as it is dangerous for men to pass outside the perimeter to reach the day latrines, special night emergency latrines ought to be provided inside the lines. These must be on the removal system, and can be made from packing cases, with empty commissariat tins for receptacles, or stable litter and ashes may be spread 4 or 5 inches deep in a shallow trench or large box, that can be cleanly removed in the morning and thrown into the day latrines, which ought to be at least 100 yards outside the perimeter of the camp and to leeward.

In the Chitral Campaign of 1895 Surgeon-General Maunsell, Principal Medical Officer of the Field Force, reported that the trench system of latrines was adopted all along the lines of communication, and, with care, answered well. There was no difficulty regarding the disposal of excreta in the plains, trenches being established and attended to at proper distances everywhere; but in the hill stations it was impossible at first to carry out the 'removal' system, owing to want of a sufficient number of sweepers or of utensils. It was not desirable to have the trenches too near the men's tents, nor yet too far away, especially during dark nights in the rains, and yet some provision was necessary for men at night. After a time sweepers were obtained for the hill stations, and a 'removal' system was improvised by means of empty tins and boxes. At the Laram Kotal incinerators were used most successfully, one in No. 1 British Field Hospital for excreta and rubbish, and one in the King's Royal Rifle lines for the latter. In both the King's Royal Rifle and Bedfordshire lines at Laram Kotal the 'removal' system, with dry earth and disinfectants, was most carefully carried out.

Arrangements for Latrines when on the March.

To obviate soiling of public roads and other places when on the march with troops, arrangements should be made by company officers to detail men to dig a trench at each halt similar to that described under the 'shallow-trench system' (see p. 100). Before the troops move off, this trench should be covered in with clay and its sods replaced. Spades should be carried for this purpose in each company, and not in the waggons. The men should not be allowed to fall out until these latrines have been dug.

Army Regulations, etc., concerning Latrines.

The following instructions concerning latrines, as laid down in 'Field Service Regulations' and elsewhere, are important:*

'CAMPS AND BIVOUACS: ARRANGEMENTS AT THE END OF A MARCH.

'Where bodies of troops are camped or bivouacked close together, the general position of the latrines and kitchens of each area will be settled by superior authority in consultation with the senior medical officer—that is to say, it will be decided whether they are to be in front, at the rear, or on the flank of an area.

'**Sanitation in Camp and Bivouac.**—1. Latrines should be constructed to seat, if possible, 5 per cent. of the troops, 1 yard per man being allowed. The trenches must be narrow and deep, to prevent the contents being blown about (see "Manual of Military Engineering"). Where natives are employed, special latrines for them are necessary. The supervision of latrines is absolutely necessary in order to ensure excreta being at once covered up. Disease may be easily spread if latrines are not attended to.

'2. Urine may spread infection. Men are on no account to urinate elsewhere than in the latrine trenches, or in urinals or pits set apart for the purpose. Receptacles, such as empty biscuit tins, should be placed at convenient spots close to the tents at night, to be used as urinals, to prevent pollution of the ground.

'3. Latrines, urinals, refuse pits, cattle lines, etc., must be situated at least 100 yards from, and when practicable to leeward of, the water supply and kitchens. They must never be placed in or near gullies which, when it rains,

* *Vide* 'Field Service Regulations,' Part I., 1909, pp. 68, 71, 73, 87, 174, and 187.

discharge into the water supply, nor in any situation the drainage or filtration from which may possibly reach, and so pollute, the water supply.

'4. The contents of latrine trenches should be covered with earth as often as possible, and at least twice daily. For general use as disinfectants cresol solution and chloride of lime are the most efficacious. To use cresol mix 1½ ounces of cresol solution with 1 gallon of water.'

Standing Camps and Rest Camps.—Care should be taken to prevent the pollution by latrines or refuse pits of ground within 100 yards of the encampment, or any possible extension of it. An improvised pail system of removal should be established, if possible. Notice boards should be put up showing the position of latrines, urinals, refuse pits, etc.

Position of Latrines in Camp and on Outpost Duty (Bush Warfare).—The position of night latrines must be arranged in accordance with the requirements of the tactical situation, but whenever possible they should be outside the perimeter, under charge of sentries. Day latrines must be farther away, but within the line of pickets. All bodies of troops on *outpost* must observe the rules laid down for the sanitation of camps and bivouacs (see *ante*). Latrines and refuse pits must be prepared. The extent of the sanitary arrangements will depend on the time the outpost position is likely to be occupied.

The Preparation and Care of Latrines.*—'The duties of the personnel of the regimental sanitary detachment of each field unit, besides acting generally as sanitary police to prevent soil pollution, are in detail to supervise the preparation and care of latrines and urinals, including the filling in of the same and marking of old sites.'

* 'Field Service Regulations,' Part II., 1909, p. 95.

In the official 'Manual of Sanitation'* it is laid down that:

'The sites of the latrines and urinals are decided upon by the staff and medical officers when laying out the camp, but the principles upon which the choice is made should be known to all.

'They must be easily accessible, but not so near the tents as to make any smell perceptible to the occupants of the tents.

'They must not be placed where there is danger of contaminating any water supply.

'All latrines should be together.

'They should be filled in when their contents come to within 2 feet of the ground level.

'Their sites must be marked in such a way that no new troops occupying the camping ground can pitch tents on or near them.'

Directions for the construction of latrines are to be found in the 'Manual of Military Engineering':

'Immediately on the arrival of the troops in camp, the latrine trenches should be dug, in order to prevent the men fouling the ground on being dismissed.

'The latrines are made at a sufficient distance from, and, when practicable, to leeward of, tents to be inoffensive, but they must also be sufficiently near to make their use at night easy: 100 yards is the prescribed distance.

'It is obvious that the conservancy of the latrines is of the highest importance to the health of the troops.

'The latrines must be at a distance from the kitchens, to avoid the danger of flies passing from the latrines to the food. *Arrangements must be made to prevent excreta ever remaining uncovered with earth.* From daylight to

* 'Manual of Sanitation in its Application to Military Life.' Issued with Army Orders dated February 1, 1907, pp. 43, 44.

sunset a man should be posted in each latrine, to cover with earth all excreta without delay. These men should not be on duty for more than two hours at a time.

'Chloride of lime and quicklime mixed with water are most useful for keeping away flies and for disinfecting the excreta.

'It is most desirable that latrine paper should be supplied.

'Latrine accommodation is to be provided for 5 per cent. of troops in camp.'

Camp Urinals.

Urinals are often much more difficult to deal with in camps and bivouacs from a sanitary point of view than latrines, as, owing to the distance of the day urinals from where the men sleep, it is always necessary to provide a separate set close to the tents for night use.

Day Urinals.

For use in the day-time urine pits or trenches may be dug adjacent to the latrine trenches already described on pp. 99-105. Urine trenches, wherever possible, should, like latrine trenches, be dug to leeward on the outward flank of the camp, on a site not likely to be flooded by storm water from higher ground, well away from the drinking and other water supply of the camp, and, when space allows of it, at least 100 yards from the nearest occupied tent, cooking place, bakery, or slaughter ground. In a camp to be occupied for a few days the pits or trenches should be fairly shallow (3 feet deep), and the earth at the bottom well loosened. If the soil is sandy or absorbent, the urine soon disappears and all goes well; but if the soil is clayey, marl, or chalky, a urine-sodden quagmire may result. This will clog the men's boots and mud is carried back to camp. If infected by a typhoid carrier with bacilluria, an outbreak of enteric fever may result. In all cases exposed urine-sodden soil must be covered, until it is quite dry, with dry, clean earth, to keep down possible infection and smell, and protect it from flies. If the camp is to be occupied for a week or ten days, the trenches should be from 4 to 5 feet deep, since the use of shallow trenches will only result in a larger extent of surface pollution. All urine trenches or pits should be disinfected daily by burning in them a layer of dry grass, paper, or litter, and their conservancy must be supervised with the same amount of care as is necessary in the case of latrines. Lime, if available, may also

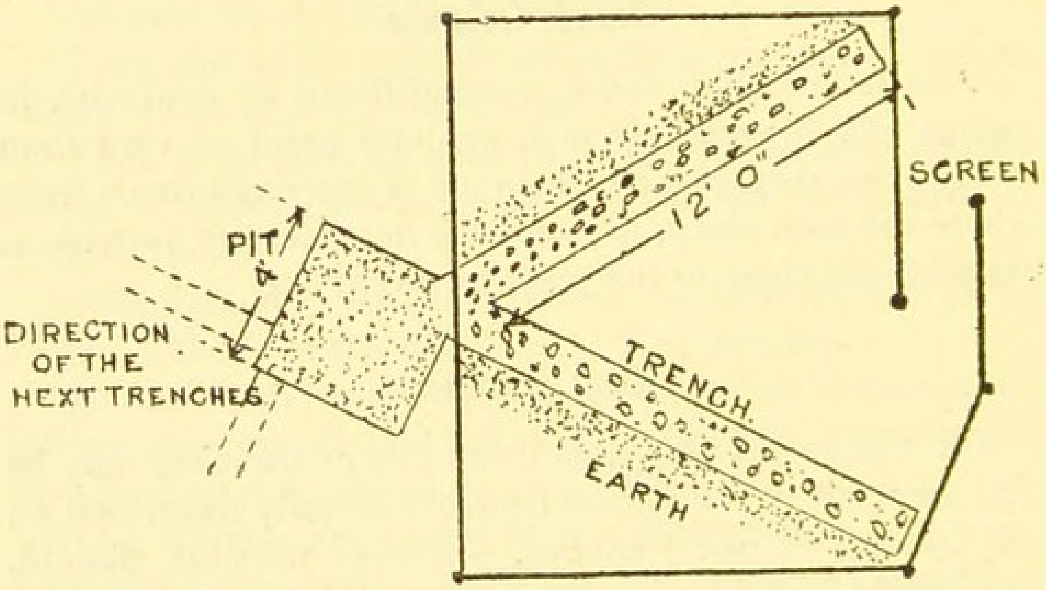

FIG. 14.—DIAGRAM OF PLAN FOR URINE TRENCHES.

be used freely for disinfection purposes, as urine is just as liable to contain disease germs as solid excreta. If the ground in front of both urine and latrine trenches gets sodden, gravel, dry earth, or ashes, should be obtained, and some laid down at intervals during the day in front of the trenches. Captain Tilbury Brown, R.A.M.C., made trials at manœuvres in England of a system of shallow urine trenches, leading into pits filled with coarse earth. A pit to take the excess of urine, 4 feet square and 4 feet deep, was dug; this was refilled loosely with the coarsest earth available for 2 feet.

From this pit two shallow trenches, or 'arms,' 2 feet wide, 12 feet long, and with a fall of 1 inch for every foot of length towards the pit, were dug. The trenches were intended for urinating purposes, and were filled with lumps of coarse earth or chalk, and, when foul, they were filled in and others were constructed.

It is important that the arms are fully 2 feet wide, and it helps to deodorize the ground if the sanitary man in charge sprinkles earth on the ground between the 'arms' every morning when the troops leave camp, and sweeps it into the pit before they return; ashes may also be used for this purpose.

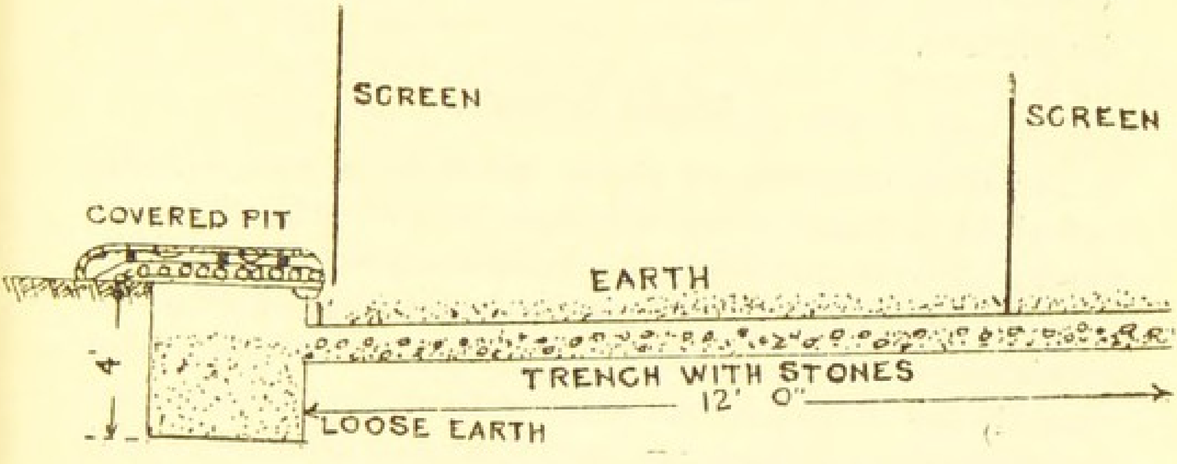

FIG. 15.—DIAGRAM (SECTIONAL VIEW) OF URINE TRENCHES.

If urine stands in the pit owing to slow soakage, more earth must be put in until no urine shows. If chalk is used for putting into the 'arms,' large lumps should be used; but it is not as good as stones, which should be used if procurable.

A little fresh earth should be added daily, or oftener if urine collects in the pit. Small detachments and N.C.O.'s will only require a small pit and a single 'arm.'

New trenches were dug as required, the old ones being filled in and new ones dug, radiating from the central pit, which was untouched, as it usually lasted for some fourteen days. The urine trenches in use were surrounded by a screen, which moved as new trenches were dug, the entrance opening being so placed as to allow the men to enter between the trenches in actual use. The central pit may be covered with boards or brushwood and earth, to prevent the men using it. The sods from the trenches, after being carefully removed with any spare soil, should be heaped up round the central pit, the former to be replaced carefully afterwards, when the trenches are filled in. This method has been found preferable to the usual open pits ; surrounding ground is much less fouled, and many men can use the trenches at the same time. If properly constructed and looked after, smell and flies should not be present.

Night Urinals.

Arrangements should always be made for the provision of night urinals—either trenches, pits, or tubs—in every camp close to the lines where the troops sleep, and men should be punished if they are found urinating outside their tents or otherwise fouling the ground. Night urinals are always essential, but more difficult and troublesome to deal with and keep sanitary than day urinals in camp, as men are unwilling and often unable to find the day urinals in the dark. They must be located in a position easy of access, only a short distance from where the men sleep, and easily found in the dark. Their position should be indicated either by a lantern on a pole, a white post, or by a path marked out by white or whitewashed stones, to enable the soldier to find his way thither in the dark. Captain Tilbury Brown recommends wooden tubs for night urinals, placed along the streets (not in the lines) and flanks of the camp. By the side of these lights were hung up at night on whitewashed poles. Wooden trays, filled with sand, are used to act as stands for the tubs. At least four such tubs should be placed close to the canteen. The tubs are to be emptied at 10 p.m. and réveillé daily into a special urine soakage pit—4 feet by 4 feet by 4 feet—which has been refilled for 3 feet with loose earth, and a little fresh earth should be added daily. During the day-time the tubs should be either inverted or filled with water. During field operations, when tubs are not available, small shallow urine trenches may be dug each night, one for each half battalion, a light placed by each, and the trenches filled in next morning. Colonel R. H. Firth, R.A.M.C., recommends (when urine tubs cannot be provided, and when the day urine pits are at a distance from the men's tents), the digging of shallow urine pits near the men's lines, but he says that this practice should be resorted to as rarely as possible, and that it must be zealously safeguarded against abuse, and at all times such pits should be carefully filled in at dawn. Lieut.-Colonel H. S. McGill, R.A.M.C., recommends that night urinals should be located in the space between the perimeter of the camp and the outer line of tents on the side opposite to the cooking places, their position being marked by a lamp or a white post. He suggests the use of receptacles, such as empty kerosene-oil tins, these being placed in position at nightfall and removed at réveillé, when the sites on which they were located should be cleaned, and disinfected with burning litter or a strong solution of chlorinated lime. In temporary camps, when receptacles are not available, he recommends that a few broad shallow trenches should be dug, these being filled with 3 or 4 inches of dry litter, or, better still, wood ashes, this being removed and buried after dawn, and the trenches disinfected. During the South African War the writer had a 3-foot circular pit dug at each corner of the regimental bivouacs, with a pile of stones erected beside each for a landmark, and a line of large stones as a guide to its position from the nearest place occupied by the men, white stones (quartz) being used when available, and a lantern placed on the pile of stones when lights were permissible. The pits were sprinkled with earth each morning to keep away flies, and were filled in when fouled, and fresh pits dug. In standing camps empty beer barrels were obtained from the canteen and sawn in half, forming tubs. These were removed in the morning, and, after cleansing, were treated with strong disinfectants. In standing camps urinary receptacles are an absolute necessity, and must be provided.

'Dry' Urinals.*

If permanent urinals are not available, 'dry' urinals are very suitable for standing camps, etc. It may be noted that earth, sand, peat, sawdust, charcoal, all exercise a purifying influence on urine if the latter is allowed to filter slowly through. A small barrel filled with peat used as a urinal will be perfectly free from offensive odour, if used by a limited number of people, for over a year. For the use of a community such urinals should be under cover to prevent access of rain, and made of corrugated zinc such as is used for roofing the trough being triangular in section, 3 feet 6 inches wide above, and 2 feet 4 inches wide below. If a board be provided as a central screen placed vertically along the centre, the urinal can be used from either side. The lower part of the trough may be perforated at its most dependent end, and a gutter attached to allow of surplus urine being run off to a urine pit. If such a trough be in constant use, the purifying material (sawdust, etc.) should be turned over and stirred occasionally. If this be systematically done there will be no smell, and the sawdust can be used for a long period. A reserve supply of sawdust should be provided to replenish that used up, when the latter may be dried and used again if the supply is limited. The sawdust after use, if well mixed with soil, has a good manurial value for growing sugar or

* The late Dr. Vivian Poore was the first to advocate these urinals.

maize in India, where it is applied at the rate of 8 tons to the acre.

The Disposal of Waste Water.

There is considerable waste of water in a standing camp. The present basin for washing holds much more water than is necessary, and it is suggested that one means of reducing waste of water would be to diminish the *depth* of the basins. It is a common practice among the men to place a basin under a tap and let it stand there after it is filled, the water running over, thus causing wastage.

Other means of diminishing the waste of water are—

1. Placing the taps away from the benches.
2. Allowing benches to be used only at certain hours.
3. Policing the benches.

At most standing camps there is great difficulty in disposing of waste water. This may be overcome in the following ways: (1) A main 4-inch iron drain is laid in rear of the camping ground. This drain is closed at the upper end, and empties at the other end into a pit. Each unit is also supplied with a large connecting pit for the waste water. A pulsometer steam pump, drawn by horses, is taken along the rear of the camp, and a short hose from it is dropped into the collecting pit of each unit which requires emptying. A fatigue party connects up the pump to the nearest junction on the main drain by means of a long hose, and the waste water in the collecting pit is pumped out and forced along the drain into the pit. The large pit rapidly absorbs the soapy water, from which there should never be any offensive odour. (2) At other times the ablution benches may be connected up by surface channels with a common pit, from which the water is pumped by hand on to the surface of ploughed fields, etc., being distributed over different areas of the field day by day.

When this method of disposal of waste water is employed, the following points require attention :

1. The trenches and pit should be dug by fatigue parties of units, under supervision of the Royal Engineers, who mark the site, in order to obtain the best gradient for the trenches and calculate the required size of the pit. The surface channels must be as small and narrow as possible, in order to obtain the best flushing, and are covered in by the Royal Engineers where traffic over them is necessary.

2. As there is always a certain amount of spillage about the pump, a platform on which to stand and work it should be constructed by the Royal Engineers. The pump should be securely fixed to the platform, for if this is not done there is difficulty in working the pump, and the surrounding ground becomes a quagmire, especially in wet weather.

The Disposal of Refuse.

Sometimes sufficient attention is not paid to the necessity of keeping the surface of a camp and its vicinity absolutely clean and free from refuse. All rubbish must be collected daily by fatigue parties in each unit's camp, and carried outside the perimeter by a fixed hour. As a rule, everything burnable should be destroyed by fire, and whatever cannot be dealt with in this way should be buried in pits 9 feet diameter by 2 feet deep. One of the first rules of camp conservancy is that no trenches or pits for filth or rubbish are to be allowed *inside* the perimeter of a camp, and that, for the purposes of general camp sanitation, fatigue parties should be placed at the disposal of the Provost Marshal or else the chief sanitary officer. When necessarily contracted camps are occupied by mounted troops, the horses should be picketed outside the perimeter by day, so that their night picketing lines within the perimeter may be well cleaned out and aired, and surface fouling reduced to a minimum. In all standing camps incinerators should be used; they were tried in all the large standing camps in the South African War with marked success. In temporary camps all rubbish should be swept into heaps, and burned or buried as soon as the camp has been struck. In stationary camps the tent floors, spaces between tents, and the camp streets should be swept daily.

All light rubbish, paper, fragments of food, etc., should be collected in empty sacks,* barrels, or boxes with movable lids, placed at the end of each row of tents to prevent any of it being blown about, removed and burnt or buried on a selected site well away from the camp. The site of the pits for such burial must be as carefully chosen as that for latrines and urinals. Care must be taken to see that the site selected for burying refuse does not endanger the water supply.

Earth and chloride of lime, or quicklime if procurable, should be used to cover the refuse in the pits daily.

A considerable amount of dry rubbish and litter can be usefully disposed of by burning it in the latrine and urine trenches, and over soiled areas of ground, and so utilizing it as a disinfectant. Though litter and dry rubbish may be safely disposed of by burial in deep pits, the method is not to be recommended for refuse in general, which should always be burned. A convenient and effective method for disposing of refuse is referred to on p. 135.

All litter and refuse must be disposed of *daily*, to obviate the attraction and breeding of flies. On no account should litter or refuse be spread out on the ground to desiccate under the influence of the sun and air, as a nuisance will certainly be caused; flies will be

* In camp equipment there are no temporary receptacles provided for tent refuse. They must be improvised from biscuit boxes, etc., placed near the tents, and emptied daily into the camp rubbish pit.

attracted, and there is a great risk of food and water becoming contaminated. All garbage and offal should be removed daily from kitchens and slaughtering places, and burned at some distance from the camp. The environs of the camp for a radius of 100 yards should be kept free from all avoidable pollution. Slaughtering places and other soiled areas of ground should be daily disinfected by burning litter over them. In stationary camps a Horsfall's movable destructor might be employed for the destruction of refuse, when fuel is easily obtainable.

The following methods may also be recommended:

1. High cylindrical incinerator, built of sods, with air inlets at base. This is a most efficient method, and is most suitable when the soil is turf; it burns away if it is peaty.

2. Low cylindrical incinerator, built as (1). Good, but (1) is preferable.

3. Pit with central cone of stones. Very efficient and quickly built. Suitable when stones are available.

4. Horseshoe-shaped mound of earth. This is found particularly suitable when the earth is peaty and is loose and crumbly, and also when stones are not available.

The above means for incineration are all satisfactory, and, in the case of pattern (1), when once the fire is lighted it keeps going for weeks, the residual ash in the incinerator being very small. Pattern (4) leaves more residual ash, and in (2) and (3) the destruction is not so complete, and the residue may require to be buried in pits.

Waste Food.—Collect in wooden tubs.

A good and cleanly arrangement is to supply a light wooden pedestal for these tubs to stand upon.

The garbage is removed by contractors at manœuvre camps.

When removal is inefficient, refuse can be readily burnt, especially in incinerator (1).

Empty food tins should all be burnt before being placed in a heap for removal by contractor or burying.

Kitchen (Greasy) Water.*—All water should be strained and run into soakage pits. The following methods are good and easily improvised :

1. Two large biscuit tins are taken, the upper one (which is perforated by holes in the bottom) acts as a coarse strainer, and, when required, is emptied into a refuse tub ; the lower tin has one hole above the bottom, an inverted **V**-shaped piece of tin being cut and folded to form a directing spout to water to make it flow into a small pit, which acts as a grease trap, and is filled with furze (dried grass, heather, hay, etc., can be used), which is burnt and renewed daily. A narrow and shallow trench runs from this small pit into the large soakage pit.

2. A box turned upside down over the grease trap (pit) ; a hole is cut in its bottom, and a colander or perforated tin can is fitted into the aperture.

3. A grating placed over the soakage pit, on which furze or other straining material is placed. Not so efficient or cleanly as (1) or (2).

4. A small pit is dug, and some furze or straw is placed in it to act as a grease trap ; this is drained into a soakage pit.

Baths.

The importance of the personal cleanliness of the soldier should not be lost sight of when he is in camp.

At every bathing tent a N.C.O. should be always on duty, who, besides seeing to the supply of sufficient hot water, should keep a book, in which is entered the name and company of the bather, a check being thus kept on the non-bathers.

* The methods here described are of a more or less improvised nature, and are suitable for temporary camps. For a standing camp the method described on p. 128 is much preferable.

The following methods may be employed :

1. **Under Cover.**—(*a*) A marquee divided into ten compartments by canvas screens, each compartment containing a seat, a foot-grating, and a tin bath. The bath has a wooden plug, which opens over a trough made of strips of galvanized iron. Each compartment has a door made of a strip of canvas, which can be rolled up when not in use.

(*b*) A temporary hut, made of tarpaulin sheets or canvas stretched over wood. It should contain a pair of long seats, foot-gratings, and baths (metal), which can be tipped into a drain. It also has a separate compartment for sergeants.

(*c*) Circular tents, containing iron tubs, which can be emptied into a pit in the tent. A drain leads from this small pit to a soakage pit.

2. **In the Open.**—(*a*) Compartments, with three sides, made of canvas, each containing a seat, foot-grating, and a bath.

(*b*) No compartments. Men have tin baths in the enclosed space by the ablution benches. This method is not so satisfactory as (*a*). The hot water for the baths may be obtained from portable stoves, which hold 100 gallons of water.

When a man wishes to draw a bucketful of hot water, he should replace it by putting a bucketful of cold water into the boiler. In this way a supply of hot water is maintained.

Bathing Places.

Good bathing places in rivers, etc., should be selected and marked off, as they are greatly appreciated by the troops. It is occasionally found that the police at the bathing pool may be unable to swim. Care should be taken to avoid this, and it is always well that the bathing picket should consist of at least two men, both good swimmers.

The Drying of Wet Clothing.

This is generally done on the heather, gorse, or trees about the camp.

Some regiments have posts and ropes in regular drying grounds. This is always an improvement.

A marquee for drying clothes is always necessary for manœuvres, if it can be arranged for. It should be fitted with posts and ropes, and have charcoal braziers on the ground. Tins or buckets with holes do for braziers. In a marquee the wet clothing of two companies can be dried in two hours.

Disposal of Dead Animals.

Places will be selected where all transport animals that die should be buried. In some countries it is better to drag out dead animals a mile or two to leeward of the camp, cut them open there, and trust to their being eaten by vultures, dogs, etc. In the Chitral Campaign of 1895 the disposal of dead camels caused considerable difficulty, as wood and kerosene oil were not available.

THE CONSERVANCY OF STANDING CAMPS.

In standing camps provision has to be made for a prolonged occupation of the site, and the men may possibly be housed in huts. The ground underneath huts that are raised on plinths must be kept clean. As contrasted with temporary camps, standing camps may be expected to provide a higher standard of comfort for the men.

A water-supply system will be established, and the water laid on in pipes from specially bored or dug wells, or other suitable sources of supply.

Arrangements for disposal of refuse and excreta will be organized, and a system of earth closets may be used. Such closets should be provided with a concrete surface under the pails; otherwise the pail system is bad, as the ground becomes foul (as occurred at Bloemfontein during the South African War), and may give rise to epidemic disease.

The ground around ashbins and other places to which refuse is taken should be cemented or hardened to prevent soakage of foul matter into the soil around.

All refuse should be removed immediately from the vicinity of inhabited huts, tents, etc.

Kitchens, ablution rooms, latrines, and urinals will be covered, wooden huts being probably provided for the purpose.

If the troops are in tents, wooden floors should be provided, if available. Tent floors must be taken up frequently and the ground underneath exposed to the air.

Surface drains and roads will be constructed.

Field ovens will be set up and bread baked.

In standing camps particular care is necessary to avoid the fouling of the surface, for the longer camps are occupied, the more are disease germs likely to gain admission and develop in them. When this occurs, it is not easy to control their spread. The men are necessarily more closely together in camps than in barracks, and this fact in itself favours the communication of disease from one to another.

Much may be done towards the prevention of disease by the occupants of the camp assisting in every way they can those whose duty it is to supervise sanitation.

Refuse receptacles and destructors should be improvised, unless otherwise supplied.

Sullage Water.

The disposal of slop water is always an important factor in camp sanitation.

A good grease trap may be improvised by a basket with a wisp of straw in it. The straw can be changed as often as necessary, and burnt. Such a trap arrests all but the finest particles, and does its work efficiently and without offence. The basket should be placed over an old galvanized bucket, with an outlet in the bottom, and filled with broken clinkers, stones, or slate, varying in size from peas at the bottom to walnuts at the top. This filter causes further purification of the slops, partly by

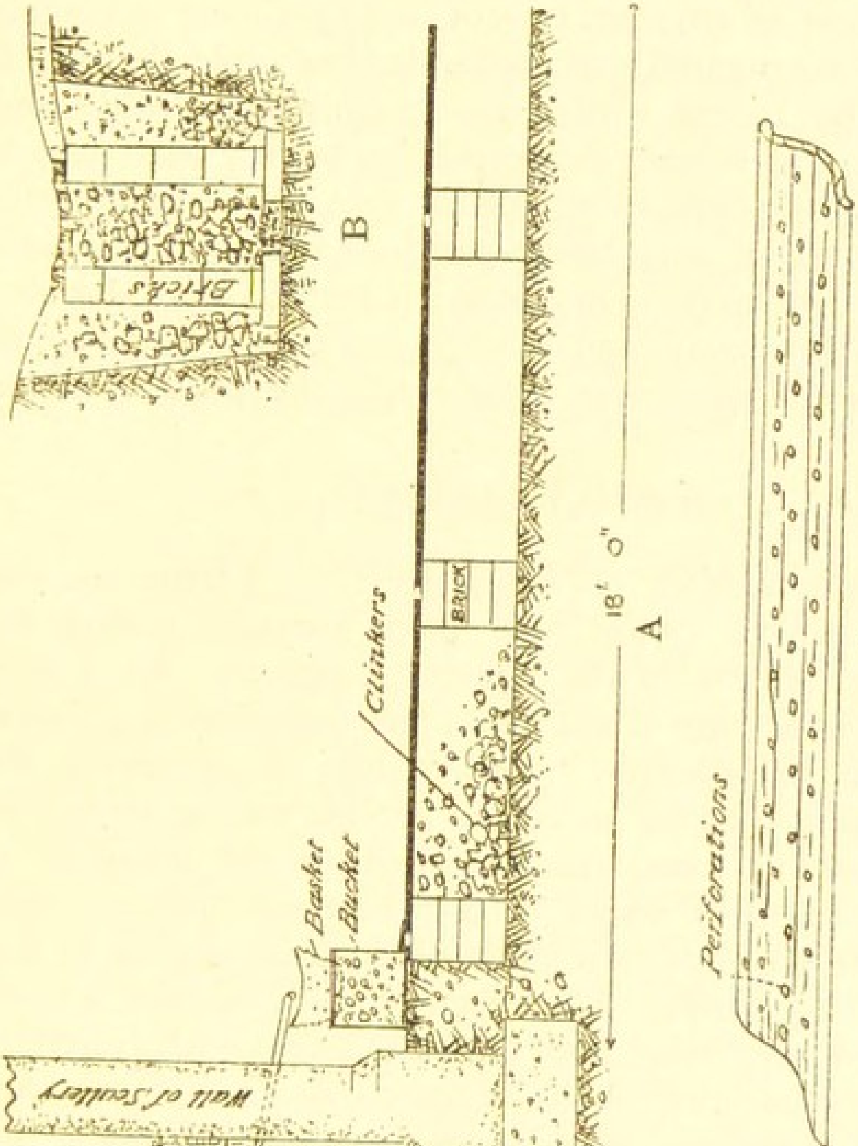

FIG. 16.—METHOD OF DISPOSING OF SULLAGE WATER IN A STANDING CAMP.
A, Plan; B, section; C, sheet of corrugated zinc (perforated).

mechanical straining, and partly by the aerobic growth and action of bacteria on the surface of the broken clinkers. In a standing camp where there are no drains, a filtration gutter or trench can be constructed to carry away the slop water after it has passed through the filter just described. A trench 18 inches wide, 18 inches deep, and 24 feet long, is dug, with a fall of 1 in 6 from the kitchen, so that the sullage cannot flow back towards the floor of the cookhouse. This trench is filled with loose stone or clinkers, and it should be made to terminate at the roots of an adjacent tree, or in a shrubbery or plantation. If corrugated zinc roofing is obtainable, the trench should be roofed with pieces of this 2 feet wide and in lengths of 6 feet, supported on bricks, each length being slightly bent from side to side, the depressions in the corrugated zinc being perforated with small holes made with a nail. This filtration gutter allows the slop water to flow away, and it stops back dead leaves, etc., which would otherwise soon choke the porosity of the drain.

CAMPS AT MANŒUVRES.

A large number of Army Reserve, Territorial, and other training camps, are held annually during the summer months in the United Kingdom. As a rule, their general state of sanitation and conservancy arrangements is satisfactory. The custom of occupying the same camp sites for prolonged periods during successive years has in many instances led to the provision of certain engineer works of a permanent nature, which place these camps on a footing somewhat similar to that of standing camps. These items chiefly include a piped water supply, wood and iron buildings, with concreted floors, for use as kitchens, washhouses, and latrines, and, to a limited extent, roads in and around the camp areas.

In order to avoid the occupation of insanitary sites, the principle of inspecting each camping ground before occupation is very necessary. Such inspection should include a general survey of the sanitary condition of the proposed camp area, together with a careful examination, including analysis, of the water supplies.

The principal difficulty in the sanitary administration of camps is generally connected with the methods for the collection and removal of camp refuse, liquid wash material, and night soil. A variety of carts are supplied by local contractors under arrangements made by the Army Service Corps; but without actually using military vehicles, it is always difficult to insist on properly constructed sanitary ones being supplied for the purpose.

At manœuvre camps the Royal Army Medical Corps personnel, besides looking after the sick, are employed in supervising the general sanitary arrangements and performing the more specialized work connected with the supply of sterilized drinking water for the troops, while regimental men carry out the lesser technical duties connected with the conservancy arrangements of their units.

The Camp Kitchen.

Cooking places should be located on the opposite flank of the camp to where the latrines and urinals are placed. Under no circumstances should any cooking place be within 100 yards of the nearest latrine, urinal, place of slaughter or refuse disposal, as the farther it is away from such areas, the less will be the danger of food contamination by smell and flies.

Cooking places should be marked out as soon as possible, and all grass round such places should be cut to prevent accidents by fire. Each company should have its own kitchen in rear and in line with its own row of tents. The easiest way to make a field kitchen is to dig a trench in the direction the wind is blowing. This trench should be of such a width that a pot or kettle when placed on it should not rest for more than an inch on each side. When Flanders kettles are to be used, the width of the trench should be 9 inches and the depth should be 12 inches at the end from which the draught enters; the depth should decrease gradually to 3 inches towards the opposite end to save fuel, and a space should be left here of about 9 inches wide to serve as a chimney.

Each company of infantry will require two such trenches, each 10 feet long. The kettles are placed on short pieces of hoop-iron so that they touch one another, and the chinks between them filled up with sods or mud, so as to make a regular place for each into which they will fit exactly, so as to hinder the draught escaping and to make a fire. The fuel is placed in the broad end of the trench, and should not extend beyond the first 3 or 4 feet of it. The chimney can be made of stones, sods, and mud, and should be 2 feet high; it should be at the end farthest from the fire. The kettles should be changed about as often as necessary to hinder the contents of one being cooked more than another. Should the wind change, similar trenches can be cut and the same chimney used. When one trench is in use, all the others belonging to the common chimney should be blocked with sods, otherwise the draught will not act.

All cookhouses and their vicinities require special attention. Scrupulous cleanliness must be observed; neither kitchen refuse nor sullage water is to be thrown upon the ground. The former should be collected in buckets, and burned or buried outside the camp perimeter daily. Kitchen refuse readily decomposes, and invariably attracts flies. The washings of pots, etc., are greasy, apt to decompose and become offensive. The best method of disposing of this kitchen water is to throw it into a soak pit prepared in the following manner: The pit is filled with stones and gravel, and covered with brushwood, dried grass, straw, etc. The latter act as strainers and retain the grease. The brushwood, etc., should be renewed daily, the old material being burnt in the kitchen fires. Special attention should be directed to the means and methods of storing food preparatory to cooking, and also to the proper cleansing of the cooking utensils. All refuse from cooking places should be thrown into a special filth pit, dug to leeward of the camp and well outside it; such pits should be closed with earth well trampled down every two or three days, and new ones dug. Only tins, cans, and things that cannot be destroyed by fire are to be put into this pit, as all refuse that will burn should be burnt. For standing camps, both on service and in time of peace, nothing short of complete removal of all refuse, cookhouse and otherwise, can be expected to give proper results; so, in order to bring about this, no cookhouses should be allowed inside the perimeter of a camp save those which are provided with receptacles for the removal of all solid or liquid refuse, which must be collected and removed, at least twice daily to the filth trenches. The sanitary officer of each division should indicate to Brigade-Majors the spot where these filth trenches are to be located; he will select the sites with due regard to the prevailing wind, as they should be to leeward of the camp, and all refuse that cannot be burnt is to be buried. To avoid pollution of ground outside the perimeter of a camp, nothing insanitary is to be buried within the limits or within 100 yards of the boundary on ground that may possibly be used for extending the encampment, as space must be reserved for extension if required on sanitary grounds.

A field kitchen for a small party may be made by digging a shallow trench in the direction of the wind. To contain the fuel, small pieces of iron may be placed crosswise over the top to support the camp kettles. Another simple arrangement is to place some kettles in two parallel rows about 9 inches apart, handles outwards; block the leeward end of the trench so formed by another kettle; lay the fire between the two rows of kettles, and place another row of kettles overhead, resting on those forming parallel rows. For standing camps covered kitchens are usually employed.

The Ablution Place.

In manœuvre camps ablution benches are provided, but even when foot gratings are used, the ground round nearly always becomes wet and muddy. Much, however, depends on the slope of the ground. The V-shaped bench has the advantages of cleanliness and self-draining, but when emptying a basin, the water is very prone to splash over the farther side and wet the man opposite. An upright plank over the V will, however, obviate this. The square box at the bottom of the overflow should be wide to prevent the water splashing out and fouling the ground.

Water must not be thrown out on the surface. An ablution place must be formed, and all washing done there; the sloppy water conveyed into pits, or otherwise removed to prevent fouling of the surface in the vicinity. A soakage pit should be dug 6 feet square and 6 feet deep. Lead a shallow surface drain to this pit from the ablution place. If possible, the water may be pumped out from this pit by the Royal Engineers daily and removed.

THE DISPOSAL OF HORSE LITTER.

In every campaign a matter of considerable sanitary importance, and often of difficulty, has been the efficient disposal of horse and other animal litter. In the Chitral Campaign of 1895 Surgeon-General Maunsell, Principal Medical Officer of the Field Force, reports that 'The chief sanitary want at first felt was a good conservancy establishment for the posts, especially for the transport lines; also a sanitary or coolie corps, who would remove and bury dead animals, take away, rake out, and burn litter, rubbish, etc. The great difficulty was with the transport lines, owing to the immense number of transport animals with the force (some 28,000 in all), and all of which had at first to be kept within the entrenchments at the various posts for safety. The mule drivers, having much to attend to besides, could not well be asked to more than remove the litter in tarpaulins to certain established places for locating the same, and there try to burn it. Their endeavours, however, were not quite successful, as unless each day's litter is carefully raked out, so that it may dry quickly, it will not burn easily, and will accumulate. Conservancy sweepers were asked for, but until they arrived the best that could be done was to obtain sweepers from the field hospitals and corps units, when they could be spared, and set them to work at the most important points. The services of the Kahars, too, were utilized to cut down and burn undergrowth. After posts were got into fair sanitary order, it was found very difficult to maintain them so, even after they had received their full conservancy establishment, owing to the number of transport animals perpetually passing through them to and from the front. The attendants with these animals—especially the hired camel drivers—were a hopeless class to deal with, and allowed their beasts to wander about grazing anywhere and everywhere during the time they were at each post, and it was found simply impossible to supervise such a mass of densely ignorant people.'

The 'Indian Method' of Disposing of Horse and Other Litter.

In a convenient place an earthen parapet, shaped like a horseshoe, is thrown up, 2 feet high. The litter is brought in by the entrance on donkeys, in bags, etc. Sweepers with forks spread it out inside to dry. Thereafter it is gradually thrown over the parapet all round, and set fire to, from the outside.

Practically the fire never goes out. Ashes accumulate, and the outer ring rises, whilst the interior slope also increases. Three sweepers can work a kiln 120 feet by 105 feet, and this has been found enough for 2,000 animals, and lasts for several months. As the sweepers work all day, it saves labour to use one large kiln, instead of two small ones.

SANITARY RULES TO BE OBSERVED ON STRIKING CAMP.

It is of the utmost importance to remember that *the responsibility of a unit leaving its camping ground* does not cease until the ground is thoroughly cleaned up, all rubbish gathered and burnt, all latrines and urinals closed in, and the ground left in a fit sanitary condition for reoccupation. It was from want of due attention to this important sanitary detail that enteric fever broke out amongst our mobile and other columns in the later phases of the South African War, when the disease was reduced in standing camps due to precautions undertaken. Movable columns had to occupy and reoccupy camps that had been left in a most polluted condition by their predecessors, and the result was disastrous. When a regiment moves out of camp, the Officer Commanding should leave a competent officer with the baggage guard to see that the sanitary squad and other fatigue parties which have been detailed for cleaning purposes do their work, and the ground should be well inspected to see that this has been done. A regimental quartermaster has not time for such work ; his chief duty is to look after the baggage and food, and it is quite unfair to add this important finale of camp sanitation on to his already arduous duties. As a general rule, the majority of the latrine trenches and urine pits should be filled in and properly closed before the 'Dress' bugle is sounded, some fifteen minutes before the 'Fall in' for the troops to leave bivouac or camp. If necessary, however, a fatigue party for this purpose may be left behind to come up with the line of march later, or join the rear or baggage guard.

GRAVEYARDS AND THE BURIAL OF THE DEAD ON ACTIVE SERVICE.

Graveyards should always be located well to leeward of camps or other places occupied by troops. The chief dangers that graveyards may give rise to are contamination of water supplies by subsoil infection, and pollution of the air by the effusion of obnoxious gases from the ground. Under civilian conditions the opinion of the medical advisers of the English Government, according to a memorandum of 1888, was that a distance of 200 yards is sufficient to prevent any injury to health as regards noxious matter transmitted through the air from a well-kept cemetery. On active service graveyards should never be in view of hospitals, whence funerals should not attract attention. Burials, for this reason, should take place at or before daybreak, if possible; all graves should be dug at least 6 feet deep. During the Russo-Japanese War in Manchuria the disposal of the dead after actions was carried out in a very systematic manner by the Japanese, both by cremation and by burying, without removing the clothing. In the former case twelve bodies were placed on a pyre, and 15 gallons of refined kerosene oil were poured over them, and the pyre lighted.

INFECTIOUS DISEASES OCCURRING IN CAMPS.

An infectious disease is one due to a micro-organism capable of being transmitted from diseased to healthy man, each fresh case being traceable to a previous case of the same disease.

Before occupation of any area for camping purposes, inquiry should be made by the sanitary officers concerned as to the presence of infectious diseases amongst the inhabitants in the vicinity of the camp, and arrangements should always be made and notified to the various medical officers of units of the means of treating and the disposal of cases of infectious diseases that may occur during the occupation of the camp. At manœuvres the local medical officer of health will supply any information available. On active service and abroad the more important infectious diseases which occur amongst the troops, in order of frequency, are enteric fever, dysentery, and cholera. Enteric fever may be considered the scourge of all armies in the field, affecting not only mobile columns, but also troops in standing camps.

Enteric Fever.—When a case of enteric fever occurs, the patient should be immediately isolated; his tent, complete kit (clothing, etc.), bedding (blankets, etc.), and feeding utensils, should all be thoroughly disinfected. All other men sleeping in the tent occupied by the patient before his removal to hospital should likewise have their kits and bedding disinfected, and they should be segregated and examined daily for a fortnight afterwards, in order to detect any possible infection. Special attention should also be paid to the sanitation of the camp area—latrines, urinals, refuse trenches—and extra care taken to protect all food and water supplies from contamination.

Dysentery.—When a case of dysentery occurs, it should be dealt with in the same way, as regards isolation and disinfection, as enteric fever, but contacts need not be segregated. Dysentery is rare under peace conditions, but common and very important in war. Every case of diarrhœa on service must be looked on potentially as one of dysentery.

Cholera.—When cholera occurs in camp, the patient must be isolated at once, and all contacts segregated for at least ten days. The infected tent, kits, etc., must be thoroughly disinfected. All cases of diarrhœa in camp should be sent to hospital for observation and treatment. Strict attention should be paid to the protection from contamination of all food and water supplies and to general sanitation. Cholera is chiefly caused and spread by something that is drunk—*e.g.*, drinking water, milk, raw vegetables—or vessels washed in contaminated water. If there is an epidemic, and water is suspected, the best prophylaxis is to stop using it, strike camp, and clear out at once. The moral effect of this is good for the troops, as an outbreak of cholera has a terrifying influence on all concerned. The scientific point is that all connection with the polluted water is severed. No utensil formerly used must be again used until sterilized. Galvanized iron cisterns should not go into camp, if this can be avoided. If inevitable, wash them with acid—*e.g.*, 1 per cent. solution of sulphuric acid.

The next utensils to be disinfected are the men's water bottles. Collect all water bottles, and personally see that each one is washed out with the dilute acid (which kills the bacillus of cholera). The water bottles must be finally filled and rinsed out with boiling water.

The new source of water for camp *must be assumed* to be polluted, and no man allowed to drink direct from it.

Mark 10 or 15 yards around the new water supply, and post an armed sentry to guard this area. Tell off for every company a water bottle party. These men should be formally paraded in ceremonial manner before the new water supply, and the water drawn. An officer should see this done, and that the water when taken back to the lines is boiled and cooled by a N.C.O. with two or three men, who carefully look after it. Water for the following day's use should be allowed to cool overnight, so as to be drinkable by morning.

In cholera epidemics all latrine trenches must be very carefully supervised, and located far from water and cooking. All excreta must be regarded as potentially infected. No excretal contamination must pass by flies to men's food ; hence it is important to cover excreta at once with earth, and reliable orderlies must be told off to see that this is done. A fresh set of trenches should be prepared for each day. Rubbish should be heaped on the used trenches, and their surface burnt over with fire. Kerosene oil must be added in rainy seasons.

All food supplies coming in from outside sources must be strictly supervised. No uncooked fruit or vegetables must be eaten in camp save limes and oranges, which should be first scrubbed in dilute acid. Traffic to the camp must be reduced to a minimum ; only one road into camp should be used.

Disinfection of Tents.*

When a tent has become infected by any infectious or contagious disease it should be evacuated, all clothing and bedding removed for disinfection, the poles scrubbed with a 5 per cent. solution of carbolic acid, and, while still pitched, both the inside and outside of the tent thoroughly sprayed or drenched with the same solution. The polluted tent area and its immediate surroundings should be well saturated with a 10 per cent. solution of chlorinated lime, and, if possible, should not again be encamped on. Tents used for the treatment of any infectious disease should be similarly dealt with. Every large standing camp should, if possible, be provided with a Thresh's portable emergency steam disinfector, or an Arnold's steam sterilizer, for the disinfection of clothing belonging to cases of contagious disease.

* See also Chapter XI., p. 297, 'Special Sanitary Rules to be observed on the Occurrence of Infectious or Contagious Disease.'

CHAPTER VI

WATER SUPPLIES IN CAMPS

General considerations—Sanitary survey of water supplies—Rough tests for the purity of water—The quantity of water required—Pumps—The suction pump—The Bastier pump—The Norton tube well—Sources of water supply—Artesian wells—Deep wells—Springs—Rain water—Rivers—Streams—Lakes—Ponds—Shallow wells—Protection of water supplies—Protection of wells, rivers, streams, springs, lakes, tanks, reservoirs—Police duties—Sanitary administration—The purification of water: In standing camps, in temporary camps on the line of march, and for forced marches—Sterilization of water by heat—The Griffith water sterilizer—The Forbes-Waterhouse water sterilizer—The distillation of water—The boiling of water—The filtration of water—Water strainers—The chemical purification of water—Alum—Bromine—Iodine—Bisulphate of soda—Chlorine—Permanganate of potash—The removal of 'hardness' from water—The electrical purification of water—Ozone—Ultra-violet rays—The carriage and distribution of water—Water carts—Pakhals and mussacks—Canvas water bags—Water bottles—The storage of water—Water for washing purposes—Diseases spread by water.

GENERAL CONSIDERATIONS.

THE presence of a good water supply is essential for every camp. In war the presence or absence of water for the troops will almost dictate the plan of campaign and compel the general officer commanding to fix the length and direction of his marches. In every camp it is essential that water should be in the neighbourhood for men and animals ; but for purposes of safety from attack, an encampment may of necessity have to be located at some distance from its water supply. Especial attention should also be paid to the quality and quantity of the water available, as well as its position relative to the proposed camp. Never locate a camp above its drinking-water supply, when it has to be occupied for more than one night. If it has to be occupied for a longer period, and such a position is an unavoidable military necessity, immediate steps should be taken to construct drains to intercept any possible pollution travelling from the camp to its drinking-water supply.

SANITARY SURVEY OF WATER SUPPLIES.

Whenever possible, a sanitary survey of water supplies should be made before any area is encamped on by troops. This will always be a matter of the greatest importance on active service. During the South African War the writer had reason to condemn certain water supplies in the Lydenburg district, as they were found poisoned by cyanide of potassium. In reporting on a water supply, the first factor to look to is 'quantity'; if this is found to be sufficient for the force, the question of its 'quality' must be carefully examined. The permanency of water supplies when they come from springs or wells can to a certain extent be ascertained from the local inhabitants, but actual measurements of flow are usually determined by the Royal Engineers, an officer of which is detailed to accompany the survey party to make this estimate. In a flat country the permanency of a spring is doubtful, unless the water is very cold ; this usually indicates that it comes from deep strata, but it may be noted that deep spring water is often perceptibly warmer than subsoil springs. Springs, however, found issuing from the lower slopes of hilly country and mountains are as a rule of a permanent nature. Again, in districts where limestone strata exist springs are usually permanent, as such strata give rise to the formation of subterranean reservoirs from the action of carbonic acid on the calcium carbonate. Chalk districts, owing to the porous nature of the soil, usually present few springs except below the chalk strata as is shown by tapping. Sandstone absorbs water like a sponge, and gives it out slowly and continuously. In granite and trap districts all forms of small streams should be regarded with more or less suspicion as to permanency, unless such streams originate in lakes; otherwise they are often very variable as to the amount of water they afford. Whatever water supply is selected should be above suspicion as to its purity and ample in quantity for the force; it should be safe from any possible pollution by the troops or from the drainage of the camp.

ROUGH TESTS FOR THE PURITY OF WATER.

For the chemical and bacteriological tests for a pure water, the reader must be referred to any of the standard textbooks on water analysis.* But it may be stated that no water can be judged from chemical or bacteriological tests alone, as it is also necessary personally to see its source and course, and also use common sense. Chemical and bacteriological tests are, however, most important if carried out by an expert analyst; either of the tests alone is often useless. Chemistry and bacteriology are needed to check the results of each other, but both should be checked by a personal knowledge of the source and distribution of the water supply.

* *Vide* 'The Theory and Practice of Hygiene,' by Colonel R. H. Firth, R.A.M.C.; also 'A Simple Method of Water Analysis,' by J. C. Thresh, M.D., D.Sc.

If chemical and bacteriological tests are not available, next to smell, taste, and ordinary common sense, a fair estimation can be made of water—in a well for example—by attention to the following points: The construction of the well, the source of its water, its depth, its immediate surroundings, and its relation to obvious pollution. Nearly all wells and springs liable to pollution yield turbid water after rain. The meteorological conditions prevailing before the date when the water is examined should be noted, and the local inhabitants should be closely questioned as to whether the water is drunk by them, and whether any specific water-borne disease is supposed to exist in the locality. The instructions for the methods to be observed in sending samples of water for chemical and bacteriological examination are laid down in Appendix III., pp. 68-71, 'Regulations for the Army Medical Services.'

THE QUANTITY OF WATER REQUIRED.

The minimum quantity of water required per day in temperate climates is—

1. *Per Man.*

For drinking, 3 to 4 pints.
For drinking and cooking, 3 to 4 quarts.
For all purposes, 3 to 4 gallons.
For a permanent hospital, 40 gallons.

2. *Per Animal.*

For drinking, per horse, mule, or ox, 6 to 8 gallons.
For cleaning, per horse, mule, or ox, 6 to 8 quarts.
For drinking, per sheep or pig, 6 to 8 pints.
In tropical climates these amounts should be doubled.

The following is an approximate daily allowance for animals: Elephants, 25 gallons; camels, 10 gallons (these animals are not regular drinkers); horses, oxen, mules, and ponies, 5 gallons each. Horses drink about 2 gallons at a time, and take about five minutes to do so.

The minimum amount of water required per head per diem on *field service* is 3 gallons in hot weather and 2 gallons in cold, half being used for drinking and cooking purposes, and the rest for the maintenance of cleanliness. This amount may have to be reduced on occasions to 1 gallon per head, cleanliness being then disregarded. In standing camps the daily allowance of water should be about 5 gallons per head, and never more than 10 gallons, since there is difficulty in disposing of much surplus water where there are no drains.

PUMPS.

There are three kinds of pumps generally used for military purposes :

1. **The Suction Pump.**—This is a small hand lift and force pump, with flexible hose. It will draw water from 18 feet and throw it about 16 feet, working with a lift of 18 feet and a throw of 7 feet (the height of an ordinary water cart). It will yield 7 gallons per minute.

2. **The Bastier Pump.**—This is a pump with an endless chain, working over a wheel. It yields from a depth of 45 feet (worked by two men) 2,200 gallons per hour.

If the water supply is from wells, troughs must be provided for the animals to drink from.

THE NORTON TUBE WELL.

This consists of tubes driven into the ground with a monkey, and with a pump screwed on the top. One of these wells takes about three hours to fix. It will yield about 7 gallons per minute, and will keep three horses drinking at one time. These pumps are very useful when searching for water. When it is necessary to search for water by borings, these should be made at low levels in a plain, or in places where long rank grass exists, or where vegetation is more luxuriant, such as the low levels, at or near the bottom of hills, or at the *junction* of watercourses of two or more valleys, or at spots where the mist is seen to rise in the evening, or under cliffs or under the highest side of a valley.

SOURCES OF WATER SUPPLY.

The sources of water may be considered to be, as a rule, in the following order of purity :

Artesian wells and deep borings.
Deep wells.
Springs.
Rain water.
Large lakes (centre of).
Rivers (mid-stream).
Small streams.
Large lakes, near bank.
Rivers, near banks.
Ponds.
Shallow wells.

Artesian Wells.—The water from Artesian wells is above suspicion of contamination, as it issues from a geological stratum that is covered by another stratum impervious to surface or ground water, and is thus usually protected.

Deep Wells.—In deep wells the sources of water lie below at least *two* impermeable strata, and are very safe if properly constructed and protected. They are generally fitted with pumps, and the small bore or Norton's tube wells sunk in many of the standing camps in South Africa were of this character.

Springs.—Spring water is usually good, if no dwellings with drains and cesspools are near. The spring should, however, be protected.

Rain Water.—If freshly caught in *clean* vessels from a *clean* area, rain water is usually quite safe. If a roof is used as a collecting area, its gutters should be kept clean and the first flow of rain water allowed to run to waste, as it will be dirty. In some places automatic cleaning arrangements are employed in roof-collecting areas.

Rivers.—The purity of water from rivers is very variable in many places, owing to villages and towns being located on their banks, the water becoming contaminated and unfit for use unless it be very thoroughly purified.

Streams.—Small streams are safest near their origin; dwellings and grazing grounds on or near their banks and draining into them are dangerous sources of contamination.

It is only in very sparsely populated areas and when the stream is very swift, as in mountainous districts, and where there is a great body of water, that it is in any degree safe to drink stream water without purification.

Lakes.—Large lakes supply good water if it be taken at a distance from dwellings, and if the lake be not weedy or muddy, but clear, and with a rocky or firm bottom.

Ponds.—The water from stagnant ponds and surface collections is always unsafe, and must invariably be purified before being drunk or used for cooking. Such water contains much mud, and sometimes animal matter; is liable to be fouled by the excreta of animals that drink there; and may contain the eggs of various worms, which, if swallowed, become adult parasites, such as tapeworms, etc., in the human being.

Shallow Wells.—These are wells which receive water from the surface layers of the ground. They are very unsafe sources of drinking water, inasmuch as the water often appears clear and pure, although liable to contamination by soakage from the surface, or from cesspools, should there be such in the vicinity.

Shallow wells are to be found in many towns and villages, both in civilized and semi-civilized countries, and the orders against drinking any well water that has not been approved by the sanitary officer, without first boiling it, must be strict.

In standing camps great advantages may be obtained by sinking surface wells a little distance from pools or rivers, whereby the soil can act as a natural filter. It must always be remembered, however, that this does not do away with the necessity of boiling water so obtained.

PROTECTION OF WATER SUPPLIES.

Water, from its source to the time of drinking, requires the closest possible safeguarding.

The first troops to arrive at a camp or bivouac will at once mount sentries over all water likely to be required for use, and prevent any form of pollution. These sentries will not be withdrawn until relieved by the permanent water guards. The selection and allotment of water supplies is the duty of the sanitary officer and the general staff respectively, but works connected with the water supply are carried out by the Royal Engineers, who will send an advance party to mark it with flags as follows:

1. White flag for drinking water.
2. Blue for watering places for animals.
3. Red for washing or bathing places for the men.

All water supplies must be protected from being fouled by men or animals.

All water from wells, ponds, streams, etc., for drinking purposes must be raised into storage receptacles, tanks, or troughs to prevent fouling. The supply should be railed in by a rough barbed-wire fence to keep men and animals off.

Springs frequently issue from the side of a hill, and the flow of water is not very rapid. The water usually comes from a number of crevices, and the ground for some yards round should be fenced off, and a basin cut in the face of the hill to collect the water, which may then be led into vessels by means of any extemporized spout (see Fig. 17).

On level country each spring-head should be opened up and surrounded by a wall made like a dam to raise the level of the water. If the water will not rise, a

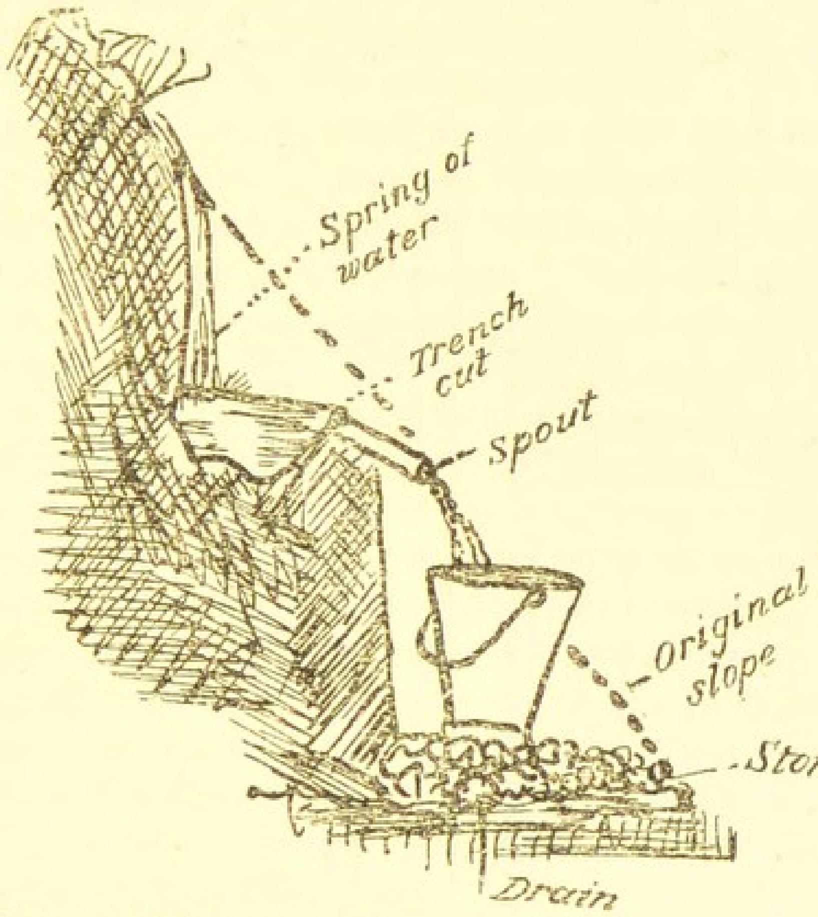

FIG. 17.—DIAGRAM SHOWING AN ARRANGEMENT FOR COLLECTING WATER FROM A SPRING.

perforated cask should be sunk to form a catchment, and the overflow caught in a series of similar casks sunk in succession, connected by wooden or bamboo gutters.

Wells, if newly constructed, should be lined inside with dry bricks, stone, or by a wooden casing, or strong cylinders of brushwood, or casks.

In standing camps, where time permits before occupation, wells should be thoroughly cleaned out, and as much water as possible drawn off before the well is taken into use ; the water should never be drawn except by a pump or by a metal bucket. The surface ground in the immediate vicinity of a well should be drained to carry away all water spilled and prevent it from re-entering the well. Unless a well is protected by *steining*, is coped, and has a cover (see Fig. 18), the purity of its water must be regarded with suspicion, even when the vicinity is apparently free from any source of infection.

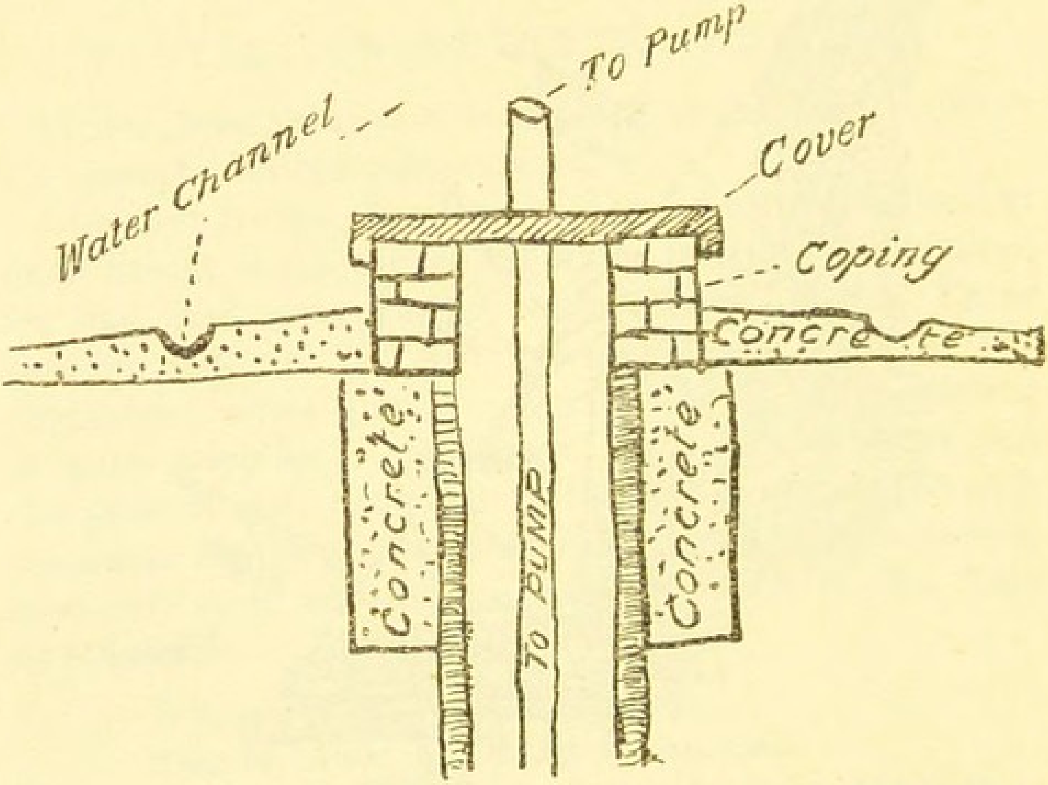

Fig. 18.—Diagram showing a Method for Protecting a Well.

When water is obtained from *rivers* or *streams*, all watering shall be done upstream above the camp. Horses will be watered below the place whence drinking water for the troops is obtained, but above that where bathing and washing take place. If surface drainage exists, it should be cut off by an intercepting trench, and made to enter the stream as far away from the drinking-water supplies as possible.

In the case of rivers and streams, the distinguishing flags already referred to should be arranged as follows: Above the white flag the water for human consumption and cooking will be drawn; below the blue flag horses and cattle will be watered; and below the red flag bathing (without soap) and water for washing of clothing will be obtained. Washing of clothes should not as a rule be done in the river or stream, but in buckets or empty cans, etc., at some distance from the banks, to avoid pollution of the stream by soap. If drinking water has to be obtained from a river or stream with steep banks, buckets on ropes should not be employed if a light hand-pump with a hose is available, as this will be found more satisfactory. The hose should have a wire framework strainer (covered with canvas) attached to keep the tube from getting blocked, and this should be weighted with lead and thrown out as far into the stream (mid-stream being the safest position) as the length of hose permits, to enable the cleanest water available being pumped out. The water is then pumped into tarpaulin-sheet baths, and allowed to stand to enable any mud to settle. If pumps and tarpaulin sheets, troughs, or tanks are not available, and if the water has to be drawn by dipping in buckets, etc., a perforated barrel should be sunk, so that the mud may not be disturbed; or a wooden pier may be constructed leading out to the deep water, and the buckets filled there.

Troops should never be permitted to dip their water bottles into water supplies, rivers, ponds, etc., which contain mud at the bottom, as this stirs up impurities. They should be made to draw it from water carts which have been filled from the tarpaulin bath by means of a hand pump. It may be taken as a golden rule that all river water is polluted and must be sterilized before being used for human consumption.

In standing camps the intake from a river or stream should be deepened and paved with stones; the banks and surface of the stream in the vicinity of the intake cleared of all bushes and rank vegetation. If necessary, a dam should be constructed just below the intake, to deepen the area from which the water is pumped out.

Water from *small streams* should be collected as near their source as possible. The intake should be placed 'out of bounds' for the troops, and grazing by animals stopped. A sanitary survey of the stream to its source should be made by a medical officer, and all possible sources of contamination looked for and remedied. If the stream is small, arrangements should be made to have a series of dams thrown across it, and the collections of water so made flagged off as described for rivers.

Where animals have to enter a stream or river to water, a place with a hard bottom of gravel should be selected, or else made with stones, to avoid mud being stirred up. Under similar conditions in a standing camp this area should be railed off, to prevent the animals straying up and down stream.

When *lakes*, *tanks*, *reservoirs*, or *large ponds* have to be used for the supply of drinking water, as well as to water animals, and when pumps are not available, the water for human consumption should be obtained as far away as possible from where the animals are watered and from where the troops bathe and wash their clothing. Water for human consumption should be pumped out from as deep a part as possible, taking care, however, to avoid objectionable sediment from the bottom. The watering of animals and ablution should be provided for by troughs, and if these are not available, animals should have a fenced-in area allotted to them, and not be allowed to wander about promiscuously.

If several *small pools* have to be taken into use, and if there is a fall in the surface contour of the ground, as is frequently the case abroad, the pools for drinking water for the troops should be selected at a higher level than watering for animals, and bathing and washing of clothes at the lowest level pools.

Police Duties.—In all camps the water supplies should be safeguarded from contamination by regimental military police, and the field officer or subaltern of the day on duty should visit to see that all is correct. An officer should accompany all watering parties of mounted units and bathing parades.

Sanitary Administration. — In arranging for the common water supply of a camp when there are a number of divisions or brigades, an understanding must be arrived at between the staff officers of each division as to the guards to be mounted daily over the water supplies and the regulations to be enforced. A special sanitary report as to the maintenance of quality and quantity of the water supplies should be furnished by medical officers of units to the administrative medical officer of each division and by the sanitary officer of each division to the Deputy Director of Medical Services of the force, in each case weekly, or more often if there is cause for complaint.

THE PURIFICATION OF WATER.

Under service conditions troops are always very prone to suffer severely from water-borne diseases (enteric fever, dysentery, cholera, diarrhœa, etc.) ; and as these diseases are all preventable if strict sanitary precautions are observed, it is very necessary to practise these precautions under peace conditions.

At military stations and in the majority of standing camps at manœuvres in the United Kingdom, the drinking water for the troops is taken from municipal supplies which are above suspicion ; but, under other circumstances, when such sources are not available, purification will have to be carried out by one of the following ways :

1. Sterilization by heat (heat exchange apparatus, distillation, boiling).

2. Mechanical means (filtration).

3. Chemical and electrical means.

Sterilization by heat, chemical and electrical means killing the germs of water-borne diseases, while filtration excludes them mechanically from the water which it is proposed to use for drinking purposes.

In large standing camps there will usually be means provided for purifying water on a large scale.

In small temporary camps units will have to arrange to purify their own drinking water, either by filtration through the service filters supplied to them, or, in the unavoidable absence of these, the water will have to be boiled in camp kettles. Under war conditions, if fuel is available, there is no doubt that the simplest, most suitable, and most efficient method of sterilization is boiling. The following line of water purification on active service should, however, be followed if means allow of it:

1. *Standing Camps.*—Employ Griffith's heat exchange apparatus or Forbes-Waterhouse sterilizer.

2. *Temporary Camps and Troops on the Line of March.*—Use candle filters (with preliminary strainers), carefully protected by suitable packing in baskets carried on trained mules; or, if suitable roads exist, employ the new army pattern field service water carts fitted with Slack and Brownlow filter candles.

3. *For Forced Marches.*—When filters cannot be carried, owing to the scale of equipment being cut down to allow of forced marches being made, bisulphate of soda tablets may be employed for not more than three consecutive days; after this period they act as a purge.

Sterilization of Water by Heat.

This can be carried out by ordinary boiling in a camp kettle, or by one of the several forms of bulky apparatus manufactured for boiling water on the principle of 'heat exchange,' which depends on the fact that, with a sufficient area of metallic surface of good conducting capacity and sufficient time, a given quantity of liquid will yield nearly all its heat to an equal amount of the same liquid. Thus, a volume of water at a temperature of 212° F. will give practically all its heat to an equal volume of water at 60° F., and the cold water heated to 180° F., less the loss by radiation. A variety of these apparatus have been designed for military purposes, but the greater number have failed to be either sufficiently portable or to yield sufficient sterilized water in proportion to their size and weight. The particular sterilizer of this kind at present in use in the service is one known as the 'Griffith.'

The Griffith Water Sterilizer.—The essential novelty of this sterilizer lies in the recognition of the fact that a momentary exposure of water to a temperature of 180° F. is sufficient to destroy all disease-producing germs that are conveyed commonly by water.

The general appearance of this apparatus when fitted up is shown in Fig. 19, from which it will be seen to consist of two main parts—namely, a boiler or heater on the right, coupled to a cooler constructed on the heat-exchange principle, placed to the left. Above the cooler is a small supply reservoir, to which the water can be conveyed by hand, or from a suitable tank or water cart by means of the hosing, the flow of water through this duct being controlled by a screw tap and a ball valve. The heat is obtained from an oil lamp working on the pressure principle, placed beneath the heater within the door shown in the diagram; the various other parts are drawn in the same figure, and their general object will be understood from the following directions for the use of the apparatus:

Place the heater and the cooler on a level piece of ground, about 6 inches apart, with the heater to the right. Connect the supply tank of the cooler by means of the armoured tubing with the water cart or tank.

Connect the heater with the cooler by adjusting the rubber union H to the openings A and B, then turn on the water to the supply tank. When the heater is seen to be nearly full of water, by inspection through the opening C, adjust the bent pipe G to the opening C, and screw the gland home; place the lamp in position under the heater and light, or it may be lighted beforehand, and then put in position; but it must never be placed

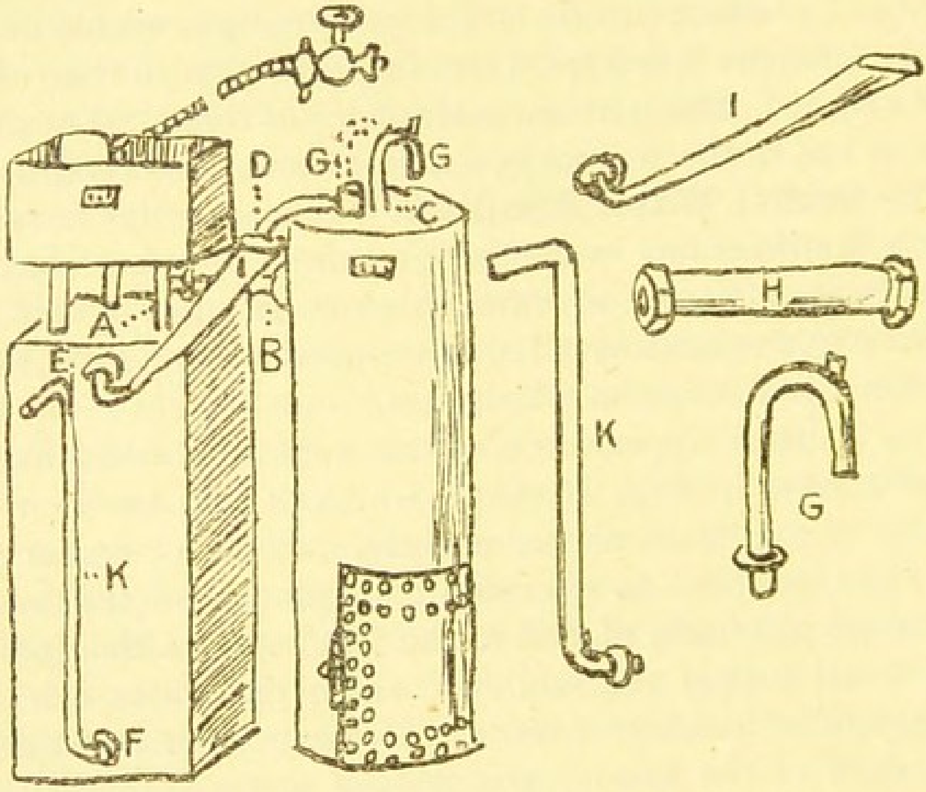

FIG. 19.—GRIFFITH WATER STERILIZER.

under the heater lighted unless the heater is full of water. Connect the expanded union I at E, taking care to have the expanded end around the aperture D in the heater; now connect the outlet pipe K with the opening F at the bottom of the cooler. As the water in the heater rises in temperature it will slowly pass through D, down the expanded union I to the cooler, but no delivery of water will take place from the outlet pipe K until the inner vessel of the cooler has filled with sterilized or safe water.

The vital part of the apparatus is the valve which controls the passage of the water from the heater to the cooler; this cannot be seen in Fig. 19, as it lies concealed within the heater. This valve is so made that it expands or opens only when the water attains a temperature of 180° F., closing automatically when this temperature is not maintained. The general plan of this valve can be seen in Fig. 20, in which C are certain capsules made of copper containing a mixture of alcohol and ether. When immersed in water having a temperature of 180° F., these capsules swell, and, being

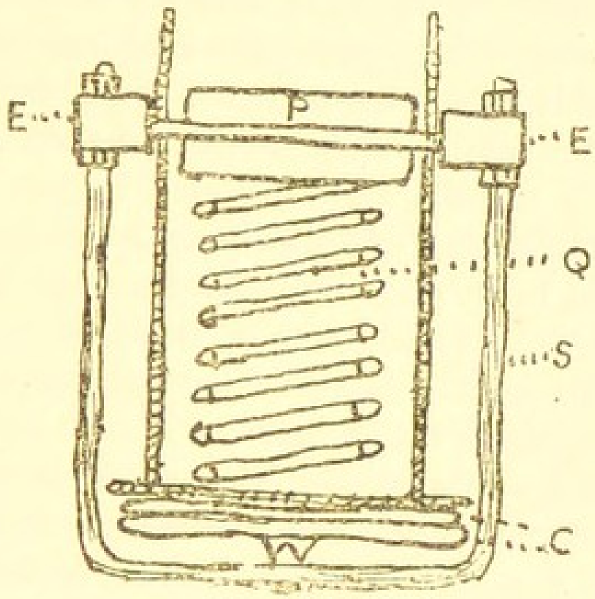

FIG. 20.—VALVE OF GRIFFITH WATER STERILIZER.

retained firmly by the stirrup S against the bottom of the spring Q, force up the plug P, which again lifts or opens a valve, not drawn in this diagram. This arrangement of expanding capsules is conveniently controlled or adjusted by manipulation of the screw nuts under and over the ends of the cross-bar E, and, once adjusted accurately, require practically no further attention, beyond occasional inspection to see that the capsules are sound and in position. If the capsules or the spring require renewal, they can be replaced readily from the spare parts supplied with the machine.

The whole apparatus packs into two boxes, one containing the heater and lamp (full of oil), the other containing the cooler. These can be unpacked, the sterilizer put together, coupled up with a supply tank, lamp lighted, and sterile water obtained flowing from the outlet pipe in fifteen minutes. The flow of water is regular, the average delivery being at a rate of 55 to 60 gallons in the hour. The rate of flow is obviously dependent on the amount of heat used, and whether the lamp is burning well. This it generally does, even in a breeze; but if the oil needs renewing or the lamp goes out, such an interruption naturally reduces the delivery of water in a given period of time. The temperature of the water at D—that is, when it leaves the heater—varies from 180° F. to 190° F. The temperature of the finished water at the outlet pipe is usually eight degrees higher than that of the original in-going water when the delivery is kept at 60 gallons an hour. In all cases the water is sufficiently cool to be drunk at once. It is also sterile, as all germs pathogenic to man have been killed by the heat to which the water has been subjected.

The capacity of the lamp for oil is $3\frac{1}{2}$ pints, if filled quite full; this is undesirable, the better plan being to put in only 3 pints. With care this amount of oil will run the machine for two hours, but for every day working, once filling of the lamp should be reckoned to run the sterilizer for an hour and a half, or, say, deliver 100 gallons of water. In working the lamp care has to be taken that it is kept clean, especially the nipple or aperture by which the vaporized oil escapes and burns. If oil is not available, the apparatus can be worked with wood as fuel, placed in the position the lamp occupies in the heater. This is not recommended, as it is more troublesome to work than oil, needing frequent stoking. When wood is used as fuel, a delivery of 40 gallons is obtained.

A larger type of this sterilizer has been made and mounted on wheels, with a small storage tank. It contains precisely the same parts as the smaller apparatus. It can turn out 350 gallons of water an hour, with an expenditure of less than $\frac{3}{4}$ of a gallon of oil. With this large machine some 1,900 gallons of water can be sterilized with a consumption of 4 gallons of oil.

In India, when worked under laboratory conditions, Griffith's heat-exchange apparatus has given satisfactory results, but in its present form it is not well adapted for pack transport, and has not stood well the rough usage of camp. To work any form of heat-exchange water purifier specially trained men will probably be required, and for use with constantly moving troops the apparatus must be of very simple construction, and more capable of standing rough usage than most of those at present on the market.

The Forbes-Waterhouse Water Sterilizer.—This is the pattern used by the American Army. The apparatus weighs 90 pounds when packed, and can deliver 25 gallons of sterile water hourly, having a temperature 15 to 20 degrees higher than that of the raw water, with the consumption of only 8 ounces of kerosene oil. The apparatus should be worked under shelter, as wind easily puts out the fire or wastes the oil.

The advantages of the Forbes-Waterhouse sterilizer are: (1) Continuity of action, as the reservoir holds enough oil (5 quarts) to allow of its being worked for twenty four hours. The raw water can be continuously supplied to the apparatus from a barrel, and the sterile water is delivered without intermission.

(2) Conservation of heat by the heat exchanges, with the consequent economy of fuel, only 8 ounces of oil being required for the sterilization of 25 gallons of water.

(3) Comparative coolness of the sterile water, which on delivery is not more than 20° F. above the temperature of the raw water.

The disadvantages are:

(*a*) Cost.
(*b*) Weight.

The weight of the Forbes-Waterhouse sterilizer is a drawback, but this is almost counterbalanced by the small amount of fuel required to be carried. The sterilizer is strongly constructed, and should be able to withstand a fair amount of rough usage when on field service. The output from the apparatus is about 25 gallons per hour. It is a difficult matter to provide *moving* bodies of troops on field service with sterilized water. It is seldom practicable to carry the water sterilizers and necessary fuel with a rapidly-moving, lightly-equipped force, and almost impossible in the case of mounted troops employed on several days' reconnaissance.

The sterilizers would probably not be available at the end of a long day's field operations, when the water carts and water bottles were empty and the troops eager to quench their thirst as soon as possible.

With the best endeavours water carts cannot at all times keep in constant touch with their units, and it is certain that sterilizers could not do so either.

The Distillation of Water.

Distilled water is absolutely pure, but is not palatable unless aerated. As it cannot be produced without a large and expensive apparatus, it cannot often be available for troops on active service in the field. It is, however, used to a large extent for troops on board ship, when it is usually served in equal parts with ordinary fresh water from the storage tanks, as distilled water by itself, if drunk for any length of time, is prone to produce dyspepsia, gastritis, or enteritis. During the Egyptian War of 1884-85 the water used by the troops at Suakin was all distilled from sea water, and it was not unfrequently ound to be slightly brackish, rendered so through some leakage in the tubing of the apparatus, or through some defects in the process, whereby water from the priming box or boilers got over into the condensers. Although no animal or vegetable life can pass through the evaporator, still, where salt water from the source of supply finds its way, water containing bacterial infection may also escape. Manifestly there is a danger in distilling water for drinking purposes from stagnant lakes, ponds, creeks, or other impure sources. Occasionally some grease comes over through the distilling apparatus. Distilled water may *at times* also be contaminated by lead, zinc, or copper from the distilling apparatus. Water rather too salt for drinking by itself may, however, be rendered less salt by mixing with oatmeal or barley, or it may be used for the boiling of vegetables.

During the summer of 1885 at Suakin enteric fever and dysentery prevailed among the troops, notwithstanding that every drop of water for cooking and drinking was distilled from the sea.

Boiling of Water.

If fuel is available, the best method of purifying water is by boiling it, and keeping it at the boil for at least five minutes. Boiling gets rid of temporary hardness, renders dissolved organic matter harmless, and, when carried out effectively, destroys practically all micro-organisms. Water should be boiled in camp kettles each night on service in sufficient quantity to fill each man's water bottle. When boiling it should be poured direct into the water bottles, thus effectually sterilizing their interior ; the bottles should then be hung up to cool, and a supply of safe water is thus ensured for each man's use on the following day's march. Troops should also be made to boil water in their mess tins in order to train them in this method of purifying their drinking water when on detached duty. This method was invariably carried out by the Japanese troops in the Russo-Japanese War in Manchuria. Instructions should be issued at the beginning of every campaign for troops to boil all drinking water when possible, and officers should encourage the use of *tea drinking* both in camp and on the march. To ensure water being boiled, an extra ration of tea should be issued when possible, and such issue becomes an absolute necessity when there is reason to believe that the drinking water is bad.

At times, however, it may not always be possible to boil water to any extent for drinking purposes under the conditions of field service. Fuel is sometimes, if not often, scarce; in rainy weather fuel is wet and will not burn; even when it is dry and plentiful, and a certain amount of boiled water is in consequence obtainable, there are usually no means available, even if there be always time, to cool it in hot weather. When suffering from heat, fatigue and thirst, human nature will drink the coolest water that can be found, be it good, bad or indifferent, in preference to the authorized supply. On the line of march the quantity of water in the men's water bottles is necessarily limited, and on long marches they will renew it from time to time from the nearest stream or spring, if not carefully watched.

It may be noted that boiled water becomes more palatable if aerated before use. This can be done by passing it through a sterilized sieve, or improvised sieve made of empty biscuit tins pierced with small holes. Great care must, however, be observed to prevent the addition of fresh impurities during aeration and distribution.

Filtration of Water.

Much illusory security exists in filters and filtration of water. The majority of filters are absolutely useless, many of them being in fact dangerous, as, instead of purifying water, they contaminate from the residue left behind by water that has previously been passed through.

If such residue be not got rid of by cleansing and sterilization, the germs therein may increase in growth and number, and will contaminate any water that passes through the candle, so that its last stage will be worse than its first. If a choice of filters has, however, to be made, only one class of filter is at all possible—namely, those made either from porous infusorial earth or unglazed porcelain, or a combination of these substances. The Berkefeld filter is made from the first and the Pasteur-Chamberland from the second material.

No existing type of filter appears quite free from the danger of becoming in time infected, and most of the filters made in the form of cylinders (called 'candle' or 'bougie' filters), of which many have been extensively tried on field service in recent years, are all too liable to choke with mud and become too slow in delivery. They are all too fragile for the rough usage of field service, becoming injured in course of transport, and require time, skill and perseverance to work and set up in camp. The filters used by the Continental armies, as well as by our own for the last ten or fifteen years, have all been of the 'candle' type, such as the Pasteur-Chamberland, Mallie and Berkefeld filters. These, when new, can efficiently sterilize water, but they have not proved satisfactory when tried with moving bodies of troops, as portions are easily broken off their candles; leakage then occurs, allowing the impure and filtered water to become mixed. The candles require to be frequently cleaned and sterilized, both of which operations are very liable to wear away minute pieces off the surface of the bougies, with consequent impairment of the germ-stopping power of the filter. The most suitable filter for use on field service is the Berkefeld, which, though not so efficient and durable as the other two patterns, has the advantage of being more rapid in delivery. Berkefeld filters were supplied to the troops in large numbers during the South African War. When carefully looked after by intelligent workers who understand their purpose and mechanism, and when the water to be filtered has been clarified with alum, these filters answer a useful purpose in standing camps, hospitals or officers' messes. Muddy water should always be clarified before it is passed through these filters, otherwise the candles get clogged with an impervious layer of slime and mud. The candles should be carefully brushed clean and boiled* every third day they are in use—the former operation to remove any gross deposit, and the latter to sterilize the candle and kill off germs, which will otherwise gradually grow through the candle, crumbling it away, cause cracks and infect the water.

The junction of the hollow candles (which are fitted by flanges) to the metal case should be carefully examined daily, and defects in the joint looked for; otherwise a crack at this place may pass unnoticed, and allow of the filtered water becoming contaminated. This junction is always liable to give, as the candles are somewhat brittle and rough; jolting during transport is very apt to cause damage. A cracked candle is quite useless.

The disadvantages of candle filters may be summarized as follows:

1. They are too fragile for troops on the move daily on field service. Considerable care is necessary in handling them. On the line of march the candles and fittings often get out of order.

2. Cleaning, sterilization, and their actual working require the service of skilled men, using considerable care on account of the brittle and fragile nature of the candles.

3. The difficulty of detecting small cracks or flaws (which may occur during transit or during cleaning) is very great. If even a minute crack is present, all the

* They should not be placed in *boiling water*, but in either cold or chilled water, and gradually raised to boiling-point, so as to avoid sudden cracking.

good effects of the filter are completely done away with, as contamination will thus occur.

4. The delivery of the filtered water is too slow for the number of men requiring the same. The output becomes slower still if the water is foul. The output diminishes in proportion to the length of time the candle is in use.

Lengthened trials abroad, more especially in India, with installations of candle filters containing *multiple* bougies, have shown them to be very unreliable and troublesome when employed on tropical service. Leakage and breakages constantly occur, repairs are frequently required, and no reliance can be placed in the efficiency of their sterilizing powers unless frequent bacteriological examinations of the filtrate can be made.

The French War Department has recently made exhaustive trials in barracks, with favourable results, of a new form of Pasteur-Chamberland filter with multiple bougies, which is fitted with André's cleaning apparatus. The candles are cleaned by a revolving indiarubber comb inside the metal, worked by a crank, and jets of water play on the candles at the same time. The combs in turn come into contact with the entire surface of each candle, and fine charcoal dust is put in to aid the cleaning. After cleaning and washing out, a fresh supply of fine charcoal dust is put into the filter so as to envelop each candle, thus forming a shield to keep slime deposits from forming on its surface pores. Though this apparatus in its present form may not appear suitable for field service, chiefly on account of its bulk and fragility of candles, yet it seems to favour the use of candle filters, in that not only is the risk of breakage (due to having to take the candles out for cleaning) lessened, but the cleaning arrangements can be entrusted to inexperienced hands, so that the wear and tear of the candles is stated to be almost inappreciable even after two years' work.

During the Russo-Japanese War water was filtered by the Japanese troops by means of canvas bags of a conical shape, known as *Ishiji* filters ; the resulting water was said to be satisfactory.

Water Strainers.—When chemical means of clearing water from muddy sediment and other forms of débris are not available, recourse should be had to the employment of some means of straining the water through a form of mechanical strainer. Such utensils can be easily improvised by converting clean beer barrels, biscuit tins, etc., and covering their tops with several layers of fine cloth or khaki, through which the water is allowed to flow. If an empty beer barrel is cut in half so as to form two tubs, one of these should have a hole a foot square cut in the bottom, and several layers of fine cloth stretched across the aperture, and firmly fixed there by means of small tacks. This tub-strainer can be then placed over another complete barrel from which the top has been removed. The filtered water can then be drawn off from a tap fixed below.

It is of the utmost importance to clear all muddy deposit from water, for, even if muddy water is boiled, the mud will act as an intestinal irritant and produce gastro-intestinal inflammation and cause diarrhœa. Muddy water should always be strained before filtering in order to prevent the 'candles' of the filters from becoming clogged. For this purpose water from a muddy stream is made to pass through 'sponge chambers' before reaching the filters in the water carts now in use.

Chemical Purification of Water.

During recent years experiments have from time to time been made to test the efficiency of the various methods of chemical purification of water which have been recommended for employment on field service, and although the majority have been found more or less effective in killing germs, the advisability of their use by *individual* soldiers cannot be recommended. The following processes may be noted:

1. **Alum.**—If alum in the proportion of 6 grains to the gallon be added to muddy water some hours before it is required, it causes the water to become clear by removing any carbonate of lime present, and forming sulphate of lime. This and the bulky aluminium hydrate, falling as a precipitate, entangles all the floating particles of mud in the water, and carries them down to the bottom. Besides purifying and clarifying the water by sedimentation, the alum is also slightly germicidal.

If the water is soft, a little carbonate of soda to precipitate the aluminium hydroxide should be added.

A lump of alum rubbed round the inside of a barrel full of muddy water for a few seconds will hasten the deposit of sediment, and will not affect the taste of the water. The water is then let stand for a few hours until the sediment settles, and the clear water can be run off and filtered through a Berkefeld filter, through which it will now be found to run easily, or else it may be boiled.

2. **Bromine.**—This is known as Schumburg's process. A solution of bromine, put up in glass capsules (each containing 2 c.c. or 0·06 of free bromine, which is considered sufficient for 1 litre of water), is added to the water to be purified; the mixture is allowed to stand for half an hour, when a mixture of sodium sulphite and sodium carbonate is added to neutralize it. This causes the smell of the bromine to disappear, but the water will be found to have a slightly stale taste.

3. **Iodine.**—Three tablets are employed, each coloured differently for distinctive purposes:

(*a*) Blue tablet, containing iodate of soda and iodide of potassium coloured with methylene blue;

(*b*) Red tablet, containing tartaric acid; and

(*c*) White tablet, containing hyposulphite of soda.

On adding these tablets to the water which it is intended to purify, free iodine is liberated from the iodate of soda by the addition of the tablet containing tartaric acid. The water should now be allowed to stand for ten minutes, at the end of which time a hyposulphite of soda tablet (white tablet) is added; this chemical combines with the free iodine, and renders the liquid inodorus. Water so treated is free from any marked smell, taste, and colour.

The use of these chemical tablets in the army has not been very satisfactory. A modification of the iodine process was tried at manœuvres in 1906. This was a modification of that originally recommended by Professor Vaillard, a French army surgeon. Although the chemical ingredients of the tablets remained the same, the quantity in each was considerably increased, so that, instead of sterilizing water in small quantities—namely, 1½ pints—an attempt was made to carry out group sterilization by using tablets capable of sterilizing 100 gallons of water. The water in bulk was chemically treated in water carts, and subsequently distributed to the men. It was, however, found that the larger sized tablets did not effect complete sterilization of the increased quantity of water, and that the water so treated when used for tea imparted a disagreeable taste to the infusion.

The principal objection to chemical sterilization of water for troops by tablets is the fact that its success is dependent on individual action, and to carry out the process each man is obliged to sterilize his own drinking water. In practice it is found that no reliance can be placed on their doing this.

4. **Chlorine.**—Bleaching powder and bicarbonate of soda are added to the water, and free chlorine is evolved, which acts as a germicidal agent. After allowing the water to stand for ten minutes, the free chlorine is neutralized by adding some sodium sulphite; the resulting mixture, however, has a taste and smell of chlorine.

Captain V. B. Nesfield, I.M.S., has devised a method,*

* *Vide* 'A Chemical Method of Sterilizing Water without affecting its Potability,' by Captain V. B. Nesfield, I.M.S., *Public Health*, July, 1903.

based upon an extensive series of experiments made with the *Bacillus coli*, the *Bacillus typhosus*, and Shiga's bacillus of dysentery, and the sterilizing agent employed is chlorine. The experiments were conducted in the bacteriological laboratories of St. Mary's Hospital. Each experiment was made with 1 litre of tap water, into which had been poured 10 c.c. of a twenty-four or forty-eight or sixty four hour-old broth culture of one of these organisms. Nesfield found that 0·125 gramme of chlorine per infected litre was invariably sufficient to sterilize it in five minutes. The water was dechlorinated subsequently with sodium sulphite in accordance with the formula:

$$Cl_2 + H_2O + Na_2SO_3 = Na_2SO_4 + 2HCl,$$

the hydrochloric acid formed being neutralized by the alkali present in commercial sodium sulphite.

The chlorine was first obtained from the liquid gas stored in lead-lined iron cylinders, such as might be used to sterilize supplies in military water carts. Nesfield then set to work to devise a tablet which could be used to evolve small quantities of nascent chlorine for the use of individuals. For this purpose he found that $1\frac{1}{2}$ grains of bleaching powder mixed thoroughly with $\frac{1}{2}$ grain of sodium bicarbonate would sterilize a pint of water teeming with typhoid or coli bacilli in five minutes. At the end of this time $\frac{1}{4}$ grain of sodium sulphite rendered it free from chlorine and practically tasteless. The bicarbonate was added to keep the tablet dry, and because the CO_2 contained in it acts sufficiently strongly as an acid radicle to liberate the very feebly combined chlorine from bleaching powder (chlorinated lime).

Dr. J. C. Thresh, Medical Officer of Health, Essex, has shown* that in clear (filtered) water far less chlorine than has usually been employed can effect practical sterilization. As little as 1 part per million will suffice in most cases. He adds calcium hypochlorite (about $\frac{1}{3}$ of a grain

* *Vide The Lancet*, December, 1908.

to a gallon of water), and allows the mixture to stand for fifteen minutes. He then adds a few drops of sodium bisulphite solution, or else passes the water through a special charcoal filter, and thus obtains a bacteriologically pure water.

5. **Bisulphate of Soda.**—The use of this has been recommended for employment on forced marches and for occasional use by mounted brigades on rapid reconnaissance duty, or small bodies of troops detached from the main body—scouts, etc.

Fifteen grains of bisulphate of soda will sterilize 1 pint of water, but it imparts an acid taste to the liquid, and water so treated will take up iron from the enamelled water bottles if the enamel is chipped. The acidity of the water can, however, be done away with if it is neutralized by bread soda (sodium bicarbonate). Bisulphate of soda tablets should not be used for more than three consecutive days, as otherwise they are prone to purge and cause diarrhœa.

6. **Permanganate of Potash.**—The process known as 'pinking' water has been extensively used in India and at other stations abroad, but is quite useless unless the salt is used in such large quantity as to make the water unpalatable. It certainly removes offensive odours from the water, and oxidizes both vegetable and a certain amount of animal matter. Some organic bodies (amongst others certain pathogenic bacteria) are not affected by it if the water is merely pinked a permanent colour, at which tint it possesses no disagreeable taste.

7. **To remove 'Hardness' from Water.**—Objectionable mineral matter (alkaline carbonates and other salts), causing hardness in water, can be removed either by the addition of lime water or by boiling for drinking purposes, or by the addition of carbonate of soda for washing purposes. The latter salt should not be used for softening water which is required for drinking purposes, as it gives it an unpleasant taste.

If chemical means of purification have to be used in providing for an army in the field, solid substances are always preferable to those in a fluid state, as the former are less liable to destruction and loss in the process of transport.

Electrical Purification of Water.

1. **Ozone.**—This is a purification agent which has been experimented on with good results in the German Army, and, although an expensive method, it will probably be used as a sterilizing agent for standing camps in the future, since a perfectly sterile water can be obtained. Raw water is pumped through a strainer to a receptacle, from which it is passed through a coarse filter. It then passes into a sterilizing chamber, where it is subjected to the action of ozone, prepared by pumping air dried by passing over chloride of calcium into an apparatus in which ozone is produced by electrical action. The apparatus delivers from 437 to 755 gallons per hour, and, bacteriologically, is stated to give excellent results.

2. **Ultra-Violet Rays.**—The sterilization of water by means of the ultra-violet rays has recently been effected with considerable success. The apparatus is cheaper and far simpler than that required for the ozone method. A battery (dry cells) is carried which works the Cooper-Hewitt mercury lamp. The lamp is made from transparent quartz and creates the ultra-violet rays. The water to be sterilized is allowed to flow over the lamp, and it is almost instantly purified.*

THE CARRIAGE AND DISTRIBUTION OF WATER.

Water may be transported and distributed, under field service conditions, either by means of the regulation water carts, tanks, barrels, *pakhals*, *mussacks* (skin bags), or by canvas water bags.

* *Vide The Lancet*, April 2, May 14, and December 17, 1910.

In calculating water in bulk it may be useful to note that 1 cubic foot of water contains 6 gallons. When water is not available locally, and has to be carried for any considerable distance, transport is very costly. During the Egyptian Campaign of 1884-85, 13,000 gallons of water required 700 camels to accompany the force from Suakin to Hasheen. In the Soudan Campaign, the iron tanks for storing water on board ship were used at the base and at the advance depôt. A sanitary committee assembled at Cairo during this campaign to consider the various patterns of water-carrying appliances, and gave it as their opinion that iron tanks were at all times preferable to wooden receptacles for either storage or transport of water, and recommended their use for the Suakin Expedition. In the South African War all drinking water required by the troops at Frere and Chieveley had to be moved by trains in railway water tanks from down country, and at the Battle of Colenso these water trucks supplied the troops with water on the battle-field.

Water Carts.

Owing to the difficulty of obtaining a pure water for troops on active service, a special form of water cart* has recently been designed, which not only clarifies but also filters the water. This service filter cart consists of an iron tank, capable of holding 110 gallons, and is mounted on two wheels and drawn by two horses. It is fitted with two pumps, two clarifying filters, and, for sterilizing purposes, eight filter tubes, arranged in two batteries of four each. There is a small 7-gallon tank at the back of the cart, which receives the sterilized water, and fitted to this and to tubes running along each side of the main tank are twelve taps, at which water bottles are filled. A locker is placed in front for carrying spare parts, and a kettle for sterilizing the filter tubes is strapped on the

* *Vide* 'Royal Army Medical Corps Training,' p. 154.

top of the locker. Two lengths of hose pipe, each having a rose fitted with wire gauze at one end, and a screw winged-nut attachment at the other end, are carried coiled round hooks on the top of the large tank.

The main tank carries water which has been freed from coarse suspended matter by having passed through the clarifying filters. The clarifying filters consist of coarse sponges compressed and contained in the two horizontally placed cylinders shown on each side at the top of the hinder part of the large tank. Water can be sterilized as required. The eight filter tubes are in two sets of four, placed in separate chambers, which are fitted inside the tank. Each filter tube is covered with a cloth, which is found to lessen clogging. The already clarified water in the main tank is pumped through the sterilizing filters. Each filter tube has its own delivery tube, or 'swan-neck,' as it is called, which gives, perhaps, an appearance of complication and fragility; but it is considered better to have eight separate tubes than to have all run together so as to deliver from one, as alteration of the delivery from any one of the filter tubes would give immediate evidence of defect, and show which filter was defective; and for a similar reason the tubes are made to discharge into the open.

A store of sterilized water is not carried, excepting the water that may be in the 7-gallon tank behind. The reason for this is that the water can be sterilized as fast as it is distributed, and the possibility of the sterilized water becoming contaminated during storage reduced to a minimum. Indeed, the filling of the men's water bottles can be carried out much more expeditiously than was previously possible from the ordinary water cart. Both tanks are readily accessible for special cleansing. Provided the source of supply is not excessively muddy, the main tank can be filled with clarified water, using both pumps, in half an hour. The same can be emptied by passage of the water through the filter tubes in forty minutes. The pumping is not laborious.

The instructions for the working of the field service filter tank are as follows :

1. The pumps are independent, and can be worked together or separately ; each pump serves one set of filters—namely, the clarifying and sterilizing filter on its own side.

2. The pump can be opened by unscrewing the four bolts and lifting off the round face-plate ; this is seldom necessary, and should be done only by a skilled man. The valves are fitted with leather seatings, which reduce friction to a minimum, and can be renewed easily.

3. To fill the main tank, screw the wing nut of hose pipe with leather washer inside (the newer types of this filter tank have no washers) on to the elbow union below the pump, and make an air-tight joint. Drop rose end of hose into source of water supply and hang clear of the bottom, or fix a piece of wood to the end, to cause it partially to float, and so keep clear of the bottom. Examine the rose occasionally to remove mud or weeds.

4. Turn the cock underneath the pump, so that the indicators point towards the hose pipe and pump, also turn the cocks placed between the clarifying chambers and the filter batteries, so that their indicators point left and right respectively ; this shuts off the sterilizing filter, and opens the way for the passage of water through the sponge chamber into the main tank.

5. The pump should be worked at about twenty-five strokes per minute. Pump easily and steadily, nothing being gained by pumping too vigorously.

6. To filter direct from source through the filters, turn the cocks placed between the clarifying chambers and the filter batteries, so that their indicators point directly towards the operator ; this opens the way for water to pass through sterilizing filters from the source via clarifying chambers only.

7. Fasten the bent delivery tubes (swan necks) by means of wing nuts to the eight ends of the metal tubes which come through and project above the cover of the filter batteries. The wing nuts (with leather washers inside) should be screwed up, so as to make an air-tight connection.

8. The free ends of the swan necks should be brought together in two sets of four, so that each set delivers into one of the two circular openings on the top of the small tank situated at the back of the main tank. The lids for covering these openings should be kept closed, except when filtering is going on. The pumps are worked as when filling the main tank.

9. If any tube is observed to be working defectively, especially in excess of discharge, the pumping on its own side should be stopped, the swan neck of that particular filter tube removed, and a blank plug from the spare parts screwed on. This throws that tube out of use until time can be obtained for its examination. The filtration can be resumed meanwhile with the remaining tubes in use.

10. There are twelve taps at which sterilized water can be drawn. The tap underneath the small tank is intended for filling kettles, and through it the tank should be flushed out occasionally. This tap can be opened only by means of a key kept in the locker of spare parts. This key should never be out of the care of the man in charge of the apparatus. In the newer make of these tanks a similar tap is placed under the main tank to facilitate the drawing off of clarified water in bulk for cooking. This tap should not be used except by permission of the orderly in charge, and never used for filling water bottles.

11. To pump clarified water from the main tank through the sterilizing filters, turn the cock underneath the pump so that the indicators point left and right respectively; also turn the cock between the sponge

chamber and the filter battery as in paragraph 6, and resume pumping.

12. After filtration is finished, remove the swan necks and store them in the locker in front, screwing one of the blank plugs provided for the purpose over each of the openings of the tubes from the filters. Also remove the lengths of hose and coil them round the hooks on the top of the main tank.

13. To clean and sterilize the tanks and filters, flush out the large tank once a month, or once a fortnight if very muddy water is in use. The small tank should be flushed out with boiling water once a week. When a tank has been standing disused for a time, both tanks should be cleaned out carefully before the apparatus is again taken into use.

14. The filter tubes should be removed every three days, and, without removing the cloth in which they are wrapped, they should be placed in cold water in the flat kettle supplied, and the water raised to boiling-point.

15. Every sixth day the filter cloth should be removed for the examination of the filter tubes. If the inside of the cloth is dirty, it may be rinsed in boiling water, but it should never be scrubbed.

16. If the filter tubes are dirty, scrub the surface well with the brush which is among the spare parts ; rinse in clean water, replace cloth, and boil.

17. Once a week remove the sponges from the clarifying chamber and rinse in boiling water ; boil the sponges once a fortnight, or oftener.

A smaller filter exists for carriage on a pack animal. A mule or horse can carry two of these filters with ease, together with the vessels in which to boil the filter tubes. The principle of working and design in these mule filters is similar to that fitted to the water tank. Each filter has a pump with hose, a central clarifying or sponge chamber, and two cylinders, each containing a filter tube. This latter tube is the same as, and interchangeable with, those used in the filter tanks. These filters for mule transport are contained in wicker casings, and have all detachable parts fastened by chains. There are no washers or other parts which are liable to be lost or mislaid. The sponge and filter tubes in these pack-saddle filters must be cleaned in exactly the same way, and as often as, those in the tank filters.

The output of sterilized water by means of this water cart exceeds that obtained by any other method. After nine days' continuous use the yield has been found to be 210 gallons per hour. The new water cart has also the advantage of not adding to army transport, as it simply replaces the old pattern, two being allotted to each battalion of infantry.

The service filter water cart must be placed under the charge of men who have been trained in its use. In other hands it will suffer damage.

Pakhals and Mussacks.

These are bags made of leather, which are used by the Mohammedans of India from time immemorial for carrying water, and they have been used on many of the frontier expeditions of that country to supply water for the troops when other means of conveying water have not been available, owing to the absence of roads and the mountainous nature of the country. Unless very carefully looked after, *pakhals* and *mussacks* become very foul inside, and their use should always be condemned on sanitary grounds if any other means of water transport is possible.

To prepare a skin as a *mussack*, it should be removed from the animal (calf or goat) while still warm, without any cut, except round the neck, close to the head, and at the feet. The hide is then roughly tanned and dressed with oil or lard to make it watertight, and the openings at the feet and neck closed.

Pakhals are of larger capacity than *mussacks*, the former being carried one on each side of a small hill pony or on a mule, and the latter carried by men. During the Chitral Campaign of 1895 the *pakhals* and *mussacks* were directed to be constantly inspected and scoured inside periodically. Small quantities of either alum or permanganate of potash were periodically placed in them overnight, and let stand until morning, for disinfecting purposes.

Canvas Water Bags.

These are made of the best canvas, with double and close-stitched seams. They leak when first made, but become almost waterproof after a few days' use. Owing to evaporation from the surface, the water in the interior becomes very cool. These bags should be constantly cleaned out and sterilized with boiling water.

Water Bottles.

The soldier's water bottle becomes very foul and insanitary on service if not constantly inspected. If water bottles are dirty, the labour of purifying water may become useless. It is therefore important that the bottles should be frequently cleansed, and, in fact, sterilized. This is best effected by filling them with boiling-hot water. If filled with tea, the tea should also be poured in boiling-hot.

The felt covers of water bottles should be occasionally disinfected by dipping the bottles into boiling water.

Water-boiling stations should be formed at every halting place on the lines of communication to enable troops on the march to refill their water bottles with boiled water.

THE STORAGE OF WATER.

The means of storage usually available in the field are canvas tanks or troughs, iron tanks, water carts, barrels, etc. Water is pumped up and stored in these receptacles by means of the lift and force pumps. The regulation canvas tank consists of a double sheet of canvas, with rubber between the layers; the edges are fitted with brass eyelets and strengthened with rope. The sheeting is supported by picket posts. One such tank holds 2,300 gallons, and can be covered by another sheet to keep out dust.

WATER FOR WASHING PURPOSES.

In large standing camps storage will usually be provided for half the day's supply, enabling the washing water to be available morning and evening.

Benches on which the men can place basins will be a convenience, and should always be provided in standing camps. The ground around the benches must be paved and drained towards the drain into which the basins are emptied. Men may bathe or wash in a stream below the horses' watering place, but there will be no objection to men filling buckets, biscuit tins, etc., from the stream above the horses' watering place, provided any washing is carried out at least 20 yards from the banks of the stream.

It is difficult to wash clothes during a campaign, and yet it cannot be long dispensed with without injury to health. Linen or cotton shirts should not be used in the field. Two good flannel shirts, either the regulation 'blue-back' or of a greyish colour, are ample for all ranks, if worn day and night about; when occasion allows, the shirt should be hung up, stretched out and exposed to the sun and wind. It should be shaken and well brushed. The same rule applies to trousers and drawers when the latter are worn. The repeated washing of flannel or any woollen material soon ruins it; this is especially the case when muddy water and much soap are used.

DISEASES SPREAD BY WATER.*

The following diseases are capable of being conveyed by water: Cholera, enteric fever, dysentery, enteritis (diarrhœa), parasitic diseases, tape worms, round worms, fluke, bilharzia (common in South Africa), guinea worm common in some parts of India), goître (Gilgit), etc. In connection with the incidence of the water-borne diseases —enteric, cholera and dysentery—amongst troops in camps and on field service, it should always be kept in mind that the men will be less susceptible to them if the sanitation of the camp area is carefully looked after, all refuse removed and buried, excreta buried deeply and covered several times a day, trenches frequently disinfected, all cases immediately isolated, and their clothing, bedding, and feeding utensils and tents, disinfected. These sanitary precautions will also assist in closing other possible avenues for the admission of the specific nfection.

* For information concerning the parasites causing water-borne disease, see 'Aids to Microscopic Diagnosis,' by the author. Published by Messrs. Baillière, Tindall and Cox.

CHAPTER VII

THE FOOD OF THE SOLDIER

Importance of a proper food supply for troops—The soldier's rations during peace—Recruit's food—Messing arrangements—Inspection of fresh meat—Conditions of contract—Diseases affecting meat—Beef: age, sex, quality, sweetness, dressing—Mutton: age, sex, quality, sweetness, dressing—Inspection of bread—Conditions of contract—Inspection of contract bread—Storage of bread—'Emergency' bread—Biscuits—Unfermented cakes—The soldier's rations during war—War rations of various armies—Scales of rations in different campaigns—'Emergency' rations—The necessity of a varied diet in war—Scurvy—Preserved food—Inspection of tinned foods—Preserved meat—Cooking on service—Travelling kitchens—Transport for rations.

Too much attention cannot be paid to the provision of a proper food supply for the soldier, as this is absolutely necessary for the maintenance of health and vigour, as well as for the supply of energy, without which muscular work cannot be satisfactorily done. If troops are not liberally fed on active service, debility will ensue. Debility leads to disease—especially enteric fever—and disease leads to disaster. War cannot be made in kid gloves or on boiled water, but we can try to keep our men healthy by wholesome food.

The lack of suitable food broke the back of Napoleon's great army in Poland in 1806, and again led to his disastrous retreat from Moscow in 1812, in which he lost

400,000 men. Want of sufficient food led to the retreat from Corunna; it also caused disasters in the Crimea, and in many other campaigns, which furnish a list too lengthy to repeat. Parkes, one of our greatest military authorities on food supplies in war, writing on their failure, states: 'The effect of food upon strength, endurance, and even courage, is remarkable. It is useless to supply the ammunition for guns if the men who have to work them have no supply of energy issued also to them.' General Sherman says the four most important duties of the commander of an army should be the proper supply of food to his soldiers, of suitable clothing according to climate, of shelter from the weather, and of prompt medical assistance to the sick and wounded. These are four duties a commander should never neglect personally to attend to, for who, after all, should take so much interest in the welfare of his soldiers as their General, who owes them a lasting debt of gratitude for his fame, towards the attainment of which they so largely contribute?

THE SOLDIER'S RATIONS DURING PEACE.

At Home Stations.—The daily scale of free rations is as follows:

(*a*) In barracks or stationary quarters	1 lb. of bread. $\frac{3}{4}$ lb. of fresh or preserved meat.
(*b*) When under canvas or (with the approval of the General Officer Commanding) when temporarily accommodated in unequipped buildings	1 lb. of bread. 1 lb. of fresh or preserved meat.

At Stations Abroad.—Except at stations where special scales have been arranged locally, the daily free scale is—

1 lb. of bread.
1 lb. of fresh meat, or $\frac{3}{4}$ pound of preserved meat.

Additions to the ordinary rations may be sanctioned by the General Officer Commanding on very exceptional occasions, such as when troops are only able to obtain their meals at irregular and inconvenient hours, owing to (*a*) being employed on unusually onerous and prolonged duty, (*b*) the exigencies of service at manœuvres or summer drills, and (*c*) unexpected delay in the hour of embarkation (Allowance Regulations, paragraph 16).

Groceries are not supplied except at certain stations abroad, where special scales are in force; but, instead of receiving a free issue of groceries, each soldier is allowed a 'messing allowance' of threepence a day, which is expended by his company officer to the best advantage of the soldier in the purchase of oatmeal, fish, eggs, bacon, etc., on alternating days for breakfast; vegetables, puddings, etc., for dinner; and jams, cheese, etc., for tea or supper. Moreover, meals can always be obtained at any reasonable hour in the regimental institutes at a moderate cost. The soldier's pay is now amply sufficient to enable him to spend a portion of it on extra food, and he actually does this in practice. In calculating a dietary the main factors determining the amount of food necessary for the soldier must be the amount of physical work he has to do, and the amount of muscular energy necessary to perform it. The harder the work, the more the amount of food required; and with strenuous exertions an average of not less than 4,000 calories* must be provided if his strength and military efficiency are to be maintained. A Committee of experts recently appointed by the War Office† have worked out

* Energy value is most conveniently expressed in calories, a calorie being the energy, in the form of heat, required to raise the temperature of 1 kilogramme (2·2 pounds) of water by 1° C. (1·8° F.). Roughly speaking, 1 gramme of protein or carbohydrate is capable of yielding by its decomposition in the body 4·1 calories, and 1 gramme of fat yields 9·3 calories.

† *Vide* 'Report of the Committee on the Physiological

the food values of the various meals supplied in four different units. These comprised a cavalry regiment, an English infantry battalion, a Scottish battalion, and an infantry depôt. There was not much variation between these different supplies. Reckoning the food value in calories per day per man, the dietaries supplied (ordinary Government ration and messing allowance, excluding food bought elsewhere) gave averages of 3,478, 3,340, 3,248, and 3,409 calories for the units in the order just mentioned. On an average for the whole four regiments, the protein* supplied daily was 133, the fat 115, and the carbohydrates† 420, stated in grammes. The committee took Atwater's diet for men doing moderate work—viz., a diet containing 125 grammes of protein and affording a total energy value of 3,500 calories, as the standard for comparison, and found that, though the protein supplied in each case was sufficient, the average calorie value did not quite reach 3,500 in any of the four dietaries examined. But they point out that this dietary was nearly always supplemented by food bought for supper at the canteen or elsewhere, and that the pay of all soldiers is now sufficient to enable this to be done without hardship. The amount thus bought probably brings up the average energy value of the food to fully 4,000 calories, and at the same time gives elasticity to the diet, as each man can select the quality and amount of food which suits him.

The Recruit's Food.—The recruit usually will require more food than the fully trained soldier, as many of the newly enlisted are growing lads, and are, perhaps, out of employment and badly fed before enlistment. This con-

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Effects of Food, etc., on the Soldier' (*Journal of the Royal Army Medical Corps*, vol. xii., pp. 669-681, and vol. xiii., pp. 458-477).

* Nitrogenous substances similar to white of egg or meat, absolutely necessary for life.

† Carbohydrates, starches and sugar.

clusion is supported by the fact that they spend a considerable portion of their pay, after enlistment, on cakes, sweets, chocolate, etc. The Army Council has recently granted the messing allowance of threepence a day to recruits as well as to trained soldiers.

Messing Arrangements.—The restaurant system of messing has been recently introduced in certain units with varying success. This system is held to give the soldier a greater variety in the food provided, as well as to improve the manner of serving it and to make the meals more attractive and appetizing. Separate dining rooms are provided, and the men sit down to tables with a table-cover, usually of white American cloth. In some units provision has been made for the men to obtain beer, mineral waters, or water, at their dinners, and this has been much appreciated; it has tended towards temperance, in that beer drinking has been found to decrease elsewhere and the canteen less resorted to.

THE INSPECTION OF FRESH MEAT.*

All meat before issue to troops is subject to the daily inspection and approval of a board of officers (or, in some cases, of an officer with special qualifications), and any meat rejected will be immediately removed. A copy of the conditions of contract for the current six months should always be kept hung up in every meat store, and wherever the daily ration board assembles.

Conditions of Contract.—The usual conditions of army contract for the supply of meat by civilian contractors for the use of troops in the United Kingdom are as follows:

1. The meat supplied shall be subject to the approval of the officer receiving it, and any meat rejected as not being in accordance with the specification shall be immediately removed by the contractor at his own

* *Vide* 'Army Service Corps Training,' Part II.

expense, and the authorities may purchase meat in lieu of that rejected, any extra expense incurred in this way being defrayed by the contractor.

2. If the contractor shall fail to deliver the supplies demanded at the specified times and places, or to replace meat rejected, if so ordered, the authorities may take steps to procure or replace the quantity deficient at the contractor's expense.

3. The premises of the contractor, where the meat to be supplied under contract is in course of preparation, may be inspected from time to time by an authorized military officer.

4. No portion of the contract shall be transferred or sublet unless the written permission of the General Officer Commanding shall previously have been obtained.

Specification.—1. The fresh beef shall be ox, not under two years or over five years old, or heifer and cow, not under two years or over four years old. The beef shall be well fed, good, sound, sweet, and wholesome, and shall not be excessively fat.

2. The frozen beef must be thoroughly and carefully thawed prior to issue to the troops. It must be in bright and sound condition, and free from damage. Quarters must bear the original tags, labels, or wrappers, indicating country of origin, and must weigh from 170 to 200 pounds.

3. The meat shall be delivered in quarters or whole pieces, and not in small joints. The bone shall be cut off from 4 inches above the hock and knee bones respectively, and 1 per cent. shall be allowed free of charge to cover loss in cutting up in all cases where the day's issue exceeds 50 pounds in weight.

In general terms the inspection of meat involves questions of the recognition of disease, and estimations of age, sex, quality, sweetness, and dressing.

Diseases Affecting Meat.

When the earlier stages of disease have passed, the meat of diseased carcasses usually shows one or other of the following conditions:

Congestion ('*Fevered Meat*').—Bloodvessels congested and distended with dark fluid blood, muscles swollen, dark in colour, soft, friable, and 'soapy' to the touch. Small or medium-sized hæmorrhages are often present, especially around the 'stellate' veins on the abdominal and thoracic cavities. Such meat has not been properly bled, or possibly has not been bled at all, the animal having died of disease, and not been slaughtered.

Œdema ('*Dropsical*' *Meat*).—The meat is pale in colour, wet, slimy, and flabby to the touch; the carcass is generally emaciated, and in all cases the meat should be rejected.

In either of the above conditions the whole carcass is unfit for food, whether or no any definite cause of the changes in the meat can be detected, as death may be due to accident, choking, poisoning, drowning, etc., or to disease, the lesions of which have been removed by the butcher's knife to avoid detection.

*Tuberculosis.**—All tuberculous meat should be condemned. Tuberculosis is the most common disease to be looked for in cattle; it is, however, rare in sheep, but affects pigs in a varying degree. It is most easily noticeable on the surface of the peritoneum and pleura, and on the internal organs of the body, as well as in the lymphatic glands and the udder. The muscles are only affected in extreme cases. The disease is characterized by the presence of small nodules, varying in size from millet seed to pigeons' eggs. The nodules tend to

* For a more detailed description of the causal agent of these diseases, see 'Aids to Microscopic Diagnosis of Bacterial and Parasitic Diseases,' by the author. Published by Messrs. Baillière, Tindall and Cox.

collect into bunches and clusters as the disease progresses, these being known in the trade as 'grapes.' If the nodules be cut into with a knife they will be found to be cheesy in the centre and often gritty to the touch. Microscopically millions of tubercle bacilli will be seen. As the disease progresses the animal becomes emaciated, but it is usually slaughtered before this stage is reached, and all evidence of the disease may be so skilfully removed by the butcher's knife that detection may be difficult.

As the pleura and peritoneum rarely escape infection, special attention should first be paid to these, and, if found to have been removed—*i.e.*, stripped off by the butcher—suspicion should be aroused. The presternal glands are also generally diseased, and an examination of these is often confirmative; lying as they do out of sight, their removal is generally overlooked by the butcher. Under the terms of army contracts the smallest extent of tuberculous disease entails the rejection of the whole carcass.

The pig is also very liable to tuberculosis, and the disease spreads with great rapidity. The lymphatic glands in the neck, especially those below the tongue, are usually the earliest to show signs of the disease, and should therefore be closely examined.

Actinomycosis.—This disease is not uncommon amongst cattle and swine, but it rarely attacks sheep. It usually starts as an ulcer about the mouth, lips, tongue, or neck of the animal, causing a lumpy tumour, which tends to ulcerate; hence the popular name 'wooden tongue' or 'lumpy jaw' is often applied to the disorder. Ulcers and nodules may also be found in the stomach, intestines, lungs, etc., as the disease becomes advanced.

The parasite (*Discomyces bovis*, or the ray fungus) sometimes affects man, and particular care should be taken when handling animals or their carcasses so affected.

*Fluke Disease.**—This disease, popularly known as

* See note, p. 187.

'rot disease' or 'liver rot,' attacks sheep, oxen, and other animals; sometimes it affects man. The chief seat of the disease is found in the liver, which in the early stages of the disorder is much swollen and congested, and eventually becomes disorganized. The animal wastes away; the carcass becomes emaciated, anæmic, and dropsical. The parasite (*Distomum hepaticum*) is flat and leaf-shaped, measuring about ½ inch long. The meat of infected animals should not be used for human consumption.

*Trichinosis.**—This is a parasitic infection chiefly found attacking pigs, due to the presence of the encysted larvæ of a nematode worm, the *Trichinella spiralis* (syn., *Trichina spiralis*). Since cooking large pieces of pork may not kill the parasites, such meat should be condemned. The disease is chiefly confined to the muscles, and when in an *advanced* stage the meat appears dotted with little white specks; but in the *earlier* stages of the disease there is no means except by the microscope of detecting the presence of the parasitic larvæ. The chief localities affected are the psoas muscle, diaphragm, tongue, abdominal, laryngeal and intercostal muscles, and the points of insertion of tendons.

Other Diseases affecting the Quality of Meat.—Other important diseases are pneumonia, pleurisy, cystic worms, staggers, braxy, foot and mouth disease, rinderpest (cattle plague), anthrax (splenic fever), blackquarter, red water, milk fever, scab, etc.

Beef.

The Estimation of the Age of Beef.—The usual conditions of contract require that ox beef shall not be under two or more than five years old, and heifer or cow beef not under two or more than four years (forty-eight months). Sometimes, especially abroad, attempts are

* See note, p. 187.

made by dishonest contractors to pass off the beef of old cattle as rations.

An estimate of the age of meat may be formed from certain external and internal appearances.

It is the object of an inspecting officer to decide whether the beef submitted for his inspection comes within certain well-defined limits, and to exclude everything which is outside them. The indication of age in carcasses of animals slaughtered between two and five years old being very distinct, a satisfactory conclusion on this head can be arrived at with little difficulty if attention be paid to the following anatomical characteristics:

Temporary cartilage will be found to be invariably present in the carcasses of young animals on the tips of the processes of the vertebræ, and at the symphysis pubis.

Since cartilage disappears from these places at or about the age at which the animal becomes an adult, which coincides very nearly with the limits of age quoted above, inspection for age may be directed to this condition alone whenever a complete quarter is the subject of examination.

Cattle reach adult age at or about three and a half years, and cartilage disappears, through having become ossified, at about the same period. The process of ossification is, however, gradual, and the deposits of bone are at first markedly soft and porous, and blue or rosy in colour, becoming compact, hard, and bleached in appearance as age advances.

The presence of cartilage at the tips of the processes of the vertebræ is a sufficient guarantee that a fore quarter is under the limits of age. The slow process of ossification which leaves the tips of these processes pink in colour, soft, porous, and capped by a red line even after cartilage has disappeared, enables an inspecting officer to decide if the cartilage has but recently turned into bone. The inspection for sex and quality will assist should there ever be any doubt. For instance, in countries where oxen are not used for draught purposes, the five-year-old ox is practically unknown, and therefore a fore quarter obviously well over four years old is most unlikely to be ox beef, and is liable to rejection as cow beef, which is not to be accepted over that age.

As regards the hind quarter, in the young animal the pelvis is divided at the symphysis pubis by a layer of cartilage, and can up to adult age be cut through with a knife, leaving the exposed section of the os pubis in each quarter covered with a layer of cartilage. The ossification of this cartilage follows the general rules already outlined.

When only a portion of a quarter is presented for inspection, examination may have to be extended to other indications of age which do not need to be regarded when the whole quarter is present. Should any of the spinal processes or the os pubis be contained in the portion under inspection, the rules above hold good. In their absence, if the portion is acceptable under the terms of contract as regards quality, the age may be taken as sufficiently correct to warrant the waiving of an objection on that score. It may also be of use to remember that the bones of young animals are soft, and the sections of the vertebræ of the spine appear red and porous; whereas the bone in an old animal is hard, compact, and white. The neck of an old cow is long and lean, the shoulder is prominent, and the shin-bone fine and pointed. There is little need to look for carcasses of animals *under* the stipulated age. At two years old neither oxen nor heifers are developed sufficiently to be profitable for slaughter, and this lack of development is manifest in the carcass.

The examination for age may be summed up as follows:

A fore quarter is acceptable in this respect if cartilage is still present on the tips of the spinal column, or if it has quite recently become ossified, as shown by the condition of the bone at those points. A fore quarter that does not display this condition should not as a rule be accepted at home stations, since the five-year-old ox is so rare ; and, assuming that the quarter is therefore that of a cow, it would be over age—in this case four years. Both fore and hind quarters of bull or 'stag' beef would be eliminated under the sex clause.

A hind quarter of ox beef is at home stations practically acceptable at sight, so far as age is concerned. In countries where oxen are used for draught purposes the appearances of the bones of the os pubis and spinal processes will be a sufficient indication of the age of the carcass.*

A hind quarter of heifer or cow beef is acceptable only if cartilage is to be found on the os pubis, or there are clear indications that ossification has only recently become complete.

Estimate of Sex of Beef.—If examination is conducted in the order previously mentioned, carcasses of old cows will already have been rejected under the age clause, and examination for sex becomes merely a question of detecting bull and 'stag' meat.

At the same time, it may be useful to remember the characteristic conformation of the old cow, as mentioned above. The bones are generally white and brittle, and the os pubis oval in shape. 'Cow beef' from animals as much as eight or nine years old is frequently fat, and answers to the description 'well-fed.' The udder is generally large, pendulous, and spongy.

There are no means of distinguishing the fore quarter of a young well-fed ox from that of a young well-fed heifer, but this is not necessary, since the meat of both is acceptable.

The fore quarter of bull beef is most easily recognized by its thick, heavy, dark-looking 'crest.' There is also

* In some parts of Sussex and in the Fen country oxen are still occasionally used for draught purposes.

a general massive appearance of the frame, showing more lean than fat.

In the hind quarter sex is recognized as follows :

In the ox the root of the penis (pizzle) is much smaller than in the bull, and the erector penis muscle is usually from ½ to 1 inch wide. The cod fat is ragged and lobulated.

In the bull the root of the penis (pizzle) is thick and coarse, and the erector penis muscle may be as much as 3 inches wide. The cod fat will be more massive, and the cavities where the testicles have been will sometimes be found stuffed with fat.

The buttock of the bull shows far greater muscular development than that of the ox.

The characteristics of 'stag' meat are similar to those of bull meat, but are less marked.

The udder of a heifer is smooth and oval, and consists of solid fat. The greater part of the udder of a young cow will be solid. The udder of an old cow will be loose, *brown*, spongy, and pendulous, in proportion to the age attained.

Butchers often cut the udder partly or entirely out of an old cow, and fasten the skin neatly over the part with a wooden skewer, or sometimes by means of stitches. The use of a skewer or the presence of stitches should always arouse suspicion.

Quality of Beef.—The conditions of contract require that the meat shall be 'well-fed, good, sound, sweet, and wholesome.'

Assuming that the animal is of the right age and sex, the quality of the meat will mainly depend on the way in which it has been fed, and on its freedom from disease.

A healthy carcass of well-fed beef has externally a rounded, well-filled appearance ; the back will be covered with bright clean-looking fat, the haunches, hip-bones, and shoulders being well covered, and there will be no hollowness behind the shoulder blades. The buttock will be full and sound. Internally, the portion of the chest cavity nearest the sternum will often be found to be well covered with waves of fat; but while their presence is indicative of good feeding, their absence is not necessarily due to poor feeding, since the condition is very largely due to peculiarity of breed. Many carcasses of undeniable quality are entirely deficient of fat on the ribs.

The pelvic cavity will be well filled with firm healthy-looking fat, and the kidneys will be well covered with fat. The total fat in the carcass should be moderately abundant, the normal proportion being held to be about 33 per cent. of the total weight. The proper proportion of bone is from 17 to 20 per cent.

The colour of the fat varies from cream or pale straw to bright yellow. The latter shade may arise from peculiarities of breed or feeding. It should be well set—that is to say, it should solidify within twelve hours of slaughter. In horse flesh the fat does not solidify.

The muscles should be soft and silky to the touch, full of juice, and of slaty-blue colour; but a freshly cut section changes colour in a few minutes to a bright cherry-red as the result of exposure to the atmosphere. The muscle should be well bled and free from bruises, elastic under slight finger pressure, and free from any tendency to 'pit,' moist without being wet, and well mottled or marbled with fat. In the old cow there will be a total absence of marbling, and the lean will be harsh and stringy to the touch, duller in appearance, deficient in juice, and there will generally be little fat.

In the old bull the flesh is dark in colour, with a feeling like india-rubber, and marbling is absent. There is a very much greater proportion of muscle than fat.

Abnormal conditions are generally due to disease.

A carcass may sometimes be found to have been 'stripped'—that is to say, the pleura (the lining membrane of the chest cavity) and sometimes the peritoneum (the lining membrane of the abdominal cavity) will have been removed. These are both very suspicious signs.

To remove the lining of the pleura is an easy task if it is done when the carcass is still warm, and the fact that this has been done is generally not apparent to the casual glance of an untrained observer.

Investigation, however, will almost always disclose the marks of the knife under the sternum, and should any doubt still remain, an infallible test consists in trying to strip the quarter *de novo*. There is a fascia immediately covering the ribs and under the pleura, but this will only tear off in little pieces, instead of coming away whole, as does the tougher pleura.

To remove the peritoneum is a difficult operation if done in such a manner as not absolutely to mutilate the carcass, and the result is always unsightly and obvious.

It is usual, when stripping is apparent, to suspect that it has been done to conceal some disease characterized by growths on the pleura or peritoneum. *Stripped carcasses should always be rejected.*

There are, however, two perfectly legitimate reasons for stripping a fore quarter.

Calves are very subject to pleurisy, and although they become quite cured, the two layers of the pleura will often have become united, and after slaughter the removal of the viscera causes the pleura to tear and leave an unsightly appearance. The butcher therefore resorts to stripping to make his meat saleable. The second reason for stripping is the result of 'bodying' or 'over sticking,' caused by the knife used for bleeding being allowed to cut a passage into the thorax, and so admit blood into the chest cavity from the severed jugular vein; this stains the pleura, and necessitates its removal before the carcass is saleable. These two exceptions cannot, however, be allowed to interfere with the general rule that *all stripped fore quarters should be rejected.*

Sweetness of Beef.—If any doubt exists after smelling it, as to whether meat is tainted or not, a *clean* wooden skewer should be driven for about six inches into the thickest portion of the joint. If the skewer smell offensively on its withdrawal the meat is tainted. If doubt still exists the joint can be more closely examined if cut right through.

The Dressing of Beef.—The conditions of contract require that carcasses of animals killed in the United Kingdom shall be dressed as follows:

In oxen, the root of the penis (pizzle) shall not be removed, nor any portion of the cod fat. In heifers and cows, no portion of the udder shall be cut away.

Any violation of this clause should always be met by rejecting the meat.

If the kidneys are removed, the kidney fat must also be taken out.

'Short' fore quarters—viz., those with the fore ribs cut off—should not be accepted, except in the case of imported meat. The reason is that the fore quarter is always of less value than the hind quarter, and the difference is increased proportionately, as each additional rib goes with the hind quarter at the expense of the fore quarter.

The bone to the extent of 4 inches from the lower end of the radius in the fore quarter, and from the tibia in the hind, is to be either removed or allowed for in the weight. It is customary to allow 2 pounds per quarter when the bone is not removed.

Mutton.

Mutton, like beef, requires to be examined for disease, age, sex, quality, sweetness, and dressing.

Many of the rules applicable to the inspection of beef can be modified to meet the requirements of the inspection of mutton, but mutton being delivered in whole carcasses, some of the signs, such as the section of the vertebræ, are not visible unless made so with the consent of the contractor.

Age of Mutton.—The five-year-old wether is just as rare as the five-year-old ox. The old female, however, is frequently met with, and sometimes the ram.

In a young animal the ribs and the knee (hock joint), will be pink in colour, and comparatively soft. In an old sheep the ribs and leg joints will be white, and the bone dense and hard.

The age of mutton is, however, best told by the appearance of the sexual organs. The cod fat of the wether is a certain guarantee of youth. The udder of a gimmer is a smooth oval of solid fat, that of the young ewe is partly solid and white, and partly of a spongy consistency and brown in colour. The udder of the old ewe is a brown, spongy mass, which never sets. If any doubt exists—and the contractor will consent—the division of the carcass into two sides, thus exposing the spinal processes and the 'os pubis' will settle the question, for the presence, or indications of the recent presence, of cartilage will be found in all animals within the prescribed limits of age.

Sex of Mutton.—The wether is known by the clitoris ('string,' or pizzle), which should not be much thicker than an ordinary lead pencil. The cod fat is lobulated and bunchy.

The legs of the ram exhibit much greater muscular development, and the neck is very much thicker and heavier, showing a decided 'crest.'

In the case of the female the condition of the udder, as described above, shows plainly whether the animal has been allowed to bear young.

If the ewe has had many lambs, small veins will be seen where the uterus is attached, and the pelvic cavity becomes larger with age. The knuckle bones are smaller in ewes than in wethers.

Quality of Mutton.—A carcass of good, well-fed mutton should be 'mackerel-backed'—that is, there should be alternate red and white bars over the loins. These marks are natural, being caused by superficial muscles, and must not be confused with artificial marks often made by the butcher's knife. Too much stress must not, however, be laid on this marking, since its presence or absence is not infrequently due to breed. Some of the best carcasses of every consignment of New Zealand mutton will be found to lack wholly, or to a large extent, the regular marking so prominent in others. The fat should be fairly abundant, firm, and white. Any discoloration is suspicious. The muscle should be red, soft, and silky to the touch, moist without being wet, and slightly elastic under the pressure of the finger. There is sometimes a little fatty marbling, but it is rare.

The diseases to which sheep are liable, and their general effects upon the carcass of mutton, have already been described, together with the diseases of cattle, pp. 187-9.

The carcass of mutton contains the same lymphatic glands as the carcass of beef, but only the largest are of any assistance, the remainder being so small that even when they can be found they show practically nothing. The largest glands being all deep-seated, and so not available on account of the mutilation of the carcass entailed by cutting them out, the only glands that can be of use for inspection are the inguinal glands, or the mammary of the female. A very little practice enables the unskilled hand to find this gland by making one cut only in the cod fat or udder. One clean cut will close up again, and leave no unsightly traces, especially if the inspection is carried out when the carcass is still warm.

The most common form of complaint about mutton is that it is too fat, but good mutton is unobtainable without a fairly high proportion of fat.

Old ewes which are penned up and well fed rapidly put on fat, frequently to an excessive degree. For army rations the best sheep are those between 60 and 70 pounds in weight, and in a profitable carcass the shade of the lean will show through the fat between the two shoulder-blade bones and at the rump. This is generally accepted as the test, and mutton displaying dense white at the rump and over the shoulders should be liberally pared at those parts, provided the contractor consents; otherwise they should be rejected. Sheep weighing over 80 pounds should not, as a rule, be accepted from an economical point of view.

Sweetness of Mutton.—The sweetness of mutton can be tested by probing at the os pubis and smelling the skewer or knife. This part is the first to go bad, as it is the thickest portion of the carcass, and retains animal heat longest.

Dressings of Mutton.—The conditions of contract require the dressing to be as follows: In wethers, the pizzle shall not be removed. In ewes, no portion of the udder shall be cut away. Carcasses having these parts tampered with should be rejected.

The ration mutton must be delivered in carcasses, excluding heads, and also the shanks from below the knee and hock joints.

If the kidneys are removed, the kidney fat must also be removed.

THE INSPECTION OF BREAD.

The following are the chief characteristics of *good bread:* The crumb should taste and smell sweet. The crust should be of a rich brownish-yellow tint, well baked, but not burnt and not too thick. The crumb should be light and flaky, and if worked between the fingers it should be neither too brittle nor too doughy. It should be elastic and resume its place after light pressure. The whole of the crumb should be cream white and show small evenly distributed cavities. These are caused by the carbonic acid gas, which distends the gluten, and thus makes the loaf to 'rise.'

Defects in Bread.—If the bread be acid, badly risen, or of a yellowish colour, it may be owing to the use of old or fermented flour. If bread is unnaturally white, light, or brittle, alum or some other chemical may be suspected in the flour. Bread which is very compact and briny is probably 'salt-bound' If the loaf is large, but wanting in firmness and insipid to the taste, sufficient salt has not been used. Among many causes which may lead to bread being sodden and heavy are the use of bad yeast or inferior flour, the dough being made too slack or badly kneaded, in which case the uneven size and distribution of the cavities in the crumb will be noticed, and possibly the presence of uncooked portions of flour. Another is the use of too hot an oven, which causes the crust to form too soon, before the inside is baked, and thus hinders the moisture at the centre of the loaf becoming evenly distributed.

Conditions of the Army Bread Contract.—The usual conditions of army contract for the supply of bread by civilian contractors for the use of troops in the United Kingdom are as follows :

1. The contractor, if required, to weigh the bread at the time of issue to the troops, providing, if necessary, the requisite scales and weights.

2. The bread supplied shall be subject to the approval of the officer receiving it, and any bread rejected as not being in accordance with the specification shall be immediately removed by the contractor at his own expense ; and the said officer may purchase bread in lieu of that rejected, any extra expense incurred by such purchase being defrayed by the contractor.

3. If the contractor shall fail to deliver the supplies demanded at the specified times and places, or to replace bread rejected if so ordered, the officer in charge

may take steps to procure or replace the quantity deficient at the contractor's expense.

4. The premises* of the contractor (where the bread to be supplied under contract is in course of preparation) may be inspected from time to time by an authorized military officer.

Specification.—1. The bread shall be of good colour, sweet, well made, and properly baked; made from flour clean and free from grit, the produce of good, sound, sweet, and dry wheat.

2. The bread shall be delivered not earlier than twenty-four hours and not later than forty-eight hours after baking.

3. Each loaf shall weigh fully 2 pounds at the time of issue.

Inspection of Contract Bread.—When weighing, it is best to select several loaves from different parts of the consignment, and weigh each singly. Contractors do not, as a rule, scale the bread with the same care as military bakers, and therefore like to weigh a number of loaves at a time.

In addition to the defects liable to occur in all bakeries, there are certain devices resorted to by dishonest contractors for the purpose of fraud. One of the commonest of these is 'underbaking,' which consists of retaining in the loaf the excess of water which should escape during baking. This is done by placing the dough into too hot an oven, thus causing a thick crust to be formed before the bread is baked inside. Placing bread into too slack an oven also causes the bread to be underbaked and heavy. Not leaving it sufficiently long in the oven has a similar effect. Underbaking, and adding boiled rice, rice flour, or alum, is sometimes done to make the bread absorb and

* The inspection of the bakehouse and its annexes is of the greatest importance. The staff employed should be closely looked at for infectious disease, especially tuberculosis.

retain a large quantity of water, and thus water is sold at the price of bread.

By these means 100 pounds of flour may be made to retain 40 pounds of water, whereas in properly baked bread there should not be more than 35 per cent. To determine the amount of water in bread, weigh 500 grains of crumb, place in an oven at a temperature of 212° F. for two hours, then weigh again, and the difference will be the amount of water contained in the bread.

The use of potatoes in making bread was at one time much more common than at present. Formerly boiled potatoes were added direct to the dough, and employed as a substitute for flour. This practice is now forbidden by law, unless the bread be stamped and sold as a mixture. But it should be remembered that the use of potatoes for the purpose of yeast making and development is not in any sense an adulterant, and this is definitely permitted by law.

The objection to the use of potatoes in bread is that they are not so nutritious as flour, and that they tend to make the bread go sour.

Among the mineral adulterants found in bread, alum is the commonest. It is used for two purposes :

1. To enable flour of bad colour and inferior quality to produce bread equal in appearance to that made from good flour.

2. To enable the flour (by hardening the gluten) to retain a larger proportion of water, thereby increasing the weight of the loaf.

If the crumb of the loaf appears to be unnaturally white, dry, and very brittle when rubbed lightly with the fingers, the presence of alum may be suspected. As the chemical test for alum and other mineral impurities requires time, suspected samples are generally submitted to the specialist sanitary officer.

The Storage of Bread.—The bread store should be dry, cool, and well ventilated. The racks should be placed in the centre, so as to admit air freely to the whole of the bread. Not more than two layers of loaves of new bread should be placed on each shelf in the rack, but if the bread is thoroughly dry, there is no objection to storing it several tiers high. If warm bread be piled up in a heap, the loaves, especially those in the centre and at the bottom of the heap, will most likely be sodden.

If the bread store is not properly ventilated, the evaporation of moisture from the bread is reduced, and this is prone to make it heavy.

'Emergency' Bread.—The following extract is taken from Professor Church's book on 'Food':

'In times of scarcity all sorts of vegetable matter have been mixed with wheaten flour and meal to eke out a limited supply of these nutritious matters. During the Siege of Paris a coarse bread was made containing but little wheat, the main ingredients being potatoes and beans, with oats, rice, and rye, together with a good deal of fibrous vegetable matter in the shape of chaff and straw. In Norway and Sweden the sawdust of non-resinous woods, like beech and birch, is boiled in water, baked, and then mixed with flour to form the material for bread; and in England, during the seventeenth century, a very tolerable bread was made from a mixture of the pulp of boiled turnips with wheaten flour.'

BISCUITS AND OTHER BREAD-STUFFS.

Biscuits.—Army biscuits are made by machinery, and consist of meal, salt, and water, kneaded into a thick paste, cut into the proper shape, pricked with holes, and baked in the oven. Bread made with yeast, etc., soon becomes musty, whereas biscuits will keep for a long time. Biscuits are generally made of the meal of wheat from which only the coarsest bran has been separated, and are made in the form of flat cakes to ensure their being deprived of moisture in baking.

Biscuits are a convenient and compact form of food, especially as regards transport and keeping properties, and are well adapted for the use of soldiers in the field. If properly packed in casks or tins, they will keep a long while, but if exposed to damp they soon become mouldy. They contain much more nutriment than the same weight or bulk of bread, $\frac{3}{4}$ pound of biscuit being equal to 1 pound of bread. This is the ration on peace service, but in the field 1 pound of biscuit is issued in lieu of $1\frac{1}{4}$ pounds of bread.

In the manufacture of biscuits there is a loss of about 10 per cent. in weight, whereas in the manufacture of bread there is a gain of about 30 per cent. The reason of this is that biscuits, being flat, compact, and highly dried in baking, lose not only the water used in making the dough, but also the moisture in the flour itself.

Biscuits should be of a light yellow colour, highly dried and crisp, but not burnt. They should float in water, and when struck give a ringing sound. A piece put in the mouth should thoroughly soften down.

The army biscuit must be hard enough to permit of its being carried without crumbling in the soldiers' haversacks, together with the miscellaneous collection of articles usually contained therein. For field service biscuits are packed in tin-lined cases. The present pattern army biscuit weighs 2 ounces.

Unfermented Cakes.—The 'chupatty' of India is simply made with flour, water, and salt. It is agreeable to the taste and nutritious. When made in India by the native cook it is eatable; when made by the British soldier after a long day's march or work, it is often the reverse.

It is made by mixing flour and water with a little salt into a stiff dough, which is rolled out to a thickness of about a quarter of an inch between the palms of the hands. It is then cooked over a hot fire on a piece of metal.

The Australian 'damper' is made by digging a hole in the ground, filling it with a wood fire, and when the fire has thoroughly burnt up, removing it, laying the dough on a large stone, covering it with a tin plate, and heaping the hot ashes round and over it. In a campaign every soldier, if he could get flour, baking powder or bread soda, and wood, should learn to bake a cake for himself. The only point of manipulation which requires practice is not to have the heat too great; if it be above 212° F. too much of the starch is turned into dextrine, and the cake is tough. Exposed to greater heat and well dried, the unfermented cake becomes biscuit.

Should the chupatty or damper be spoiled in the cooking, soak it in water—or milk, if available—and bake it again in any form of improvised oven. A fairly palatable form of biscuit may thus be obtained.

THE SOLDIER'S RATIONS DURING WAR.

For men constantly engaged in marching and fighting the peace-ration (3,500 calories) is insufficient unless supplemented from other sources. About 4,500 calories would be needed, to judge from available data.*

Scale for Active Operations.—A special scale of rations dependent on the climate and the circumstances of the expedition is directed to be fixed by the General Officer Commanding the force, and it is laid down (Allowance Regulations, paragraph 27) that the following daily scale be adopted as far as possible as a guide:

Meat: 1¼ lb. of fresh meat, or 1 lb. (nominal) of preserved meat, or 1 lb. of salt meat.
Bread: 1¼ lb., or 1 lb. of biscuit, or 1 lb. of flour.
Tea: ½ oz.
Jam: ¼ lb.
Sugar: 2 oz.

* *Vide* 'Report of Committee on the Physiological Effects of Food, etc., on the Soldier,' *loc. cit.*

Salt: $\frac{1}{2}$ oz.

Pepper: $\frac{1}{36}$ oz.

Vegetables: $\frac{1}{2}$ lb. of fresh vegetables, or 4 oz. of dried vegetables, or 4 oz. of preserved fruit.

Lime-juice: $\frac{1}{320}$ gallon ($\frac{1}{10}$ gill), with $\frac{1}{4}$ oz. of sugar, on days when fresh vegetables are not issued.

Rum: $\frac{1}{64}$ gallon ($\frac{1}{2}$ gill).

Tobacco: Not exceeding 2 oz. per week, for those who smoke.

Lime-juice, *rum*, and *tobacco* are issued at the discretion of the General Officer Commanding on medical recommendation.

Ration Equivalents.—Whenever it may be necessary, or in the opinion of the General Officer Commanding expedient, to vary the scales laid down above, the following scale of equivalents may be followed (Allowance Regulations, paragraph 28):

Coffee: 1 oz. = $\frac{1}{2}$ oz. tea.

Chocolate: $\frac{1}{3}$ oz. = $\frac{1}{6}$ oz. tea.

Biscuit *Rice*	$\frac{3}{4}$ lb. = 1 lb. bread.

Salt meat: 1 lb. = meat ration.

Meat and vegetable ration: = meat ration (also vegetables in the field).

Pea Soup or Erbswurst: 2 oz tin = 3 oz. meat.

Porter: 1 pint = $\frac{1}{2}$ gill of spirits.

Preserved potatoes: uncooked 2 oz. *Rice or peas:* 2 oz. *Onions or leeks:* $\frac{1}{2}$ lb.	= $\frac{1}{2}$ lb. ordinary fresh vegetables.

Split peas: $\frac{1}{3}$ pint *Calavances:* $\frac{3}{4}$ pint *Dhal:* $\frac{3}{4}$ pint *Oatmeal:* $\frac{1}{4}$ pint	= $\frac{3}{4}$ lb. flour.

Equivalents Special to Field Service.—When troops are under canvas at home, the extra $\frac{1}{4}$ lb. of meat allowed, or any portion of it, may, at the option of the Officer Commanding, be left undrawn, and the money value of the quantity undrawn may be expended regimentally in purchasing cheese (Allowance Regulations paragraph 29).

Active Service Alternative Issues. — On active service the following alternative issues may be made :

1. At the discretion of the General Officer Commanding, ¼ lb. of biscuit may at any time be substituted for ¼ lb. of meat on the days that preserved meat is issued.

2. When bacon and cheese are available, ¼ lb. ofbacon or 2 oz. of cheese may be substituted for ¼ lb. of meat.

War Rations of Various Armies.—The table on p. 208 shows the weight in grammes of protein, fat, and carbohydrates, and also the total value in calories, of the war rations of various armies.*

SCALES OF RATIONS IN VARIOUS CAMPAIGNS.

The following scales of rations have been issued in different campaigns :

Ashanti, 1895-96.—The daily ration for each officer and man of the European or West Indian troops was as follows :

Bread or biscuit, 1½ lb. ; fresh meat, 1½ lb., or preserved meat, 1 lb. ; tea, ½ oz. ; cocoa paste, 1 oz. ; dried onions, or compressed vegetables, 1 oz. ; preserved potatoes, 1 oz. ; sugar, 2 oz. ; salt, ½ oz. ; pepper, $\frac{1}{36}$ oz.

The following *equivalents* were used :

In lieu of fresh (or preserved) meat and the vegetable ration, one Maconochie ration ; in lieu of the bread ration, 1 lb. of flour.

Extras.—Pea-soup (1 oz.) was frequently given for the men's supper when on the march. Jam was issued occasionally at the rate of ¼ lb. per man ; rum (½ gill)

* *Vide* 'Report on the Physiological Effects of Food, etc., on the Soldier,' *loc. cit.*; also 'Notes on Rations of Different Armies in Peace and War,' by Colonel W. G. Macpherson, C.M.G., A.M.S., in the *Journal R.A.M.C.*, vol. xiii., pp. 459-477.

was issued daily when marching. On medical recommendation, lime-juice (½ oz.) and sugar (¼ oz.) were issued. Oatmeal for mixing with drinking water was supplied to all men exposed to extreme heat or toil.

The daily *rations for natives* were—

For Haussas, 1 lb. of biscuit and 1 lb. of preserved meat. For Sierra Leone carriers: 1½ lb. of rice, ¼ lb. of fresh or preserved meat, ½ oz. of salt, and $\frac{1}{36}$ oz. of pepper.

WAR RATIONS OF VARIOUS ARMIES.

	Protein.	Fat.	Carbohydrates.	Value in Calories.
	Grammes.	Grammes.	Grammes.	
British army (South African minimum)...	138	105	528	3,903
French army... ...	143	72*	517†	3,383‡
German army (war ration, 'normal') ...	118	68	411	2,801§
Russian army (Manchuria)	187	27	775	4,891
Japanese army (Manchuria)	158	27	840	4,343
United States Army (field ration) ...	167	110	608	4,199

* With soup. † With bread.

‡ The 'normal' war ration in the French army amounts to 3,064 calories, the augmented ration 3,383. With 250 grammes *pain de soupe* added, the calories become 3,686 and 4,005 respectively. The 'normal' ration in both the French and German armies is a ration that may be supplemented by whatever articles of food the General Officer Commanding may authorize.

§ The latest works on military hygiene in Germany draw attention to the insufficiency of the war ration, which it is said ought to contain 150 grammes of protein, 100 grammes of fat, and 500 grammes of carbohydrate, giving 3,575 calories.

Khartoum, 1898.—The European ration consisted of: Fresh meat, $1\frac{1}{4}$ lb., or preserved meat, 1 lb., or authorized equivalents; bread, $1\frac{1}{2}$ lb., or biscuit, 1 lb., or authorized equivalents; tea, $\frac{1}{2}$ oz.; coffee, $\frac{1}{2}$ oz., or 1 oz. cocoa paste; sugar, 3 oz.; salt, $\frac{1}{2}$ oz.; pepper $\frac{1}{36}$ oz.; dried onions, 1 oz., or compressed vegetables, 1 oz., or fresh vegetables, 1 lb., or beans, 3 oz.; preserved potatoes, 1 oz., or an equivalent; rice, 2 oz.; lentils, 1 oz.

Extras.—Lime-juice, $\frac{1}{10}$ gill, when considered necessary by medical officer; rum, $\frac{1}{2}$ gill, when sanctioned by General Officer Commanding; jam or marmalade, $\frac{1}{4}$ lb. for each man (issued once a week); bacon, 4 oz. in lieu of 4 oz. fresh or preserved meat once a week.

Rations for Natives.—Bread, biscuit, or flour, 1 lb.; meat, fresh or preserved, $\frac{1}{2}$ lb.; coffee, $\frac{1}{3}$ oz.; sugar, 2 oz.; salt, $\frac{1}{2}$ oz.

South African War, 1889-1902—*Scale of Rations for Civilian Employees.*—1. White conductors—a soldier's ration (see pp. 210-211). 2. Native headmen, and white or coloured drivers, leaders, Cape boys, intelligence scouts, wiremen and headboys, employed under the Director of Transvaal Telegraphs—a soldier's ration of meat, bread-stuffs, groceries, and fuel only.

Other South African Natives.—Mealies, 3 lb.; fresh meats, $1\frac{1}{2}$ lb. on Sundays; salt, $\frac{1}{2}$ oz. For coloured drivers, leaders, and natives, $1\frac{1}{2}$ lb. of meal was ordinarily issued as the ration of bread stuffs, and when meat was not available the ration of meal was, when practicable, doubled.

Scale of Rations for Indian Natives.—Native clerks, agents, hospital assistants, non-commissioned officers, and men of the Indian regular forces: Atta, or rice, or flour, $1\frac{1}{2}$ lb.; dhal or peas, 4 oz.; ghee or sweet oil, 2 oz.; salt, $\frac{2}{3}$ oz.; chillies or curry powder, $\frac{1}{6}$ oz.; amchur or tamarind, $\frac{1}{2}$ oz.; goor or sugar, 2 oz.; onions or other fresh vegetables, 1 oz.; meat, 8 oz. (thrice weekly); fuel wood, $1\frac{1}{2}$ lb. Non-meat-eaters might receive 3 oz. goor or sugar in lieu of the meat ration.

Scale of Rations for Troops in the South African War of 1899-1902.*

Description.	Quantity.	Remarks.
Bread-stuffs :		
Bread	$1\frac{1}{4}$ lb.	When flour or meal is issued, seven cakes of patent yeast will, if available, be supplied per 100 lb. of flour. Baking powder, 19 oz. to 50 lb. flour.
Or biscuit	1 ,,	
Or flour	1 ,,	
Or meal	$1\frac{1}{2}$,,	
Meats or equivalents :		
Fresh meat	$1\frac{1}{4}$ lb.	In issuing preserved meat to columns small tins should be issued—1-lb. tins if possible, but none larger than 2-lb. tins. Maconochie's or similar ration of meat and vegetables.
Or preserved meat	1 ,,	
Or Maconochie's ration ...	1 ,,	
Bacon	$\frac{1}{4}$,,	Bacon or cheese issued in lieu of 4 oz. fresh or 3 oz. preserved meat.
Cheese	2 oz.	
Biltong	4 ,,	In lieu of full meat ration.
Bovril	$\frac{1}{2}$,,	Ditto for mobile columns.
Flour	$\frac{1}{2}$ lb.	In lieu of $\frac{1}{2}$ lb. meat. To be issued to troops in block-houses when available.
Groceries :		
Coffee	1 oz.	Half-ounce coffee extra, when available, for early morning coffee; but when drawn for this purpose the *ration* issue will be tea, not coffee.
Tea	$\frac{1}{2}$,,	
Or half rations of each		
Or chocolate or cocoa	1 ,,	Half-ounce chocolate extra, when available, for hospital orderlies on night duty.
Sugar	3 ,,	Includes any required for lime-juice and early morning coffee.

Salt	$\frac{1}{2}$,,	
Pepper	$\frac{1}{36}$,,	
Vegetables or equivalents :		
Potatoes	$\frac{1}{2}$ lb.	When potatoes and onions or other fresh vegetables are available at the same time, they should be issued in the proportion of 2 to 1. Total ration, $\frac{1}{2}$ lb. When available, an additional ration of $\frac{1}{2}$ lb. of fresh vegetables may be drawn in lieu of the jam ration.
Other fresh vegetables	$\frac{1}{2}$,,	
Onions	$\frac{1}{4}$,,	
Compressed vegetables ...	1 oz.	
Split peas or rice	2 ,,	
Pea-soup, 2-oz. tins	1 tin	
Pickles	2 oz.	
Jam or equivalents :		
Jam	$\frac{1}{4}$ lb.	
Fruit, common	1 ,,	In lieu of $\frac{1}{4}$ lb. of jam. When rhubarb is issued, troops will find the sugar.
Fruit, superior	$\frac{1}{2}$,,	
Rhubarb	1 ,,	
Lime-juice ($\frac{1}{10}$ gill)	$\frac{1}{2}$ oz.	Daily when fresh vegetables are not available.
Lime-juice	$\frac{1}{2}$,,	On four days a week when fresh vegetables are issued.
Rum	$\frac{1}{64}$ gall.	Not oftener than thrice weekly (under authority of General Officer Commanding) when malt liquor is not available. An extra ration of tea or other equivalent may be issued in lieu to abstainers. On no account should an issue for more than one day (and that the day of issue) be made. Back issues 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.

* 'Army Service Corps Regulations.'

Extras were issuable on recommendation of medical officers, when approved by the General Officer Commanding.—Rum, ½ glass ($\frac{1}{16}$ pint), or to abstainers ¼ oz. tea or ½ oz. sugar.

During the winter months (April to September) the following additions could be made to the ration for Indian natives: Daily, ¼ oz. tea and 1 oz. sugar; weekly, ½ glass of rum.

Scale of Rations, Somaliland Field Force, 1909-10.

Europeans.—(Daily), fresh meat, 1¼ lb., or pressed meat, 1 lb.; flour, bread, or biscuit, 1 lb.; onions, 6 oz.; jam, 4 oz.; tea, coffee, or cocoa, 1 to $\frac{1}{7}$ oz.; sugar, 2 to $\frac{2}{7}$ oz.; rice, 4 to $\frac{4}{7}$ oz.; salt, $\frac{2}{7}$ oz.; pepper, $\frac{1}{7}$ oz.; dried fruit, 2 to $\frac{2}{7}$ oz.; lard, 2 oz.; Worcester sauce, $\frac{1}{10}$ bottle; candles (officers only), 1; rum (weekly), $\frac{1}{64}$ gallon.

Indians.—(Daily), atta, 1 lb., 6 oz.; rice, 4 oz.; ghee, 2 oz.; goor, 2 to $\frac{2}{7}$ oz.; curry powder, $\frac{1}{3}$ oz.; salt, $\frac{2}{3}$ oz.; tea, $\frac{1}{7}$ oz.; meat (fighting men only), ½ lb.

Africans (Daily).—Rice, 1 lb.; dates, ½ lb.; ghee, 2 oz.; meat (for African fighting men only) was provided under regimental arrangements, an allowance of Re. 1.8 per man per month being drawn.

Extras, for Africans, other than Somalis, in addition to above: Onions, 4 oz. daily; salt, $\frac{1}{3}$ oz. daily; lime-juice, ½ oz. per week; sugar, ½ oz. per week.

1. Maxim-gun porters drew rations as fighting men.
2. Followers, public or private, drew rations according to their nationality (*i.e.*, either Indian, Somali, or other African), except clerks (other than Europeans), who drew rations under the following regulations:

Class A.—Clerks of European descent (*i.e.*, Goanese and Eurasians) were allowed a free European ration, to the value of 14½ annas daily. (This was equivalent to the full European ration, less rum and candles.)

Class B.—Musulman clerks, were granted a free Indian ration.

Class C.—Hindu clerks were granted a free ration of such articles of the Class B (Indian) ration as they cared to draw.

Class D.—Somali clerks were granted a free Somali ration.

3. For Europeans, one Army ration was counted as equivalent to either $1\frac{1}{4}$ lb. fresh meat, or 1 lb. preserved meat.

4. Rations in kind were not drawn at Berbera, but a money allowance was issued in lieu at the rate of Re. 1 per day for officers, and $14\frac{1}{2}$ annas per day for non-commissioned officers.

'EMERGENCY' RATIONS.

By an 'emergency' ration is meant some form of prepared food of a concentrated nature given to the soldier in time of war, only to be used in time of necessity when any other food is unobtainable.

The manufacture of concentrated foods suitable for field rations has been perfected to such an extent during recent years, that the issue of an ideal 'emergency' ration will only be a matter of time.

Such a ration should fulfil the following conditions:

1. Be palatable, and possess a daily food value of at least 4,000 calories, in order not only to keep a man alive, but also to supply him with full fighting energy.

2. Be easily portable. It should not be too heavy, bulky or fragile.

3. Be capable of remaining sound and wholesome for at least two years under varying conditions of service and climate.

4. Be capable of being consumed uncooked or made up into a hot meal when cooking is possible.

The 'emergency' ration constitutes the so-called 'iron' or 'eiserne' ration of the German and other armies, and is of two classes:

(*a*) A small, very light ration calculated to maintain the strength of the body for thirty-six hours.

(*b*) A small but portable ration, weighing 1 to 2 pounds, calculated to give the soldier almost enough to eat for several days. Our own Army, as well as that of the United States of America, have an emergency ration based on the principle of class (*a*); the French and German Armies follow the axiom laid down in class (*b*).

The Emergency Ration of the British Army.—The present 'emergency ration' issued to British troops for use on active service weighs 6½ ounces (net), and consists of four cakes of chocolate, with added plasmon or other equally suitable milk proteid. The chocolate is roasted cocoa bean of good quality (completely deprived of husk or shell and containing the whole of its natural fat) mixed with sugar, the latter being either sucrose or lactose, or a mixture of these. The milk proteid is soluble in water; it and all the ingredients used in the manufacture of the ration are of the best quality, and free from any adulteration or chemical preservatives.

Analysis.—According to specification, samples of the proteid have to be submitted separately from, and in addition to, the sample of the completed ration at the time of tendering.

Average of analyses of samples of deliveries to give the following results:

Moisture not to exceed ...	3 per cent.	
Proteid average	31 ,,	to 33 per cent.
Cocoa fat	26 ,,	to 28 ,,
Carbohydrates	37 ,,	to 33 ,,

No individual sample shall, on analysis, fall outside the following limits:

Moisture	3 per cent.	maximum
Proteid	30 ,,	minimum
Fat	25 ,,	,,
Carbohydrates... ...	39 ,,	maximum.

Packing.—The emergency food is wrapped in vegetable parchment paper, and packed in a hermetically sealed tin, the lid of which, though sealed by a strip of metal, is easily removed by hand. The lid of each tin is stamped, showing the date (month and year) of manufacture, thus—8, '07. The tins are lacquered all over, and bear a label showing the name of the firm by whom the food is made and also the following instructions :

Instructions.

1. This ration is not to be opened except by order of an officer or in extremity.

2. It is to be carried in the haversack and produced at inspections.

3. It is calculated to maintain strength for thirty-six hours if eaten or drunk in small quantities at a time.

4. Open by removing clip round lid.

5. The ration may either be eaten dry or made into a beverage.

6. To prepare the beverage, scrape one stick of the ration, and boil the scrapings in ½-pint of water, keeping it boiling for three minutes.

The Emergency Ration of the United States Army.* —This ration is calculated to give 4,110 calories, and consists of biscuit, 16 ounces ; bacon, 10 ounces ; pea-meal, 4 ounces ; coffee, 2 ounces ; salt, 0·64 ounce ; pepper, 0·4 ounce ; and tobacco, 0·5 ounce. It was subjected to a practical trial in the field, says Munson, in 1897, by a troop of cavalry. The men had a preliminary trial of two days on ordinary rations. They were weighed and marched for ten days, doing twenty-one miles each day, on an average, in a country where no food could be obtained from outside sources. Careful records showed an average loss of 2·935 pounds per man in the ten days ; but five

* *Vide* 'Notes on Rations of Different Armies in Peace and War,' by Colonel W. G. Macpherson, C.M.G., A.M.S., *Journal of the Royal Army Medical Corps*, vol. xiii., pp. 459-477.

men gained weight, and some retained their original weight.

The Emergency Ration of the French Army.*—This is a two days' ration, carried in the haversack, and is only allowed to be used when ordered. It consists of biscuit, 1,200 grammes; rice, 60 grammes; dried vegetable, 60 grammes; tinned meat, 400 grammes; concentrated soup, 50 grammes; salt, 40 grammes; sugar, 42 grammes; and coffee, 32 grammes. Half these quantities constitute one day's ration, calculated to equal 2,130 calories only, or 2,515 if the concentrated soup is made of bean or pea flour.

The Emergency Ration of the German Army.*—Two emergency rations are carried by each soldier, and are used only under orders. Each ration consists of: field biscuit, 500 grammes; tinned meat, 200 grammes; preserved vegetables, 150 grammes; coffee (roasted), 15 grammes; and salt, 25 grammes. The value of the ration has been estimated to be 142 grammes proteins, 49 grammes fat, 420 grammes carbohydrates, or 2,766 calories.

The Emergency Ration of the Japanese Army.*—During the war with Russia in Manchuria in 1905, the Japanese emergency ration consisted of a tin of meat, containing one-third beef, with little fat or gravy, but mixed with sugar, and a bag of cooked and desiccated rice, which formed an excellent cooked rice ration when mixed with water, equivalent in quantity to the uncooked rice ration. The rice ration could be replaced by its equivalent in biscuits, a packet of three biscuits weighing about 3 ounces, being equal to one-sixth of the uncooked rice ration. Six such packets were equivalent to a rice ration.

* See note, p. 215.

THE NECESSITY OF A VARIED DIET IN WAR.

On active service every officer, from the General in supreme command to the section commander, must give the subject of the variation of rations and the feeding of his troops the closest personal attention, for the men in this matter depend entirely on their superiors. Once the troops are satisfied that their officers are doing their best in this respect, they will not 'grouse,' and will bear cheerfully the most severe privations.

Soldiers on service seldom complain of their rations: they accept the inevitable; and for this reason the greatest supervision ought to be exercised by all officers, not only over the variation of the food, but also over the methods of its preparation—*e.g.*, cooking and service in the field. Troops consider it unsoldierlike to complain on service unless things are very bad; as a rule, they content themselves, and have a strong pride about roughing it—a pride almost professional, which hinders them from making any complaint.

So much depends on the variation of food, especially in war, that the soldier should have the best variations in the market, and there should be no 'cheese-paring' policy, so long as economy of transport is not interfered with.

Modern physiological research proves that the composition of foodstuffs is most complex, and that, besides calculating their chemical composition and energy value, it is also necessary to consider the questions of personal likes and dislikes of the consumers. Rations that are unpalatable, and consumed without relish by troops, cannot in all cases be regarded as physiologically beneficial, and general health may suffer. A dietary loses its value if it is very monotonous, and it is held that on active service this monotony makes troops liable to scurvy.

Scurvy.—The causes of scorbutic conditions met with on field service are as yet imperfectly understood, and while in some cases they have been attributed to the use of tinned meats and preserved vegetables, the writer has noticed many of the signs and symptoms of scorbutic affections appear, not only in troops on service, but also in persons in civil life at home and abroad, amongst whom fresh meat and fresh vegetables were their daily diet, but in whom dirty mouths and carious teeth were noticeable, and where the necessary variations in diet were not employed; and he is forced to conclude that a septic mouth and a sameness of diet, or, so to speak, a want of variation, may be considered the causal factors. Nothing exercises so deleterious an effect on digestion as a monotonous diet, and loss of appetite is bound to occur. The late Sir H. M. Stanley, the celebrated explorer, insisted that soldiers on tropical service required a frequent change of diet to keep them in good health. Men's rations should therefore be varied as much as possible from day to day, and no opportunity should be lost of obtaining fresh green vegetables or potatoes. Lord Wolseley has suggested that mustard and cress seed might be taken on field service, and no doubt seeds of many vegetables might be usefully employed on the lines of communication, or in blockhouse gardens, as all green vegetables are good antiscorbutics. As a prophylactic against scurvy, lime-juice is now always issued at certain *fixed* intervals to British troops on service, and it is also issued *at any time* when so recommended by a medical officer (see Scale of War Rations, p. 206).

Whenever the issue of lime-juice becomes necessary, fresh limes, if available, should, if possible, be given in preference to the preserved juice; the latter, though cheaper, is much less protective against scurvy than the fresh juice. The taste of lime-juice should be pleasant, acid, but not too bitter. It should *always* be issued on service and not delayed until the men's gums begin to become spongy. Sugar should be issued with it if it is unsweetened. Lime-juice should not be sent on service in bottles ; to avoid breakage it should be sent in jars.

It must not be forgotten that native troops and camp followers are very prone to scurvy, and that it is very possible that the disease becomes infective.

In the Russo-Japanese war, during the siege of Port Arthur, considerably more than half the garrison were markedly affected by scurvy (8,000 cases of scurvy being in the hospitals alone) ; the officers, however, suffered very little in comparison with the men. No prophylactics against scurvy, such as lemon or lime juice, could be obtained by the Russian garrison, and this lack of forethought was one of the chief causes of the early capitulation of the fortress. Citric acid was given after scurvy appeared, but this was more or less ineffective as a prophylactic. The treatment of scurvy at Port Arthur after the capitulation resolved itself into a dietetic (fresh meat and fresh vegetables) rather than a medicinal one.

PRESERVED FOOD.

During war troops have to depend to a large extent upon preserved rations, notably tinned meat. The palatability and quality of the various brands of the latter are subject to great variations.

The Inspection of Tinned Foods.—When examining tinned foods, the following points should be borne in mind :*

1. *The Age of the Supplies.*—Each tin should bear the date of its manufacture legibly stamped in the metal of the tin itself.

* For detailed information, *vide* 'Practical Hygiene,' by Majors C. F. Wanhill and W. W. O. Beveridge, R.A.M.C.

2. *The External Condition of the Tin.*—(*a*) Each tin should be painted or lacquered. Paper labels should not be used on tins intended for active service.

(*b*) No marked denting or rusting should be present.

(*c*) The tins should have concave ends, and not bulged. If bulged, open under water and note any escape of gas. Satisfactory tins give a dull note on being struck, thus showing that the tin is well filled and free from gas. Bad tins give a hollow drumlike note.*

(*d*) Not more than two solder holes should be present; additional holes suggest that the tins have been tampered with—*e.g.*, resoldered after allowing putrefactive gases to escape.

3. *The Condition of the Contents.*—Open the tin and turn out the contents on a plate. In the case of *meat*, see if the meat closely fits the can and that there are no holes or hollows. The outside of the meat should have a covering of fat and jelly (gelatin). The latter should be solid at ordinary temperature. Note smell and taste of the meat. Next split the meat down the centre lengthwise, and examine for the presence of bone, bloodvessels, fascia, gristle, etc., which, if present, are indicative of bad or careless trimming, as these are all supposed to be removed. The fat ought to be evenly distributed. If it occurs in patches, it shows that the fat has not been evenly distributed through the lean before leaving the trimming table. The meat fibres should be firm and elastic, not pitting on pressure, and of a healthy pink tinge, showing in certain lights an iridescent hue from the pickling. Look for blackened patches due to metallic contamination.

In the case of *fruits, jams*, etc., note the presence of moulds or bubbles of gas (fermentation), etc.

* If a suspected tin be incubated at 37° C. for fourteen days and no bulging appears, the *Bacillus cadaveris* and other spore-bearing organisms are absent.

4. *The Condition of the Inside of the Tin.*—(*a*) Note any erosion of the tin, and also any marked blackening (can-burn) of the tin plating (due to sulphide of iron and tin). The interior of the tin is sometimes varnished.

(*b*) There should be practically no solder visible along the seams. The use of outside seams should be insisted on whenever possible.

Preserved Meat.—Tins of preserved meat, soup, etc., will be considered as unfit to be received from contractors for any of the following reasons :*

1. When perforated by nails, etc. The preserving qualities of tinned articles depend upon their being hermetically sealed after undergoing sterilization, and therefore the piercing of the tin exposes the contents to the germs of putrefaction.

2. When there are any angular indentations which are likely to have caused partial fracture to the tin, and rendered it liable to rust. Rust soon works its way through tin and causes minute holes, which, although not visible to the naked eye, are yet large enough to permit the ingress of the atmosphere laden with the germs of putrefaction.

3. When they contain deleterious gas, and are bulged, or 'blown.' Such tins are called in the trade 'swells.' The condition indicates that the sterilization of the contents has been imperfectly carried out, with the result that they have putrefied after the tin had been closed. The process of putrefaction engenders certain gases, the presence of which causes the sides of the tin to bulge.

The sides of a tin containing a preserved article of food should always be slightly concave, this being due to the pressure of the atmosphere on the outside being greater than on the inside, owing to the partial vacuum which exists within. The ends are usually made of thicker material, and may or may not show this characteristic. Should putrefaction ensue, the position is re-

* *Vide* 'Army Service Corps Training,' Part II.

versed, the pressure becomes greater inside than out, and the sides of the tin become convex. If pressed in, they will, when released, spring back to their old position with a snap. If the tin is pierced with a nail, or holes supervene through rust, these gases escape, and, the pressure being released, the sides of the tin resume their normal position. The contents are bad, however ; hence the necessity for examining tins carefully to be sure that they are intact.

4. When they are rusty, or when the lacquer has worn off the tins, which renders them more liable to rust.

5. When it is found that the tin does not adhere closely to the contents, or when it is evident that the tin has not been hermetically soldered; and that the meat has either dried or putrefied in consequence.

After each tin has been subjected to such inspection as would minimize the possibility of any of the above damages escaping detection, the whole quantity should be placed in rows, and the examiner should strike each tin lightly with a small wooden mallet or lead pencil, and put aside for further examination any tins which by their hollow sound appear to contain meat in an incipient state of putrefaction, or which have not been filled to their full capacity.

The good tin gives a clear ring when struck, which cannot be mistaken for the hollow dull sound given by the tin which contains deleterious gases or is half empty.

A proportion of each consignment of tins should be opened, and the interior of the tins should be examined for signs of corrosion. Many articles that are preserved in tins (particularly fruits) contain acids which are likely to act on the metal and absorb sufficient quantities to make the consumption of the contents dangerous to human beings.

In the report upon the food of the soldier recently issued by the sub-committee of the Advisory Board to the Medical Services appointed by the War Office, many important suggestions have been made as a result of its investigations. In regard to the amount of fat in tinned meat, the sub-committee considers that meat with less than 10 per cent. or more than 15 per cent. of fat is unpalatable to most men. It also considers that the reason why tins of meat, after passing the tests applied by the manufacturers, become suddenly blown after keeping good for months, or maybe years—a condition thought to be due to minute punctures occurring from rust or damage allowing air to enter—is really the development of spores of bacilli, such as the *Bacillus cadaveris*, which were present in the meat at the time of packing and were not destroyed by sterilization, the heat of sterilization having been insufficient to penetrate to the central parts of the meat in the tin. In some cases the amount of nitrate derived from the pickling fluid was found excessive, and its ingestion would probably cause gastric derangement. The nature of 'can-burn' was found to be due to a deposit of sulphide of tin, sulphide of iron, and oleate of iron.

The sub-committee came to the following sound and practical conclusions: (1) That the soldier—both the recruit and the trained soldier—receives sufficient food during peace time, and that its quality and variety are generally satisfactory; (2) that further investigations concerning the field service rations are needed; (3) that the supply of tinned meat requires careful supervision,* for some brands contained meats of inferior quality; (4) that to prevent 'blowing' of tins the lowest temperature of the surrounding sterilizing fluid during manufacture which

* It is stated in the report issued by the sub-committee on 'The Physiological Effects of Food, etc., on the Soldier,' *loc. cit.*, that 'they understand, from a communication from the Director of Supplies, that in future the manufacture of tinned meat in the United States of America will be under the supervision of the supply branch of the army, and that in the British colonies only the firms which prepare the best articles will receive contracts.'

will completely sterilize the tins within a reasonable time is 120° C. (248° F.), and that this temperature must act for not less than sixty minutes; and (5) that the amount of fat in tinned meat should be from 10 to 15 per cent. It was recommended that the preparation of tinned meats should continue to receive, as at present, the careful supervision of the supply branch of the Army, and that there should be a definite relation between the weight of a tin and its contents. The tins should be painted and not lacquered, and no paper labels should be used (these cause perforation by becoming damp and corroded by rust); all tins to have their date of issue embossed on the tin; sample tins to be examined after incubation for a fortnight at 37° C.

COOKING.

Next to having a proper food-supply for troops is the importance of its preparation. Too much attention cannot be paid to good cooking, and men should be trained individually to be able to cook for themselves while in camp, as in war time it often occurs that a man may have to cook his own rations. To cook well and rapidly is an art which can be easily acquired, and which every officer and man should learn. General Sir Charles Douglas, K.C.B., in a recent report on Field Training, states: 'Cooking *in mess tins* should also be practised, so that the men should prepare themselves for what they would be required to do in war.'

Travelling Kitchens ('Field Cookers'). — During recent years the question of supplying troops on active service with food cooked in travelling kitchens has engaged the attention of the Continental Powers as well as our own War Office. The Army Council has decided, as a tentative measure, that 'cooks' waggons' shall be provided for units during peace training and manœuvres on the following scale: Brigade of artillery, regiment of cavalry, or infantry battalion each to have one four-wheeled waggon; smaller units, such as field companies and divisional telegraph companies of Royal Engineers, each to have one two-wheeled cart. These vehicles will form part of the first-line transport of the units to which they are attached, and should carry a portion of the day's issue of fresh meat and vegetables in camp kettles ready for immediate cooking when required. A portable field cooking apparatus designed by Lieutenant Sykes, Quartermaster of the Royal Irish Fusiliers, has recently been tried on army manœuvres in the South of England, and is claimed to effect the following results:

1. It is made in two sizes—the larger cart is capable of cooking a dinner for 1,000 men, the smaller one for about 300. It bakes, boils, grills, and fries.

2. It cooks on the march in any sort of weather. No matter how rough the road, it cannot spill.

3. Only one man is required to attend it once the cooking commences. There is no delicate mechanism or parts to get out of order and no chance of failure. There is no smoke or smell, and the fires are invisible.

4. The actual weight of the larger cart, without the food, is only about 12 cwt. It carries its own fuel for the day, which is regulated at will.

5. It will boil 100 gallons of cold water in the open in half an hour.

6. At any corner of the road or halting place or lull in the operations the cart can come up with the men's dinners ready cooked.

German Patterns of 'Field Cookers.'—In order to obtain a field kitchen of a transportable nature suitable for the German Army, the German Ministry for War offered a prize, open to public competition. The special conditions laid down as necessary were that the field kitchen should be constructed as a two-horse four-wheeled vehicle, the hind carriage to be easily detachable from the front part of the car, and each section to be capable of being drawn by one horse and used independently if necessary. The kitchen to be able to follow infantry along roads at a trot, and also to be capable of transit over soft or uneven ground. The hind car must carry the kitchen utensils, extra rations for the horses, fuel for one day, drivers' baggage, and 200 extra rations for the troops in a separate compartment. The total weight of the loaded vehicle, exclusive of the drivers, must not exceed 1,100 kilogrammes. All varieties of rations were to be cooked, and special arrangements were to be employed to prevent the danger of burning the food by the use of a bath of glycerine. As a result of the trials, a field kitchen was finally selected comprising a copper holding 200 litres in a boiling bath and a boiler holding 70 litres of water for making tea or coffee ; both these boilers may be heated either singly or together. The boiling bath surrounds the whole of the inner copper, and prevents the food being burned. The fuel used may be either coal, wood, or peat, and after twelve hours the temperature of the food still has a warmth of 140° F., and is palatable up to seventy-two hours. When the food is being served out, or when the kitchen is being cleaned, the fore part of the vehicle may be sent away for a fresh supply of food. It has since been decided to supply a complete travelling kitchen to each company of infantry, battery of artillery, etc. The troops will, however, still carry their mess tins and be trained to cook for themselves. The wheeled kitchens are filled up from the company supply waggons, which carry one day's ration, three tea rations per man, and one day's ration for each riding horse, besides butcher's utensils, each company having its own skilled butcher. The company supply carts are filled from the supply columns and other central stores, or else by local purchase. Another cart for supply purposes, acting as a canteen where the troops can purchase food, is also allotted to each battalion.

During the recent German military manœuvres at Jauer and Seignitz, at the midday halt cattle were slaughtered on the spot, and cut up and cooked for two battalions of infantry; each company prepared their dinners differently, using only their mess tins, and making fires of wood carried by themselves. Another pattern of travelling kitchen acts as a steamer, the central boiler having steam passed through it. Ten camp kettles, each containing rations for twelve men, are put in the steamer before marching, and on arrival at the midday halt they contain a savoury stew. Much time is thus saved, from not having to cook food on arrival. Digester boilers have also been tried, in which the food is rapidly cooked under high steam pressure, which reduces the toughest meat to tenderness. Another pattern is the Swedish felt-covered boiler, which keeps food warm for a considerable time. At the Austrian manœuvres of 1908, Daimler motor kitchens were tried with considerable success; these appear more adaptable for battalion cooking than for company work. Another great advantage is that they can be rapidly moved from the rear to the front, and they supply cooked food when the troops halt at midday. Our own War Office is at present making trials of a travelling kitchen at manœuvres.

TRANSPORT FOR RATIONS.

One of the most important considerations on service is that of transport for rations. The average weight of a man's daily ration is 3 to 4 pounds, and it cannot be reduced with safety below 3½ pounds. In times of emergency the soldier can carry four or five days' supplies, if put to it; but in hilly countries, where it is essential that European troops should be burdened as little as possible, they should, as a rule, only be required to carry one day's supplies. The reserve supplies must be carried either on transport waggons, in the case of flat country or where there are roads, or on pack mules in the case of hilly regions ; the latter can generally travel anywhere that infantry can go. Men should always start a day's march with biscuits, emergency rations, and either preserved meat or cooked fresh meat in their mess tins

CHAPTER VIII

CLOTHING, EQUIPMENT, AND BEDDING

General considerations — Flannel — Cotton — Khaki drill — Linen—The soldier's kit—Articles comprising the free issue of clothing—Necessaries—Public clothing—Equipment—Mess tins—The 1908 web infantry equipment—The weight of clothing and equipment—The clothing, etc., of the soldier—The head dress—The greatcoat—'Coat British Warm'—Cape—The tunic—Jackets—Jersey—Shirt—Vest—Putties—Spats—Gaiters—Boots—Shoes—Socks—Trousers—Belts—Drawers—Sleeping suits—Cholera belts—Equipment belts—Ammunition pouches—Water bottles—Bedding—The washing of flannel shirts, worsted socks, and woollen goods—The treatment of clothing infested with vermin.

THE dress of the soldier, from the fact of its relation to the prevention of disease, should be such as to permit of the free movement of every limb, so loose, indeed, that it will not fatigue him by its limitations. It should be a dress that can withstand the roughest usage compatible with comfort, and one that can be easily repaired when it does give way—such a dress as will let him fight, march, run, climb, jump, ride, and sleep in comfort, without cramping or being felt as a restraint. Each man should be supplied with two suits of identically the same pattern and design, but differing in thickness of material—one thick, for cold weather, and the other thin, for hot.

Flannel.—The low conducting power of flannel renders this material most suitable, not only in hot weather but also in cold, for use in the Army. Flannel absorbs perspiration readily, and, owing to its high hygroscopic qualities, evaporation from its surface is slow and gradual, thus chilling of the body is to a large extent prevented. Flannel is therefore the safest material that can be worn, either abroad or at home, in all weather. In warm climates light flannel shirts, loose in their cut, will be found cool, and in cold climates a heavier material will give considerable warmth. In all campaigns flannel has been found to be the best material for shirts and the best preventive against illness. Soldiers' shirts are made from a mixture of cotton and wool, as this material is cheaper, lighter, more durable, and does not shrink so much on being washed as pure wool. There should not be more than 30 per cent. of cotton in the mixture.

Cotton.—Cotton is not suitable for either shirts, vests, drawers, pyjamas, or socks. It should never be worn next the skin, as it has the effect of causing dangerous chilling of the body if it becomes damp with perspiration. It is, therefore, a most unsuitable material for any kind of undergarment. Cellular cotton has very much the same disadvantages.

Khaki Drill.—This is a pure cotton fabric dyed the well-known 'dust colour,' and is largely worn by troops in the tropics. It is a cool and serviceable material for hot *dry* weather wear, and has decided military advantages when operating in sunburnt grass, owing to its invisibility. In wet weather and cold it has decided disadvantages, from the fact that it favours rapid evaporation and causes marked chilling of the body. To counteract the danger of chill, khaki drill should never be worn over cotton shirts, and for this reason soldiers should be made to wear their silver-grey flannel shirts on all occasions when khaki drill is worn.

Linen.—Like cotton, linen soon soaks up perspiration, and this, rapidly evaporating, chills the body, and so is dangerous when worn next to the skin.

THE SOLDIER'S KIT.

The recruit on enlistment is provided with a free kit of clothing and necessaries, which, with the exception of the articles of public clothing—*i.e.*, greatcoat and helmet—is maintained by the man out of a quarterly allowance, varying in amount according to rank and where serving. All articles are supplied from Government stores at published prices.

The public clothing (greatcoat and helmet) is expected under ordinary circumstances to last five and six years respectively, and is then surveyed by a board of officers. If considered unfit for further wear, the articles are condemned and replaced at the public expense. At stations abroad, however, where the field service helmet is worn, this article is maintained by the soldier out of his clothing allowance, for which purpose fivepence a quarter is added.

Articles Comprising the Free Issue of Clothing.—The following articles (see table, p. 232) comprise the free issue of clothing to all infantry of the line, other than kilted, trewed, and rifle regiments, which have special arrangements.

Necessaries.—This term is applied to the articles considered necessary to complete a soldier's kit. The following scale of articles is required. The first issue of these articles is free, and subsequently they are kept up at the soldier's personal expense out of a quarterly allowance* made to him for this purpose.

* This allowance is included in the scale of clothing allowance, and varies according to rank.

TABLE SHOWING THE NUMBER OF ARTICLES ISSUED.

	Home.	Abroad.
Boots, ankle (pairs)	2	2
Cap, forage	1	1
,, service dress	1	1
Drawers, woollen (pairs)...	2*	2†
Frock, canvas	1‡	1‡
,, khaki drill...	—	1§
,, ,, ,, (extra first year only)	—	2
,, serge	—	1
Jacket service dress	2	—
Pugarees	—	2
Putties (pairs)	2	2
Sash, sergeant's, etc.	1	1
Shoes, canvas (pairs)	1	1
Trousers, canvas (pair)	1	1
,, khaki, drill (pair)	—	1
,, ,, ,, (pairs) (extra first year only)	—	2
,, serge (pair)	—	1
,, service dress (pairs)	2	—
,, tweed (pair)	1	—
Tunic	1	—
Waistcoat, cardigan	1	1
Sleeping suits	—	2‖
Helmet, Wolseley pattern, with chin strap, cover badge, and bag	—	1

* Recruits from Special Reserve in possession of two pairs of woollen drawers will receive one pair only as a first issue.

† Malta, Gibraltar, Egypt, Hong Kong, and South Africa only.

‡ Rank and file (except lance-sergeants) and artificers of all ranks.

§ In North China one suit of service dress, the jacket being lined, will form part of the scale of clothing, in addition to the above. The serge frock will also be lined, and two pairs of woollen drawers and two woollen vests will be kept up by all soldiers.

‖ At Hong Kong, Singapore, Ceylon, Mauritius, Jamaica, and Sierra Leone only.

The following are the necessaries supplied free to line battalions:

- 3 flannel shirts.*
- 3 pairs of socks (worsted).
- 1 pair of braces.
- 1 hair comb.
- 1 knife and fork.
- 1 spoon.
- 2 towels.
- 1 soap (piece).
- 1 sponge.
- 1 pair boot laces (spare).
- 1 cap (comforter).
- 1 identity disc with cord.
- 1 pair gloves (worsted).
- 1 razor.
- 1 hold-all.
- 1 tin of blacking.
- 1 blacking brush.
- 1 brass brush.
- 1 clothes brush.
- 1 hair brush.
- 1 polishing brush.
- 1 shaving brush.
- 1 tooth brush.
- 1 button brass.
- 1 kit bag.
- 1 housewife.
- 1 mineral jelly (tin).

Public Clothing.—For infantry this includes a great-coat, which is renewed every five years, one helmet, cloth, and bag, renewable every six years.

Equipment.—Besides the usual fighting equipment (see below), each soldier holds one haversack and one mess tin on charge as equipment.

Mess Tins.—Mess tins (with canvas cover) are used for carrying cooked rations, and for cooking in when on detached parties. The present mess tin weighs nearly 1½ pounds, and has a capacity of under 2½ pints. The German mess tin is made of aluminium, blackened on its surface, to render it less conspicuous; it weighs 13½ ounces, has a capacity of 4½ pints, and is of a good pattern. The French mess tin (*gamelle individuelle*) weighs about 1 pound, and holds 2½ pints. The Austrian mess tin weighs nearly 2½ pounds, and has a capacity of 5½ pints.

The Pattern 1908 Web Infantry Equipment.—The main principle underlying the design of the Pattern 1908

* Men who join from the Special Reserve with two or three part-worn flannel shirts in their possession receive respectively one or two new flannel shirts less with their free kit.

Equipment* is the subdivision of the complete set into what may be called the 'marching' and 'fighting' portions. In the latter nothing is included which is not essential to the fighting efficiency of the soldier, and the articles composing it consist of—

Rifle (with sling).
Bayonet.
Ammunition.
Entrenching tool.
Water.

To these may be added such cooked food as can be carried in the haversack, together with an emergency ration and a spoon and fork.

Everything else which goes to complete the soldier's field kit is to be considered as surplus to his fighting requirements, and as such is relegated to the 'marching' portion of his equipment. Such articles comprise—

Greatcoat.
Comforter cap.
Spare pair of socks.
Mess tin and cover.
Tooth brush.
Shaving brush.
Razor.
Comb.
Towel.
Soap.
Housewife.
Pay book.

and are carried in a readily removable pack.

This arrangement allows of the soldier having normally with him the whole of his equipment, while when an action is imminent the pack and its contents can be discarded, and their place taken, if necessary, by extra ammunition in 'emergency' bandoliers.

Some of the other features of the equipment are as follows:

1. *There are no Straps Crossing the Chest.*—This

* The total cost of one complete set of this equipment, excluding water-bottle and entrenching tool (but including their carriers) is £1 5s. 3d.

feature, taken in conjunction with that referred to in (2), accounts for the fact that the soldier can at all times march with his waistbelt undone and every button of his coat unfastened. The advantages to be derived therefrom are too obvious to mention, but it should be clearly understood that the correct balance of the equipment is in no way impaired even under these conditions.

2. *The Equipment is Perfectly Balanced.*—All former equipments have suffered from the defect that with no ammunition in the pouches in front, and with a pack or rolled greatcoat on the back, the weight of the latter pulls up the belt in front. In the 1908 equipment this does not occur; for no matter whether the cartridge carriers are full or empty, and whatever the contents of the pack may weigh, no movement of the equipment over the shoulders can, if it has been properly fitted, take place.

3. *The Component Parts of the Equipment are all directly connected Together.*—The result of this is that the whole of it can be taken off in one motion, and, unless it is required to be taken apart for any purpose, remains intact and ready for putting on again at a moment's notice. The advantages of such an arrangement are obvious. Men can turn out in barracks or camp fully equipped in a few moments, even in the dark. Separate articles have not to be hunted for, by no means an easy matter in a crowded tent; all that each man has to do is to seize his rifle and equipment and double to the place of assembly, and within a few seconds of his arrival there he is ready to march off.

Again, when a halt occurs on the line of march, every man can at once, if he wishes, divest himself of the whole of his load, resuming it the moment the order is given to fall in.

4. *Flexibility of the Equipment.*—With the exception of the pack, which, when worn, must always be on the back, the articles carried by the soldier can be disposed in a variety of ways.

By means of the end pieces provided there are altogether four places in which the haversack, water bottle, and entrenching tool can be carried, and their relative positions can therefore be varied at will. For example, assuming the pack to have been discarded, the haversack and water bottle can be taken away from their normal positions on the hips, fastened together, and placed on the back. In this way the hips are freed from everything except the bayonet and entrenching tool, whereby the man's actions are less hampered, especially in rough or difficult country.

Description of the Equipment.—The equipment is made throughout of specially waterproofed and woven webbing. The waterproofing process is applied to the yarn before it is dyed, and thereby produces a material more efficient in this respect than others which are treated after being made up. The result of the treatment is to render the material practically impervious to the weather, which might otherwise tend to make it hard or cause it to stretch and shrink.

All the buckles used with the equipment are of the tongueless or self-locking variety. With this description of buckle the free end of the strap is passed through the slot, over the central bar, and under the horns of the other side of the buckle. The strap will then be found to be securely locked, and though it may be tightened up, it will not slip back. The strap may either be threaded directly through the horns of the buckle, or one edge of it can be passed sideways in through the gate, the other edge being subsequently inserted by pinching up the web.

To unfasten the attachment all that is necessary to do is to pinch the edge of the strap together at a point just outside the horns of the buckle, when the web will pass freely out between the horns. The strap has then only to be pulled out through the slot.

The large buckle on the waistbelt is constructed somewhat differently from the others, being a double one ; the principle involved is, however, just the same.

The component parts of the equipment consist of the ollowing :

(*a*) Waistbelt.
(*b*) Frog.
(*c*) Braces (2).
(*d*) Cartridge carriers (1 left, 1 right).
(*e*) Pack.
(*f*) Supporting straps (2).
(*g*) Haversack.
(*h*) Water-bottle carrier.
(*i*) Entrenching-tool carrier.*

(*a*) *Waistbelt.*—This is issued in two sizes, large and small, the over-all length of the webbing being 48 and 40 inches respectively. The width in each case is the same—viz., 3 inches. It is fitted with a large buckle in front and with two smaller buckles and two end pieces in the centre of the back. The length of the belt is adjustable about the buckle end.

(*b*) *Frog.*—This consists of a loop to slip on the waist-belt and a body fitted with two horizontal loops. The scabbard is inserted and pushed through until the stud on the outside comes out between the two loops.

(*c*) *Braces.*—These are interchangeable, and each consists of a strip of webbing, 50 inches long and 2 inches wide. This width is increased to 3½ inches for a short distance about the middle of the brace, in order that the weight of the equipment may be evenly distributed on the shoulders. Each brace is provided with a sliding buckle for the attachment of the pack.

(*d*) *Cartridge Carriers.*—These are not interchangeable, one being reserved for the right and one for the left hand side ; in all other respects they are identical.

* According to the type of entrenching tool which may eventually be adopted.

Each consists of an assemblage of five fifteen-round pockets in two tiers, with separate covers, secured by means of snap fasteners. An upper and a lower stud are provided for each fastener, to be employed respectively when the pocket is filled and empty. The interior of each pocket is divided by means of partitions into three receptacles, each holding one clip of five rounds.

The carrier is fitted with a double hook at each end for attaching it to the waistbelt, to which it is further secured by two narrow bands passing round the belt and snapped on to studs on the lower front edge of the carrier. A buckle and end piece are fitted to the back, as also a narrower end piece set obliquely and protruding to the rear of the carrier.

(*e*) *Pack.*—This consists of a rectangular-shaped sack, the dimensions of which are approximately $15 \times 13 \times 4$ inches. It is open at the top, and is closed by a folding cover, secured by two narrow straps. Weather flaps are provided, which fold down under the cover. Two web loops are attached to the bottom of the pack, through which the supporting straps (*f*) are passed. A short suspension tab is fixed to each of the upper corners on the side nearest to the wearer's back; also small buckles, to which are attached the upper ends of the supporting straps (*f*).

(*f*) *Supporting Straps.*—These are interchangeable, and each consists of a strip of 1-inch webbing 32 inches long, fitted with a buckle at one end.

(*g*) *Haversack.*—This consists of a rectangular bag of dimensions (approximate) $11 \times 9 \times 2$ inches, and has a cover secured by two small straps and buckles. The haversack is fitted on the back with two suspending tabs, at the ends with large buckles, and on the front with smaller buckles at the bottom corners.

Another small buckle is fitted to the top of the cover, and a stud is provided lower down on the haversack itself. These two last-named attachments allow of the water bottle being carried on the haversack under certain conditions.

(*h*) *Water-Bottle Carrier.*—This consists of a skeleton framework, in which the water bottle is inserted and secured by a snapped-on retaining strap. The carrier is fitted with two buckles for attachment to the end pieces of the equipment, and has a short extension piece and snap fastener for use when the water bottle is carried on the front of the haversack.

(*i*) *Entrenching-Tool Carrier.*—See footnote on p. 237.

A special pattern equipment on somewhat similar lines has been made for use by officers, and has recently been subjected to trials. It is understood that it has passed all tests satisfactorily.

The Weight of Clothing and Equipment.—One of the most important factors in marching is the weight of clothing and equipment carrried by the soldier. The greater the weight carried, the more onerous the march, and the less fit will be the soldier to fight at the end of the march, if called upon to do so. The following tables show the weights of the different articles of clothing, equipment, etc., carried by the soldier :

A. Personal Clothing as worn by the Soldier.

	lb.	oz.		lb.	oz.
Helmet	1	0¾	Socks...	0	4¼
Jacket, with field dressing	2	8½	Boots...	3	14
Trousers	1	15	Putties	0	12½
Jersey	1	5½	Clasp knife	0	7½
Braces...	0	4	Drawers	1	2
Shirt	1	1½	Total ...	15	0
Woollen belt... ...	0	4½			

B. Arms.

	lb.	oz.
Rifle, with sling	8	3½
Bayonet, scabbard, and frog	1	4¾
Total	9	8¼

C. Ammunition.

	lb.	oz.
150 rounds S.A.A.	9	13½

D. Entrenching Tool and Carriage (about) ... 3 0

E. Accoutrements.

	lb.	oz.
Waistbelt	0	13
Two 75-round cartridge carriers ...	1	7
Two braces	0	9
Pack, with supporting strap	1	8
Water bottle (empty), with carrier ...	1	7½
Haversack (17 oz.), with fork and spoon (4 oz.)	1	5
Total ...	7	1½

F. Articles carried in Pack.

	lb.	oz.
Greatcoat	6	5
Socks	0	4¼
Comforter cap ...	0	3½
Mess tin and cover	1	6½
Tooth brush... ...	0	0½
Boot-laces	0	0¼
Housewife (fitted) ...	0	3
Towel and soap ...	0	11½
Razor and case ...	0	2½
Shaving brush ...	0	1½
Comb	0	0½
Pay book	0	2
Total ...	9	9

G. Rations and Water.

	lb.	oz.
Water (in bottle) ...	2	2½
Emergency ration (9½ oz.) and portion of bread ration (say 12 oz.) carried in haversack... ...	1	5½
Portion of meat ration (say 12 oz.) carried in mess tin ...	0	12
Total ...	4	4

Marching Equipment.

	lb.	oz.
A. Personal clothing	15	0
B. Arms	8	8¼
C. Ammunition (150 rounds) ...	9	13½
D. Entrenching tool	3	0
E. Accoutrements ...	7	1½
F. Contents of pack	9	9
G. Rations and water	4	4
Total ...	57	4¼

Fighting Equipment.

	lb.	oz.
Marching equipment	57	4¼
Deduct pack and contents	12	5½
	44	14¾
Add 120 rounds S.A.A. in two emergency bandoliers ...	7	14
Total weight of fighting equipment (270 rounds)	52	12¾

CLOTHING, ETC., OF THE SOLDIER.

The clothing of the soldier will now be considered. Beginning with the head-dress, each article will be noted in the order in which it would be met in the course of removal.

The Head-Dress.—The essentials of a good head-dress are that it should be a protection to the head from the heat and glare of the sun, be waterproof, afford little resistance to wind, be possible of ventilation, be light, durable, comfortable, and not press unduly on the scalp. It is almost impossible to combine all these factors in the head-dress and at the same time suit all climates.

The solution of a suitable head-dress for all troops in time of peace and of war is one that has engaged the attention of every army in Europe, and is a subject beset with difficulties. Our present pattern of general service helmet, although in advance of its predecessors, shakos and the like, is an article far from suiting all requirements. The present pattern, when new, weighs about 14 ounces, and when in use for some time, owing to accumulation of grease and dust or water soaking, is increased up to, if not over, a pound weight. Being pointed in front, it offers no protection to the eyes from sun, rain, or wind. The temples are exposed, and headache is caused even in an English summer. Its back arrangement is even worse, as it is too low and too tight to admit of a soldier using his rifle, and not long and spreading enough to protect the nape of the neck from sunstroke. When a crack shot wishes to shoot well, he invariably takes off his helmet; or, if a tropical sun does not allow of this, he simply turns the helmet round, back to front. It is, moreover, seldom properly fitted; the majority are too small, and will not stay on unless the chin-strap is used, and even when this is done, the chin strap has to be tightened so much that neuralgia of the scalp and headache is the result. A Boer authority, in giving his views on the scouting of some of our mounted men in South Africa, stated that they were sometimes recognizable by the fact that they had to devote the greater part of their attention to holding on their helmets while in the saddle, and that the right arm uplifted for this purpose was often conspicuous. The objections to the shape used in the South African War have been mitigated by alteration in its form to that of the Kitchener or Egyptian style. Some of the patterns which are here proposed are also suitable :

1. A light pith helmet of the present Cawnpore or pig-sticking pattern—a helmet which completely protects the eyes, temples, and back of the neck from the sun. Its cover should be of quilted khaki, with a layer of thin waterproof material, such as Willesden canvas, underneath to protect the pith, which is very liable to swell if it gets wet. For ventilation purposes two wire gauze ventilators the size of a penny or a rupee should be inserted laterally in the crown, and the inside rim should be of wide corrugated papier mâché, covered with soft felt, flannel, or leather. The helmet should be lined throughout with orange-coloured glazed calico, as an orange lining will diminish or even prevent sunstroke by its power of stopping the actinic rays of the sun, which produce this trouble in the tropics. The peak should have a green lining over the orange to protect the eyes. The chin-strap should be of leather and broad. The helmet should fit easily and comfortably, without compressing the scalp.

2. A modification of the large felt hat worn by colonial troops. A cork or pith crown, with a felt brim, that can be fastened up at the side for appearance' sake, or stiff and projecting, as in the Baden-Powell type. Lining of crowns to be orange cloth ; chin-strap, ventilators, and inner rim as in the helmet just described.

3. The Italian or 'Bersaglieri' type, but the material should be of khaki colour instead of dark green. A pith or cork crown as a further modification might be useful.

Caps.—The present staff pattern, when made of thin 'proofed' khaki serge, is most suitable for campaigning; it ought to have a waterproof detachable cover, with a turn-down piece behind to protect the neck from rain. The jersey cap is much sought after and used by men on service, who bring the caps issued in their sea kits into the field, wearing them in camp and sleeping in them. They should be double length, to serve the purpose of comforters, and of khaki colour.

The Greatcoat.—The present *pattern* of greatcoat requires no modification; its *material*, however, is too absorbent of rain, and might with advantage be rendered waterproof by any method that allows of ventilation. The chief objections raised against the greatcoat are, firstly, that it is not sufficiently long to protect the legs from rain when on the march, and not sufficiently ample to warm them when asleep; and, secondly, that its length hampers the movements of the lower limbs when on the line of march. The following are the weights of the greatcoat in different armies: British, 7 pounds; French, 5 pounds; German, $3\frac{3}{4}$ pounds; Austrian, 6 pounds; United States (*Slicker*), 6 pounds; Italian, $4\frac{1}{2}$ pounds. The Norwegian army has no greatcoat, but issues a thick sweater and a sleeping bag instead. In the South African War the Natal Field Force invariably had their greatcoats carried in the regimental transport. When troops are ordered on active service, they should be supplied with new greatcoats and their old ones returned to store, as it is most essential that men should start a campaign with as warm and as waterproof an article as possible. This is all the more necessary when it is remembered that tents are seldom, if ever, used in modern warfare, and that the men have to sleep in their greatcoats.

'Coat British Warm.'—This is a most useful and comfortable article, and was very much in request among mounted troops on service in South Africa. Save for the fact that two overcoats cannot be issued, and that the greatcoat is a good protection to the lower limbs and is also useful for sleeping in, the 'Coat British Warm' might be issued generally to the whole Army. If it were possible to overcome the utility of the greatcoat as a sleeping garment, the difficulty of leg protection might be settled by some means of attaching the waterproof sheet (described in the succeeding paragraph) to the lower border of a 'Coat British Warm' by means of straps, and making the waterproof serve the purpose of a protective kilt in wet weather. This subject is worthy of attention, as by reducing weight we could reduce transport, and a 'Coat British Warm' could be more often carried rolled with the waterproof sheet around it by the soldier on service, when climatic conditions would not allow of carrying greatcoats. The transport so gained would be available for an extra blanket, and this would do away with part of the sleeping difficulty above mentioned.

Cape.—A waterproof mackintosh or Willesden canvas cape is useful for active service. If not procurable, a sheet of either waterproof material or rot-proof canvas might be issued. This should be made rectangular, with eyelet holes round its four sides 2 inches apart, and two thin strong straps stitched at right angles to one another at one corner; each strap should be equal in length to the side to which its free end points, and perforated with eyelets (equal to the calibre of a leather boot-lace) ½ inch apart towards its extremity. Such an arrangement would allow of this article being used as a waterproof sheet for sleeping on or as a cape to be worn over the shoulders in wet weather. If used for the latter purpose, the sheet would be thrown over the shoulders and the eyelet holes threaded by the straps, the longer strap going through the eyelet holes in the long side of the sheet, which would be placed round the neck, and the shorter strap through the eyelet holes down the front of the chest. Each strap should be fastened at its free end by a boot-lace, tied in a knot through one or two of the small holes punched in the strap. These sheets could also be used as shelters when two or more were laced together.

The Tunic.—The full dress tunic worn by the soldier for ceremonial and walking-out purposes is a close-fitting jacket, which not only compresses the muscles, but interferes with the free movement of the chest. For everyday wear the field-service jacket is worn, and this garment, from a physical-efficiency point of view, is a much more satisfactory article.

Jackets.—The tendency with regard to the soldier's jacket has always been to make it *too tight-fitting*. There is no more important article of clothing, where health and marching are concerned, than this one. For campaigning purposes the jacket must be loose, to allow expansion of the chest and freedom of the neck and arms, more especially of the shoulder joints.

A jacket of Norfolk pattern, with rolled collar, fastened at the neck by a hook and eye, the collar not too tight, and which when open can be hooked back like the lapel of an ordinary coat, so as to expose the front of the chest, and under which a flannel shirt with a rolled collar can be worn, would be most comfortable on service. The back should have a yoke made of two layers of cloth, to protect the upper part of the spine from sunstroke ; below the yoke it should have a central pleat, to allow of expansion and letting out if shrinkage occurs. It should be loose under the arms and across the shoulders, and generally loose enough to admit of a jersey being worn underneath when necessary. The shoulder straps should be of the same pattern as at present, and without any metal badges, as these catch the rifle. The colour should be khaki, the material serge, and the buttons of gun-metal. There should be four pockets on the outside, as at present, as well as a watch pocket and a pocket for first field dressing inside.

Braces.—These are preferable to leather belts worn round the waist to support the trousers, as they do not compress the abdomen and thus predispose to hernia. Braces should not be worn too tight, lest they compress the main bloodvessels by pressing the collar-bone against the ribs, and cause fatigue.

Jersey.—A loose jersey or sweater is a great boon for a soldier on board ship, and for camping purposes in certain climates ; the usual naval pattern is in every way suitable, but should be of khaki colour.

Shirt.—The soldier's present shirt, the 'silver-grey,' is almost sufficiently good ; it might possibly be improved if it were of khaki colour and all wool, with one vest pocket and a turn-over collar, like a cricket shirt. A shirt of such a pattern could be often worn cowboy fashion on active service without a jacket.

Vest.—For cold weather purposes, a strong woollen khaki-coloured vest might be issued with advantage. Khaki-coloured garments have the property of stopping the actinic rays of the sun, which in tropical climates produce sunstroke.

Putties.—These leg coverings are extensively used by the hill tribes of India as a protection against thorns, spear grass, and possibly snake bite. While very suitable for the natives of India, in whom the calf muscles are of quite a different shape and consistence from those of well-developed European races, they cannot be recommended for the infantry soldier as now generally worn. It has been noticed that after performing the same march together the kilted Highland regiments seem much less fatigued than other infantry who wear putties. The Highlander has his legs free, while the other marches in trousers extending to the boot and doubled round the shank of the leg. These doubled-round trousers, bound tightly by putties, so confine and heat the leg as to impede free circulation and the action of the *gastrocnemii* and other calf muscles. Leg weariness at an early stage in the march is produced, and the tighter the putties are bound round the leg, the more accentuated is the fatigue. In a muscular calf, putties will not stay on unless they are bandaged tightly, and it is the tight bandaging that gives them their smart appearance, and which has no doubt led to their introduction into the British Army since the South African War. The present pattern putties are also nearly one inch too wide.

Putties are most useful as emergency bandages for broken limbs, and can be used as abdominal belts at night, when they should invariably be taken off the legs to give the muscles rest. Spat putties are useless, as the spats wear out rapidly, and become unsightly. If the spat attachment were of leather it might be useful, but it should be capable of easy detachment.

Spats.—The spat as worn by the Highland regiments is becoming and necessary where recruiting purposes have to be considered. It is also worn with loose pantaloons by some of the foreign armies, and is comfortable to march in, but frays readily at the edges, and becomes untidy on service. Some modification of the present Highland pattern, made of double khaki drill, might possibly be desirable for infantry for use in 'spear-grass' countries.

Gaiters.—Leggings have been abolished for British troops on service, with the exception of artillery. Gaiters when worn by officers are usually the Stohwasser pattern. Whatever the pattern used, they should always be worn loose, and should accurately fit the calf of the leg. They should never come below the ankle, for when this occurs they invariably press on the instep and heel, and cause galling, leading to blisters or abrasions. The old pattern short gaiters issued to the infantry were ruinous to the overalls, and impossible to march in for any distance.

Boots.—Boots should be of the best, strongest, and most pliable leather obtainable in the market. They should be frequently greased to make them pliable, and should be kept soft and waterproof. They should be frequently inspected by the company officer to see that these factors are maintained.

The soldier's present boot, notwithstanding its alleged defects, when compared with the patterns of Continental powers contrasts favourably. The unwieldy long boot of the German Army,* the heavy, clumsy high boot of the Russian infantry, and the light boot of the French, all cause us to wonder how the men of these forces can manage to fulfil a soldier's duties at all.

The British soldier's chief idea, however, is mostly 'polish,' and to attain this other considerations are often lost sight of. The more rigid a boot the higher the degree of polish it will attain, and for this purpose dubbing or grease is often avoided—that is, the only material really essential must be omitted if a good shine is to be obtained. Exception to this is only found on active service, when men from experience and for the sake of comfort resort to the use of oil, grease, or dubbing.

The cast-iron stiffness of the sole, the rigidity of the uppers, too narrow toes, and the weight of the boot, are four factors worthy of serious consideration when selecting boots for marching purposes.

Surgeon-General Sir William Taylor, K.C.B., A.M.S., late Director-General of the Army Medical Service, in his report on the Ashanti Expedition of 1895-96, drew attention to the excellent character of boots supplied to the troops in that campaign, which were perfect in every respect, and caused very little foot soreness. The boots alluded to were manufactured as shooting-boots were usually made at home, pliable and handsewn; they had not been subjected to any hardening process, and although an ammunition boot, they did not constrict the

* It has been stated that over 30,000 German soldiers were incapacitated for duty during the first few weeks of the Franco-Prussian War on account of sore feet, attributable to bad boots hardened by long storage before issue.

front of the foot by having narrow toes—in fact, in this respect they approached the almost exaggerated square-toed boot of the German infantry, and were so comfortable that they were purchased from store by many of the officers of the force, who invariably wore them, and afterwards used them at home for shooting purposes in preference to other patterns.

The fitting of *ready-made* boots is a very difficult matter, as the feet of different individuals vary in all sorts of ways. The differences in thickness of the sock must be allowed for, as a boot which just fits over a thin sock will be very uncomfortable over a thick shooting stocking. In the army separate lasts for each man are, of course, impossible, so that care is specially necessary when fitting new boots. Only too often a young soldier is given a pair of boots about his size, and asked if they are 'all right.' After trying one or both on for a minute, possibly even without standing or walking in them, he is satisfied, or thinks it best to seem so, and takes them away, only to find out their shortcomings on the first long march.*

From a fancied idea of smartness, soldiers are only too fond of getting their regulation boots altered, and the toes pointed, the heels being raised and made small like those on ladies' fashionable shoes. This practice should be severely dealt with.

The sole should be large enough (in length and breadth) to allow for the expansion of the foot on pressure and with the heat of marching, and a definite allowance must be made for this increase in size. There is no doubt that a *roomy* boot is best for marching purposes ; but if too large, the foot may rub in the boot, or the crease in the boot and foot may not coincide, and so galling may result.

Above all things the sole should be pliant, and

* *Vide* 'Manual of Chiropody,' by the late Captain M. Louis Hughes, R.A.M.C.

especially across the roots of the toes and tread, where the natural crease appears across the uppers of good boots. When soles have been 'clumped'—*i.e.*, when half a sole has been nailed on to the tread of the sole—the boot is very stiff just where it ought to bend, and has a tendency to give across the waist rather than across the tread. Such soles are not nearly so good for marching purposes, but are more easily mended, as the worn clump has only to be ripped off and a new one nailed on and trimmed. Though a boot should 'give' a little and not be tight in the waist, yet, in that this is the narrowest part of the sole, the boot is apt to weaken and 'give' too much. To prevent this, and to support the instep, a strong shank, or tongue of stout leather, is inserted between the two layers of the sole, extending from the heel to the beginning of the tread, through the waist.

The sole is usually made of two layers of good leather, with a central filling. These two layers are either riveted or sewn together. Riveting may be done with metal or wooden pegs, or with patent screws. The two former are not suitable for marching purposes. The sewn soles are done by hand or machinery.

Hob-nails in the soles are useful, as they help to resist wear, and harden without stiffening the sole, prevent the feet from slipping, keep the sole slightly off the wet ground, and cause less splashing in muddy weather. They are especially useful on grass and on English roads, and cause no discomfort if evenly distributed over the sole. Heel and toe tips are also a great protection when marching, especially on rough ground, as on long marches, when tired, the soldier is apt to drag his feet and wear the toes through, and when marching in close order with other men in front of him he finds a difficulty in avoiding the stones and inequalities of the road. The sole should wear out on the outer side of the heel first, where it is apt to be rubbed as it comes to the ground. Next it should wear on the inner surface of the toe as it leaves the ground, and lastly in the centre (or slightly to the outer side) of the tread of the sole.

The heels keep the feet somewhat off the ground, prevent splashing, and enable us to avoid small projections, stones, etc. Though they are the first places to show wear and tear, they are easily repaired. They should be of only moderate height. With high heels the weight of the body is thrown unduly forward on to the toes, instead of being evenly supported by the whole arch of the foot. The body is in the position of a man standing upon an inclined plane—always a fatiguing attitude. When going downhill they increase the necessity for throwing the body backwards, and are no help when ascending hills, as in that case the heel is always raised. High heels give a false impression of shortness in the foot and fulness in the instep; but, besides deforming the foot, they make it practically useless for any real work. Moderate heels have their uses; immoderate ones are an abuse.

The sole of the regulation boot is curved downwards between the heel and toe. The toe thus often stands an inch or more off the ground when the boot rests upon its sole. This is technically known as the 'spring' of the last. The sole of the boot should, therefore, be the shape of the normal foot—roomy, straight on the inner side, with a good projecting welt, fairly thick, but above all things pliant and of good leather.

The upper of the boot is framed of the vamp, or front portion of the boot, and the quarter, or hind portion.

1. *The vamp* covers the toes and instep. This should be specially pliant over the natural hinge of the foot, near the roots of the toes. It should allow ample room inside the boot, over and beyond the toes, for the front portion of the foot is formed like a double wedge, which the weight of the body tends to force forwards and outwards between the sole and upper. The vamp should therefore

be rounded over the toes, and blocked to fit them, and never end in an acute angle with the toe. The greater thickness of the big toe and the varying thickness of the toes in different persons have to be considered. If the boot is too short, the toes are forced against the end of the boot, and to relieve this pressure they shorten by bending at the middle joint. This joint is apt to rub against the upper, and inflammation, sores, or corns result. The tendons also are apt to shorten permanently and fix the

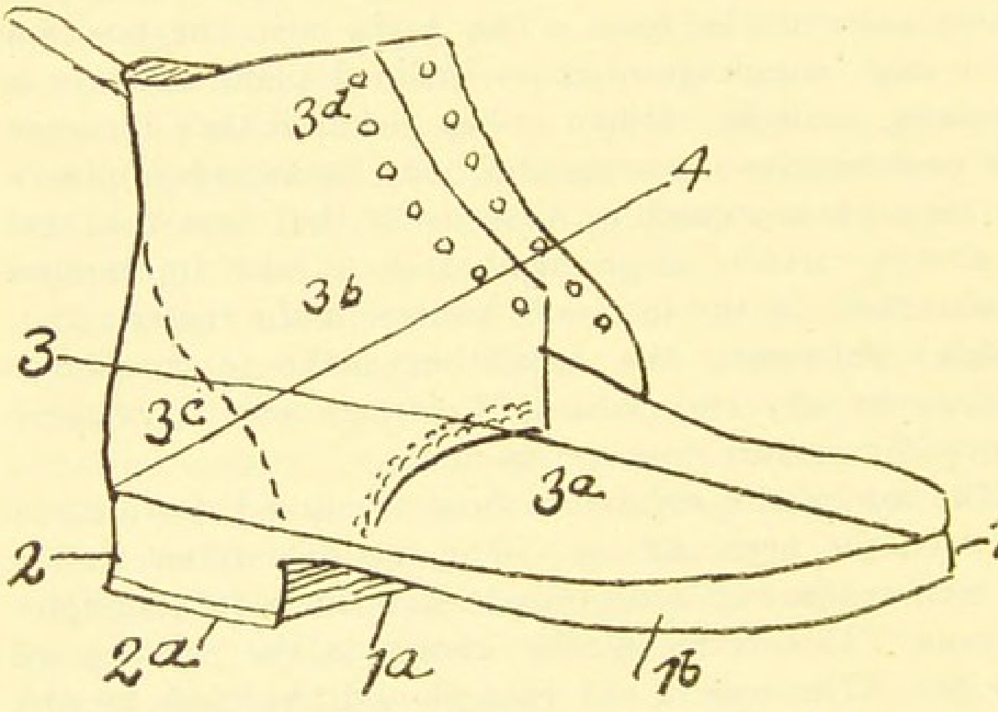

FIG. 21.—DIAGRAM OF A SOLDIER'S BOOT.

1, Sole; 1*a*, waist; 1*b*, tread; 2, heel; 2*a*, heel tip; 3, upper; 3*a*, vamp; 3*b*, quarter; 3*c*, counter; 3*d*, ears and lacing; 4, direction in which boot should grip foot.

toes in this new position, causing 'hammer-toe.' If the vamp does not fit in the first instance, the foot has to stretch it until it does—a process the reverse of comfortable, and one which leads to unsightly creases in the boots. The fit of the vamp depends to a great extent upon the shape of the sole, and many of the points already discussed have a bearing upon both. The vamp is extended up in front of the ankle as a thin piece of leather, called the tongue, which, passing up under the ears and lacing of the quarter, keeps out dust, etc. The tongue should be rounded and full at the top, and reach well to the top of the boot.

2. *The quarter*, or hinder portion of the boot, covers the heel and ankle-joint. It should be pliant over the ankle-joint, to allow freer play to that joint and to the tendon passing over it. It is made in two halves, seamed together down the back of the ankle and heel, the edges of the seam being turned outwards. In front it is prolonged over the vamp and stitched to it. The quarter must not be too high, or it will interfere with the proper bending of the ankle-joint, a fact the soldier fully realizes, and usually allows for by leaving the two upper holes of the lacing undone. The height of the instep varies greatly in different individuals, and with it the girth of the foot in that situation, even in those whose feet are equal in length. This has to be allowed for, so that while the numbered *sizes* refer to certain lengths of boots, each size is also made in five different *magnitudes*. The size and magnitude are stamped on the insole and outsole, the size above and the magnitude below—thus $\frac{8}{2}$. The quarters are pierced with eyelet holes for lacing. They should not quite meet over the foot, so as to allow of firm pressure being made when the boot is laced. Strong, sound laces are necessary to effect this even pressure, a point which it is impossible to achieve with knotted and unsound ones.

The uppers need to be kept supple with vaseline, neat's-oot oil, dubbing, etc., as otherwise on long marches they absorb perspiration and become hard and brittle. The difficulty is to find a dubbing which will also take a polish.

Boots should be fitted on *indoors* in some long room. *Both* boots should be put on over the thickest socks that will be worn under them. If thought satisfactory, they should be laced, and the man directed to walk at least the length of the room and back before final approval. The Clothing Regulations lay down (Appendix IV.) that an amount of two and a half to three sizes should be allowed in addition to the length (but length only) of a man's foot. This amount does not exceed an inch, and is ample. The height and fit round the ankle and instep should be noted as well as the length. There are four variations (magnitudes) in this respect to each size in length. These, with the sizes of length, are marked on the inner surface of each boot, so that, when once fitted, a man should know what to ask for on a future occasion. The ears should not quite meet when laced, so as to allow modifying pressure to requirements. Men with specially-formed (or deformed) feet should avail themselves of the permission to have boots specially made, as laid down in the Clothing Regulations. This also applies to those who suffer from bunions, enlarged joints, etc.

The boots should be kept properly softened, especially after getting wet, with vaseline, neat's-foot oil, dubbing, etc. Constant sweating into a boot makes it hard, stiff, and brittle. Boots should have their extreme newness worn off in barracks before being used for marching purposes. They should always be kept in good repair, as otherwise they leak, tire the feet, and often give out at a critical moment. Boots kept in store also need attention and dubbing. A dubbing that will polish is much needed.

Changing into canvas shoes after a march cools and rests the feet enormously, and allows of the boots being aired and dried. This shoe should have a good sole, similar to that of the hospital ward shoe. The extra cost of a substantial sole is amply repaid on active service or long manœuvres, as the cheaper sole soon falls to pieces.

Wet boots should be changed *as soon as possible after a march*, and arrangements put in train for drying them slowly, after which they should be oiled. It is often a good thing to oil or vaseline the boots while still warm from the feet; the pores of the leather absorb more while in this state. Waterproofing should be avoided; it is prone to make the boot too impervious and to confine the sweat inside the boot, so poulticing and softening the feet.

Shoes.—Shoes have been recommended as a substitute for boots for marching in. The points urged in their favour are that they are a lighter and cheaper foot-gear, and allow more freedom to the ankle and strengthen it by their use. The latter is, medically, a doubtful point, although there is no doubt that, if worn from childhood, this may be the case. Natives of India possibly prefer shoes, but it was noticeable that the Indian dhooly bearers employed in the Natal Campaign of 1899-1900 suffered severely, and were often rendered useless, from wearing shoes over rugged country covered with mimosa-thorns. In the Mohmand Khyber Force of 1908 it was reported that certain of the Highland regiments employed suffered severely on account of their wearing shoes. Certainly, if natives are to wear boots on service, they should be practised in their use by wearing them during peace time; otherwise their feet will become chafed and cut when boots are suddenly issued for active service.

Socks.—Three pairs of socks are supplied as a free issue to the soldier when he enlists, and he has to purchase all renewals out of the quarterly allowance given for the purpose of renewing his clothing, etc. It is most desirable that not less than three pairs of socks should at all times be available, and frequent inspections are necessary to see that a clean and proper supply is maintained by each man. Good socks are essential for proper marching, and they should be woollen, of natural colour, seamless, without knots, ridges, holes, or coarse darnings, and *clean*. For their cleanliness, like the boots and feet, the closest supervision of socks by the company officers is essential; for if clogged with dust or dirt they easily cut or wear holes, and if men have holes in their socks blisters are inevitable. Even should a man get a blister in this way, discomfort can be relieved by a wash and a fresh change, soaping the part of the clean sock that comes into contact with the blister with common yellow soap, or by the use of one part of tannin to twenty parts of zinc ointment (this was done by the Germans as a blister prophylactic in the Franco-German War with marked success), or by greasing the foot itself, as is done by the French Alpine troops, who wear no socks at all. In India coolies will march for days with no other foot covering but sandals, and they always apply oil to the feet when on long journeys.

Trousers.—Overalls are much too tight for service purposes. Strong, *loose* knickerbockers, with extensions from below the knee to the boot, not fitting too tightly, and of the same pattern as that known in India as the 'Jodhpore,' are preferable. They should be of khaki drill,* and in jungle or over rough ground, or in cold weather, putties or spats of the same material could be worn over the extensions. Such pantaloons could be used in all branches of the service, and would be most comfortable on the line of march and also in camp, when the putties would be taken off. They could also be used for riding purposes.

Belts.—Belts worn over trousers should be as broad as possible, and should be given as a general issue to all troops. Broad belts protect the abdomen and prevent rupture, which is most liable to occur on service among infantry from carrying stones for sangars or emplacements. Each belt should overlap well at the front, and be fastened by three or four small straps and buckles. It should have a small leather pocket at each side, one for identification card and another for cash, etc., as well as a small **D**-ring with a swivel catch. The latter would be

* Certain regiments of the Indian Army—Sikhs, Rajputs, etc.—wear this pattern.

useful for a clasp-knife on one side and fork and spoon combined on the other, but these articles should only be carried on active service or manœuvres, as they would bulge the tunic.

Drawers.—In warm weather short thin drawers should be worn, and in cold weather long drawers should always be worn. They should be loose except at the waist. The waistband should be *carefully* cut and fit perfectly; it should rise some distance above the top of the overalls, and thus protect the abdomen from chill. The drawers at present issued are of strong wool of natural colour, two pairs being issued to each man on enlistment.

Sleeping Suits.—Each soldier might with advantage provide himself with two *flannel* sleeping suits. At present most men sleep in their day clothes, or at best in their day shirts; a few possibly use their spare day shirts. This may not be avoidable on active service, but in peace time and in barracks it is unsanitary and far from conducive to health. Such a boon as sleeping suits would be much appreciated; they would not cost much, they are easily washed, and the fact of wearing them would make sleep much more refreshing. Their presence would reduce sickness, as many cases of illness are due to chills, and there is nothing more liable to cause a chill than sleeping in sweaty day clothes. When a soldier returns to his barrack room after a long day's exercise at field training, or an afternoon's football or hockey match, he could change into these garments and rid himself of the clothing he has on, which is usually saturated with perspiration.

Cholera Belts.—Considerable difference of opinion exists as to the advantages and disadvantages due to the wearing of the cholera belt or woollen cummerbund; but when the evidence on both sides is carefully analysed, it appears that the question really resolves itself into a consideration of the *method* whereby this useful article is worn, and the knowledge of the *proper time* and *length* *of time* to wear it. To appreciate the advantages of the use of the cholera belt, the following facts should not be lost sight of:

1. The abdominal organs, especially the liver, stomach, intestines, and the kidneys—popularly known as the 'vitals'—are extremely delicate, and are each in turn very susceptible to changes in external temperature, especially to cold. Sudden chill will often seriously affect these organs. In the case of the liver, sudden chill may cause congestion and jaundice; in the case of the stomach and intestines, cramps, catarrh, and diarrhœa; and in the case of the kidneys, chill may cause nephritis of a varying degree, from albuminuria to Bright's disease. Sudden chill is more prone to cause disease than a slow continued reduction in temperature.

2. From time immemorial various races, living in all parts of the world, have recognized the importance of taking some special precaution to keep their 'vitals' well protected in cold or changeable weather. Amongst Europeans nearly all nations who live an outdoor life have adopted some form of special protection to the abdomen. The Dutchman's baggy trousers come up nearly to his armpits, and agricultural labourers in this country have a tendency to wear similar garments with high waistbands. The Spaniards, Italians, Turks, and inhabitants of Asia Minor in a greater or less degree wear some sort of protecting sash around the abdomen. Natives of India consider a cummerbund an essential protection against cold. Amongst animals it is a universal practice in cold weather to roll themselves up in such a position that the 'vitals' gain the greatest possible heat during sleep.

3. The chief factors that have to be considered in the tropics and abroad generally are the sudden changes in temperature that may at certain seasons or under certain conditions be experienced. Healthy men sleeping on deck on board troopships may be warm and

perspiring at one period of the night on the sheltered side of the boat ; should the wind vary, or should the ship alter its course, the condition of affairs may suddenly change, and pneumonia, jaundice, colic, diarrhœa, etc., may result. In the tropics men sleeping under punkahs may be similarly affected by a cessation of the air-current due to the *punkahwallah* falling asleep. Again, troops sleeping in their clothing in the open have to provide against the marked change that takes place in the temperature of the air a few hours before dawn. For these reasons it is apparent that the cholera belt has a distinct advantage, and should form part of the clothing laid down for every soldier.

The disadvantages of the cholera belt are those entirely due to the ignorance of its wearer, not knowing when to wear it, when not to wear it, and how to wear it.

The chief error made lies in persistently wearing it in the day-time as well as at night. The persistent use of the cholera belt not only does away with all its advantages, but causes it to act as a poultice, weakening the abdominal organs, and incommoding the wearer.

On active service the writer believes the cholera belt to be an absolute necessity ; more especially is this the case when troops are bivouacking. It should, however, never be worn except during rest at night, or when the abdomen is felt to be chilly during night duty or duty at dawn. Troops in bivouac of necessity sleep in their day clothing, and the abdomen is often insufficiently protected from changes in temperature due to the movements of the sleeper, or to weather. The cholera belt should be made of two layers of good flannel, and sufficiently wide to cover the entire abdomen, from the nipples above to the pubis below. The texture of the flannel need not be heavy, but it should be strong and durable. The belt should overlap for some 4 inches in front and fasten by three small buckles, the straps being sufficiently long to allow of it being worn *over the* *shirt* or jersey. If boned with three small pieces of whalebone behind, it will be found to lie flat and comfortable. When not in use it should be rolled up and carried in the haversack. When the belt is worn at night, and troops march out at dawn, if the morning is cold the belt should not be taken off until the body becomes warm.

In the event of cholera belts not being available, the following substitutes may be improvised should necessity arise :

1. Putties wound round the abdomen.

2. The wearing of the ordinary leather or web equipment belts *over* a greatcoat, a 'Coat British Warm,' or a blanket folded like a kilt round the abdomen, or *over* dry empty sacks or the canvas bags used for earthworks, if nothing better is available on a cold night.

EQUIPMENT.

Next to the question of clothing, the subiect of equipment, and the interference it exercises by pressure on the soldier when on the line of march, must be considered.

Belts.—All belts and accoutrement straps should be of soft, brown, pliable leather, and their buckles and fittings of aluminium. Everything should be done to reduce the weight of the equipment and to render it invisible, as well as to distribute it on the body in such a way that a soldier can breathe freely and carry out any duty without restraint. As much thought and careful consideration should be bestowed on the selection and manufacture of a soldier's clothing and his equipment as are given to the turning out of a rifle or gun.

Ammunition Pouches.* — The present pattern of ammunition pouches is medically far from desirable : they

* These are now being done away with and replaced by (five-charger pouch) bandoliers or the new web equipment which is described on pp. 233-240.

press directly or indirectly on the heart, stomach, colon, and liver, and, by causing congestion of the circulation, react on the heart and produce cardiac exhaustion. Owing to their liability to open, ammunition easily falls out and gets lost, or is picked up by the enemy. Bandoliers with flap-protected pouches, each containing five or seven rounds, are better: the ammunition does not get lost, and the weight can be more evenly distributed.

Water Bottles.—The patterns at present in use are made of enamelled iron, with a felt or baize cover. These bottles, although a great improvement on the older patterns, are still open to further improvement. The method of cleaning water bottles will be found on p. 178.

Description of Mark IV. Water Bottle.—This is a flat circular bottle, made of enamelled iron, covered with brown felt, about $7\frac{1}{2}$ inches in diameter, $1\frac{3}{4}$ inches thick, holding about 1 quart. It has three iron loops on the outside edge through which passes the buff supporting strap. It is fitted with a cylindrical neck with a cork stopper about the size of an ordinary wine bottle cork, through the length of which passes a tinned iron pin. This pin is fastened to the cork by a nut which screws on to the inner end of the pin. At the outer end of the pin is fixed a loop, to which is fastened a nickel-plated chain 6 inches in length; this serves to secure the cork to the bottle, and is fastened to one of the side loops. The carrying strap is of buff leather, 74 inches in length and $\frac{5}{8}$ of an inch wide, fitted with a sliding loop.

Description of Mark V. Water Bottle.—This is a *rectangular* water bottle made of iron (enamelled) covered with brown felt, and fitted with a cork stopper similar to that of the Mark IV., but attached to the bottle by a piece of whipcord instead of a chain. The body of the bottle is about $7\frac{1}{2}$ inches long, $5\frac{3}{8}$ inches wide, 2 inches across, and one side is shaped to fit closely to the body of the wearer. It has a capacity of about 1 quart. The carrier is made of brown leather with two brass rings for the shoulder strap, which is also of brown leather 5 feet long, and fitted with a web shoulder piece about 12 inches in length, and 2 inches in width, inserted at the part which rests immediately on the shoulder. The strap passes through the two rings on the carrier by which the latter is supported. The neck differs from that of the Mark IV. by being 'bell-mouthed.'

Description of Mark VI. Water Bottle.—This bottle differs only from the Mark V. pattern in the shape of the neck, which is cylindrical and similar to that of the Mark IV. pattern, the cork being identical with those of the Marks IV. and V., and attached to the bottle by means of a piece of whipcord, as in the Mark V.

In conclusion, we may take it as a rule that a soldier should himself carry only the following articles of equipment:

1. His personal arms, ammunition in two bandoliers, water bottle, haversack with food, and a 'billy' for cooking in.

2. The clothes he actually wears, including 'Coat British Warm,' rolled in the mackintosh sheet, with a change of socks and jersey cap inside the pockets, and a small towel.

3. Entrenching tool.

The rest of his kit should be rolled in his blanket and fastened by a wide strap, with his regiment, name, and number painted or stamped legibly on it. This would avoid men having their blankets mixed while on the transport waggons, and cleanly men getting lousy blankets.

BEDDING.

For the use of each soldier in barracks there are supplied one coir mattress (in three pieces), three general service blankets (one extra in winter), one under blanket, two sheets, one coir pillow, and one pillow slip. Bedding is held on barrack charge, and is not the property of the soldier.

The sheets are changed once a fortnight and the blankets once a year. There is no method of marking the bedding of each man, so that when several men of a company go to hospital, their blankets, etc., may get mixed up in the company store. Similarly men detailed for guard duties may get their blankets mixed. There is always a possibility of infectious or contagious disease (enteric fever, scarlet fever, itch, etc.) being transmitted by this means, so it is advisable for Commanding Officers to obviate this regimentally.

Under canvas, one waterproof sheet (issued as camp equipment), and blankets, when specially ordered, are provided. During inclement weather straw bedding may be issued on recommendation by the medical authorities.

During the winter months, or when the weather is so severe as to render it necessary for the health of the troops, an extra blanket for each man, and each woman on the married establishment, occupying barracks or huts, will be issued on the authority of the General Officer Commanding.

Bedding will be exchanged for clean bedding on the indent of the Officer Commanding after it has been in use at home stations for the following periods :

Barrack blankets	12 months.
Palliasse and bolster cases (straw) for Special Reservists	3 ,,
Sheets and bolster slips (coir) ...	2 weeks.

Or in recruit barracks or receiving rooms :

Blankets, palliasse cases (straw), and bolster cases (straw) for Special Reservists	1 month.
Sheets	A clean pair for each recruit.

At stations abroad no precise period is fixed during which bedding should be in use without being washed, local arrangements being made to suit existing conditions.

Coir Bedding.—The coir mattress is made in three pieces, the cases being tan-coloured dowlas. Each piece contains 8 pounds of coir fibre, and its gross weight is 9¼ pounds. The bolster case is made of dowlas of ordinary service pattern, filled with 2 pounds of coir fibre, and its gross weight is 2 pounds 7 ounces. A case (slip), is provided for the bolster. Each coir bed should be remade when necessary after having been not less than a year in use.

Extra Blanket.—An extra blanket (which has become too thin for ordinary use) is issued as an under blanket with each coir bed. The four corners of each of these blankets are cut off to the extent of 6 inches from each corner before issue, to mark them.

Washing.—The washing of barrack and hospital bedding is carried out either at Government laundries or under contract made periodically.

Washing Flannel Shirts, Worsted Socks, and Woollen Goods.—The water in which these articles are washed should be lukewarm only ; they should on no account be put into boiling or even very hot water, as it tends to shrink the material. The articles must be well rinsed in clean tepid water before drying. Yellow soap only should be used, and the use of washing powder is prohibited. A little ammonia (1 tablespoonful to 2 gallons of water) may be added to remove grease and perspiration. After the water has been completely wrung out of them, the articles will be well pulled out by hand before drying. (*Vide* 'Regulations for the Clothing of the Army,' Appendix V., paragraphs 22 and 23.)

Treatment of Clothing infested with Vermin.—Clothing infested with vermin* will be treated (with materials obtained from the officer in charge of barracks) as follows :

1. The infested clothing will be hung up in a small

* *Vide* 'Regulations for the Clothing of the Army,' Part I., Appendix V., paragraphs 20 and 21.

room in such manner that the fumes of burning sulphur will have access to all portions of the garments.

2. About $\frac{1}{2}$ pound of flour of sulphur will then be put into an earthenware saucer (standing in the centre of a bath, with some water in it, to prevent t e fire spreading) and ignited.

3. All doors, windows, and other openings in the room will be closed before commencing the fumigation of the garments.

4. After from three to four hours, the doors and windows will be opened and free ventilation established.

5. The clothing will subsequently be well aired and shaken.

CHAPTER IX

MARCHING

General considerations—Physiological aspects of marching—Adverse meteorological conditions — Open jackets—Open order — Smoking — Practising marching — Forced marches — Undisturbed sleep — Night marches — Food before starting—Time of starting—Pace for infantry—Pace for mounted troops—March formations—Distance on the march—Halts—March discipline—Water on the march—Alcohol on the march — Stragglers — Hints on care of the feet.

One of the essentials in the medical examination of recruits for the Army is strict attention to the normal development of the candidates' feet. The presence of marked degrees of flat feet, hammer-toe, overlapping toes, bunions, corns, ingrowing toenail, etc., any of which lead men to 'fall out' on the march and break down on active service, disqualifies the candidate from being passed 'fit' for the Army.

Normal feet are essential for all branches of the service, but more especially for the infantry, and in this branch the standards laid down should always be rigidly adhered to.

Marching is far more trying work than getting over the ground like an ordinary pedestrian.* A civilian takes off

* *Vide* 'The Second Report of the Committee appointed by the War Office on the Physiological Effects of Training on the Soldier.'

his coat, turns up his shirt-sleeves, and opens his shirt at the neck when he is working on a hot day. The custom in the army appears to be the exact opposite: the soldier marches with his jacket buttoned up to the neck, and confined by a belt and by straps across the chest, and only takes off his coat and opens his shirt when he reaches camp and his hard work is over. The reason for this appears to be unnecessary regard for appearances or smartness on the line of march. The practical result is inefficiency. The soldier is made to sweat more than is necessary for a given amount of work. Perfectly free evaporation can only proceed from the jacket after the shirt has been soaked. The cooling effect is thus delayed, so that the temperature of the body in the meanwhile rises; great discomfort is caused, and a much larger quantity of moisture must be lost to produce a given cooling effect than would be required if the evaporation had proceeded directly from the opened shirt and partly exposed skin. A healthy body maintains its percentage of water at a very constant level, and the soldier must replace any excessive loss. The loss of moisture produces a thirst which must be, and is, satisfied, and, unfortunately, not always from the most suitable source. Loss of water from the body by sweat increases the specific gravity of the blood, makes it more viscid, and puts more work on the heart and impedes the circulation.

Some omnibus companies in London have found that freely watering their horses in hot weather saves their powers and makes them work more. No doubt the same procedure in moderation would be beneficial in marching, as in hot weather the body must be supplied with water to replace that lost by sweat. Lieut.-Col. C. H. Melville, R.A.M.C., has pointed out that among soldiers there exist two kinds of thirst—the thirst of necessity and the thirst of habit. The former cannot be avoided, as it is the cry of the blood for water. Thirst of habit, on the other hand, can be very much mitigated by military training.

'Marching,' says Lieut.-Col. Melville,* 'means walking, wearing certain clothes; carrying a certain load, disposed on the body in a certain manner; at a fixed pace, regulated not by the physical necessities of the individual, but by the average physical character of the body of troops of which he forms a part.'

The conditions of marching are quite different from those met with in any other form of exercise, the essential differences being—

1. The carrying of a heavy load. The total weight of a man's clothing, equipment, rifle, ammunition, etc., is approximately $58\frac{1}{4}$ pounds (see Chapter VIII., p. 240).

2. Marching in more or less close ranks, in step and in uniform, the latter not being always suitable for prevailing weather conditions or for free play of the muscles.

3. The necessity of maintaining a reserve store of energy—*i.e.*, the soldier must be ready—if necessary, at a moment's notice—to march at the double, come into action, and use his rifle. Should there have been previous fatigue, his shooting capacity is seriously impaired, his 'sighting power' becomes uncertain, and the 'pull off' tremulous.

In war especially, the fitness of troops for fighting depends to a very great extent upon the method and manner in which their marches have been arranged and their marching powers nursed. Men who have been overmarched, or whose health and comforts have not been attended to whilst on the march, can never be expected to maintain their stamina should an engagement occur. One of the great advantages of moving troops by rail when long distances have to be covered is that the men reach their goal quite fresh and their stamina is nursed. 'For nearly every hundred miles that are marched continuously,' says Lord Wolseley, 'you will lose in strength from 2 or 3 per cent., accord-

* *Vide* the *Journal of the Royal United Service Institution*, December, 1910.

ing to climate,' and this is not an over-high estimate under the present short-service system in our Army.

Some Physiological Aspects of Marching.—Davy, in 1876, was one of the first observers to draw attention to the fact that the forced continued position of inspiration which occurred during the compulsory position of 'attention' in the Army caused a form of irritable heart which is now known in the service as 'soldier's heart' (D.A.H., or disordered action of the heart). Such irritability is due to impeded and obstructed circulation caused by the act of inspiration being held in abeyance time after time on the parade ground. This at length caused an habitual semi-expansion of the chest and loss of full action by the respiratory muscles. Soldiers so affected were quite incapable of the arduous work of a campaign, and often broke down on long marches. If experiments be made whereby the pulses of men 'standing easy' and again after five minutes standing at 'attention' be counted, it will be found that the pulse rate in the latter position will, as a rule, be markedly increased. The pulse rate is also increased if tight tunics are worn.

A series of interesting experiments, carried out recently on soldiers of the various arms of the service at Aldershot and Salisbury Plain by a sub-committee of the Advisory Medical Board appointed by the War Office, have furnished some very interesting details connected with the physiological effects of marching as practised in the regular Army. The marching was carried out under varying meteorological phases in summer, winter, and spring, to determine the effects of atmospheric conditions, such as temperature and humidity of the air. Measured distances were marched and timed on country roads and on grass, as far as possible under service conditions for dress and equipment, rate of march, halts, etc. Observations were made connected with the physiological differences found before and after the march, having special reference to changes in body-weight, weight of clothing and equipment, pulse rate, blood pressure and temperature. The temperatures were recorded as rectal and surface (face, wrist, and cheek).

The more important facts determined by these experiments were—

1. That the body temperature is considerably *raised* by marching. This is a most important observation, because if the heat equilibrium of the body is not restored the first effect may be exhaustion, which will cause the soldier to fall out on the march; and if this exhaustion is carried to excess, it may result in heatstroke in varying degrees up to collapse, and even to a fatal termination.

2. That the influences which maintain a normal equilibrium of body temperature on the march depend chiefly on the following factors:

(*a*) The temperature of the air and the amount of moisture contained in it.

(*b*) The amount and effectiveness of the evaporation of sweat from the soldier's body.

(*c*) The influence of practice in marching and the carrying of his normal marching equipment by the soldier.

(*d*) The rate of pace. More heat is accumulated if the soldier is made to march quicker than his ordinary rate of stride.

(*e*) The amount and kind of clothing worn, and the method whereby it and the equipment are distributed and worn.

An experiment showing the amount of sweat excreted by men marching is also quoted in the report above mentioned. Five men who made a seven-mile march in two hours' time on a hot day in September, with a south-west breeze blowing, and with the temperature of the air by the dry and wet bulb thermometers at 79° F. and 67° F. respectively, were found to lose by evaporation an average of over three pints of water; the average gain by moisture in their clothing being about half a pint.

Other men marching under the same conditions, but having their tunics unbuttoned and open and their shirts exposed, showed that this procedure saved them the loss of about one pint of water.

Adverse Meteorological Conditions. — The chief adverse meteorological conditions to prolonged marching, if storms and wet weather be excepted, are a high temperature, moist air, and an absence of wind.

If the air is dry and there is a breeze, evaporation of the sweat takes place more readily from the surface of the body, and therefore a higher temperature can be borne. The evaporation of sweat is the chief way in which a man's body is cooled when it becomes hot.

The humidity of the air (as shown by the wet and dry bulb thermometer) is a factor to be taken into consideration when troops are on the march, as it indicates to some extent the heat to which the body temperature can rise before heatstroke is produced.

Marching in Wet Weather.—In wet and stormy weather, unless compelled by military exigencies, men should not be allowed to march, as such weather causes a heavy sick roll. When, however, such marching is unavoidable, as soon as the march is over, the men should be at once dismissed and allowed to change their clothing, dry themselves, and have some food as soon as possible. An issue of rum, if available, will often ward off an attack of chill or illness.

Open Jackets.—Every possible means should be taken by commanders of infantry on the line of march in warm weather to narrow the margin between the increased temperature caused by the exertion of marching and the normal temperature of the body when at rest.

This can be done to a very great extent by ordering the men to unhook their collars and unbutton their jackets and shirts when on the march in warm weather, and thus avoid all possible constriction of the chest and at the same time allow evaporation to take place.

For the same reason equipment straps lying vertically and not crosswise on the chest should be worn.

Open Order.—Another important aid is to avoid marching men in close formation. The most open order should be adopted, so that the air around each man may be ventilated as freely as possible. If the ranks march close up, then the temperature in the ranks rises, respiration is hindered by the accumulation of CO_2 gas, and the conditions of heatstroke and sunstroke are favoured.

Smoking.—There is no doubt that the smoking of cigarettes—especially cheap brands—diminishes the efficiency of the marching powers of soldiers; the heart's action becomes disordered, and the rate of the pulse is raised to an extent above the normal. Moreover, in some cases trembling of the hands and fingers can be observed. For these reasons cigarette smoking in the ranks on the line of march should be forbidden.

Necessity of Practising Marching.—A soldier learns to march efficiently only by marching frequently. Training therefore in marching should, after the first fortnight of the recruit's enlistment, have the same value attached to it as physical training, according to the terms of the manual on that subject, and it should be a definite order that each young soldier perform at least one march a week. The load carried and the distances traversed in these marches should be progressively graduated. Such marches should not take place on the same day as physical training, and should be continued until the recruit is finally dismissed drill and physical training. Experiments show that with practice a trained soldier in full marching order can march the same distance over the same road with less fatigue than that produced when he performed the first march of the series in ordinary dress. A soldier by being practised regularly in marching learns to accommodate his body to the demands of muscular work, and to carry his equipment with the minimum of exertion. The benefits of practice are obtained most readily by training of a progressive nature, both as regards equipment and distance.

Forced Marches.—Marches may be roughly divided into two classes, 'ordinary marches' and 'forced marches.' The latter should be avoided as much as possible, as they break the backbone of an army and fill the hospitals with sick. At times they may be unavoidable, but when practised to excess they are ruinous to military efficiency.

When absolutely necessary, only picked troops—seasoned soldiers—should be employed, and an extra half-pound of meat ration issued.

Necessity of Undisturbed Sleep.—Unless there is something very great to be achieved, it is best to spare men from all unnecessary fatigue, as the less that is taken out of them the better will be their health and the greater will be their power of endurance for marching and fighting. For this reason, loss of sleep, if continuous, soon causes an increased sick rate, and also reduces general efficiency. Men should have plenty of sleep to recruit exhausted nature, and when it is found necessary for troops to march out at dawn their slumbers should not be disturbed by being awakened to 'strike camp' until it is absolutely necessary, or by other troops detailed to move out during the night.

Night Marches.—Marches undertaken as night falls, *before* the men have had their sleep, are destructive of health and efficiency, and for this reason they should be avoided as much as possible. They are very wearying to the men, and demand at least half as much time again as the same distance would require by daylight, unless there be a full moon.

Necessity of Food before Starting.—In all cases when troops march before breakfast, arrangements should be made to provide them some sort of light refreshment, such as coffee, tea, or cocoa, with bread or biscuit. This should be prepared and issued in good time before the

'Fall in' is sounded; men should always quench their thirst before marching, and fill their water bottles.

Time of Starting.—The season of the year, the distance to be covered, the climate, and military exigencies must determine the hour of setting out. Unless it is necessary on account of the heat of the sun (in the tropics) to march extremely early, it is better for men and horses not to start until a good hour after breakfast, which should be at dawn. To save unnecessary fatigue for man and beast, the hour at which the 'Fall in' for each unit is ordered to be sounded should always receive special consideration. It is not necessary that the men of the advance guard, main body, and rear guard, should fall in at the same hour when the march is in column of route, as the column will probably extend over several miles, and it is impossible that all units can start at the same time. If men are kept standing in the ranks or 'hanging about' in cold weather, they are liable to get chilled to the bone.

Pace for Infantry.—The pace of marching is most important with reference to fatigue. Men should not be hurried for the first two or three miles of a march, especially after meals, or they will get out of breath. They should be allowed to fall out freely, if they desire to do so, to answer the calls of nature. In fact, a halt for five or ten minutes for this purpose should be made when a march starts after troops have had food. Once the men warm up to their marching, the rate will increase of itself to the normal three miles an hour, which is certainly the rate at which the best work can be done with the greatest conservation of energy; and this rate should not be increased without good military reason, as an increased expenditure of energy will readily produce fatigue and physical exhaustion. Moreover, there is a certain pace combining the best progress with the least resistance. Thurn has estimated this at about 100 steps per minute, and states that at this rate the lower limb, as a pendulum, traverses its full swing; at a less rate the swing is not completed. The rate of 100 steps per minute combines the least expenditure of muscular force with the highest satisfactory number of steps per minute.

On good roads the pace at the head of an infantry column is officially regulated at one mile in eighteen minutes, and it is directed that infantry should be practised to keep this pace with regularity for considerable distances. The leading regiments must not exceed it; otherwise the rear will have much difficulty and fatigue in the endeavour to keep up with them.

Including short halts, an infantry brigade should average about three miles per hour.

The longer the column, the slower will be the rate of marching.

Great heat, snow, dusty, sandy, or muddy roads, a strong head wind, darkness, and steep hills, are all factors which prevent the normal rate of marching being maintained. The pace should not be permitted to relax unduly, for nothing can be more fatiguing than a very slow march.

The Length of Pace.—The length of pace in slow and quick time for infantry is 30 inches; in stepping out, 33 inches; in double time, 40 inches; stepping short, 21 inches; and side step, 15 inches.

All light infantry and rifle regiments march with a quick, short step. It is doubtful if this be economical in a physiological sense, and it is certain that it is opposed to efficient co-operation with other troops who have been trained to march at the ordinary pace.

Pace for Mounted Troops.—If mounted troops are marching independently of the infantry, the quicker the march is completed within certain limits the better. At the trot and walk, including short halts and leading, mounted men should average about five miles an hour. The men will walk and lead as often as possible, and they should always do so when ascending or descending steep hills.

Rates of Movement.—Rates of movement in the field are approximately as follows:

Arm.	Yards per Minute.	Minutes required to Traverse One Mile.
Infantry	98	18
Mounted troops—		
At the walk	117	15
Trot	235	8
Gallop	440	—

For *transport* on fairly good roads, not more than 2½ miles per hour for wheeled transport should be allowed, 1½ to 2 for camels, 2 for pack bullocks, 1½ for bullock carts, 3 for pack mules.

March Formations.—The normal march formations on a road are—

For Cavalry.—Column of sections or of half sections —*i.e.*, four men or two men abreast.

For Other Mounted Troops.—Column of fours or of files.

For Artillery.—Column of route—*i.e.*, guns and waggons in single file.

For Infantry.—Column of fours.

Distance on the March.—To prevent minor checks or delays in a column being felt throughout its length, the following distances are directed by regulations to be maintained:

1. In rear of each company of infantry, 6 yards.
2. In rear of each battalion of infantry, squadron of cavalry, battery of artillery, or other unit not specified here, 10 yards.
3. In rear of each regiment of cavalry or infantry brigade, 20 yards.
4. In rear of each cavalry or infantry brigade, 30 yards.
5. In rear of each division, 100 yards.

When checks occur, these distances are often temporarily reduced. It is ordered that they should in no circumstances be increased in the presence of the enemy, or when operating in peace under service conditions.

Halts.—The duration of halt at the end of each hour's marching should depend on whatever meteorological conditions may prevail, such as abnormal temperature, humidity of the air (moisture), absence of wind, and also on the weight of the soldier's load, want of practice in marching, and rate of march. Experimentally it has been found that on ordinary days ten minutes' halt after the first hour's march of three miles was sufficient ; after the next hour's march, at the same rate, and over the same conditions of road, a longer halt was found necessary to produce a similar decline in the pulse rate. On a hot, damp day, with little wind, a longer halt in each case would be necessary.

Over uneven, rugged, or hilly ground, a halt of five minutes every half-hour should be ordered.

Should troops start at or before dawn, there ought to be a halt about eight o'clock for breakfast, and at least half an hour should be allowed for this meal. When possible, camp kettles and fires should be arranged to be sent forward beforehand, and the men should be provided with a substantial meal—tea, coffee, or cocoa, being essential. During such an interval arms should be stacked and belts loosened. If water is available, washing should be made compulsory, as it is cooling and refreshing. This is especially the case if men can bathe their feet, but time may not permit of this. Temporary latrines should also be dug by the sanitary squad, and these should be carefully filled in before the troops resume their march.

March Discipline.—This should be strictly observed, as being of the highest importance in the interests of hygienic efficiency and for the avoidance of unnecessary fatigue to the men. The following rules are usually enforced:

1. Infantry should not be allowed to march more than our men abreast, including commanders and supernumeraries, the left side of the road being followed. In the event of men who are marching on the extreme left of the road being caused greater inconvenience than the others, after each halt the left-hand man of each section of fours should be placed on the right when the march is resumed.

2. Cavalry and other mounted troops should not be allowed to march along roads more than four horses abreast, particular care being taken to leave a space clear at one side for other traffic. When possible mounted troops should march by a different road from that used by the infantry, as horses throw up much dust; if different routes are not possible, the regulation intervals should be always left and maintained to allow the dust to settle.

Water on the March.—The subject of men drinking water on the march is a difficult one to legislate for; it has already been referred to on p. 267.

The conservative power of the eliminating function of the skin against excessive rise of temperature has already been alluded to. If the body contains too little water for the necessary amount of perspiration to take place, sweating will be diminished, and with this the temperature of the body will rise. The mechanical act of marching of itself raises the body temperature, and if the heat produced is not got rid of by sweating and evaporation, heatstroke may follow.

The value of small draughts of water at intervals during a march, rather than at the time allowed for halts, is to a certain extent a prophylactic against fatigue and heatstroke. Every opportunity should, however, be taken when halting to bathe one's face and hands. The body-weight lost during a march on a hot day, which may be taken approximately as 5 pounds for seven miles, comes from the blood, the viscosity of which is thereby increased. A man doing hard work must have something to drink to replace the amount of fluid lost by perspiration, and therefore men must have water. At the same time, they must be trained to avoid the thirst of habit, and they must be taught not to drink water until they have the honest thirst—the thirst of necessity.

Alcohol on the March.—Alcohol in any shape should never be taken on the line of march. Instances of fatal effects from drinking beer, whereby heatstroke and sunstroke have been produced, are recorded. In one instance, where a number of men were supplied with rum, nineteen *died* on the roadside.

Stragglers.—All stragglers should be got rid of as early as possible, as during long marches the sight of men falling out has a bad effect on the morale of the other men. Ambulance and other transport should always be provided, and, for obvious reasons, should be kept well out of sight—half a mile behind the rear of the column.

HINTS ON THE CARE OF THE FEET.

Some of the disabilities of the feet which cause bad marching may now be considered, and these may be roughly grouped under two headings : bad feet and bad covering for the feet. With regard to the feet, the chief cause of footsoreness in the soldier is a tender skin, due to want of cleanliness pure and simple. Many men prior to enlistment do not appreciate the importance of cleanliness, especially in reference to the feet, and after enlistment the company officer may not perhaps give this subject its due consideration. A horse whose hoofs are left unclean readily goes lame, and from the same cause the human foot becomes friable and tender. Sailors, from the nature of their work, have always clean and well-formed feet, and without exception always march well. It is desirable that every facility should be given in barracks for men not only to wash their feet, but to maintain them clean. Feet inspections should take place frequently, and any company officer who is keen on preserving a good marching record for his company cannot do better than interest himself in this matter. Next to clean feet will come clean socks and clean boots; the last named is of particular importance, and yet it is often lost sight of. The *inside* of a soldier's boot after a period of wear becomes clogged with dry dust and sweat, abounding in all kinds of septic germs. When the foot becomes heated on the line of march, it naturally perspires and damps the sock and interior of the boot. In a short time the dirty matter inside the boot dissolves and contaminates the sock and its wearer's skin. If an abrasion is present, it becomes infected and a septic sore results.

In order to ensure that troops are in a good condition for marching long distances without fatigue, company officers should see that attention is paid to the following details:

1. On the day before a march all socks and boots should be examined, and repaired if necessary.

2. During the first few days' march socks should be soaped inside, and before and after marching, the feet should be washed.

3. When in camp, after a day's march has been concluded, the socks should be examined and washed, if it be possible to get them dry before the next morning; if this is not feasible, they should be well stretched and rubbed to take out all wrinkles. If a change of socks is not available, it is often a good plan to put the right sock on the left foot and *vice versa*, or even to turn them inside out and wear them occasionally in this way.

4. On halting for the night the feet should be carefully examined for blisters and inflamed patches. Blisters should be washed with boric lotion (or hot water if this is not available), then pricked with a *clean* needle, and afterwards powdered over with boric acid. The loose

skin of a bleb or blister should not, as a rule,* be cut off or removed until several days after its occurrence, as the cuticle protects the raw surface underneath.

5. For tender feet it is a good plan to rub the feet with salt and alum dissolved in hot water, as this will harden them.

6. *Toe-nails.*—Keep the toe-nails cut, but do not cut them too short, or they will not protect the toes. If toe-nails are suffered to grow too long they are prone to cut holes in the socks; they also cause great fatigue on the march by being pressed on by the boot. If toe-nails are cut too short, the flesh is pressed up over them and an 'ingrowing toe-nail' results. Toe-nails should always be cut square at the sides and the corners, not rounded off.

7. *Cuts and Wounds.*—All abrasions, cuts, and wounds of the feet must be dressed with an antiseptic to kill germs; otherwise blood poisoning may occur. Dirty rags and messes used for poultices nearly always cause poisoned wounds. If ordinary antiseptics are not available, boil some water, cool it down, and then wash the cut or wound. Turpentine is, however, a good antiseptic, and so is any kind of spirit; these antiseptics are generally available.

8. *Wet Feet.*—Standing about in wet boots and socks is a fruitful cause of chills or rheumatism. Never sleep in wet socks. If it is necessary to sleep in socks that have been worn during the day, or if a change is not available, always turn them inside out before putting them on again.

9. *Socks.*†—If possible, never wear socks with holes in them, as they will cause blisters. Darning should be

* The exception to this rule is when the bleb or blister appears inflamed; it should then be immediately removed with a clean pair of scissors, cutting as close to the edge of the blister as possible, and afterwards washing the raw surface with boric acid lotion and putting on an antiseptic dressing.

† See also Chapter VIII., p. 255.

neatly done ; a lumpy darn will cause a blister. If it is necessary to wear a sock with a hole in it, always change it to the foot which did not cause the hole, or in some cases, where a very large hole exists in the heel, the sock can be reversed so as to make the hole lie on the instep under the tongue of the boot, and thus give the heel an unbroken part of the sock to protect it.

The fitting of socks is most important. The Army socks, which cost ninepence a pair, are the best value in the market, and far superior to any offered in shops for double the price. They should, however, be selected about three sizes larger than required, as being made from worsted yarn they shrink on being washed.

Socks that are coloured with aniline or harmful dyes should not be worn. Any sock or stocking which discolours the feet is dangerous, for if the dye gets into a cut blood poisoning may occur.

Thin socks are no good for soldiers, and are useless for marching in. Always wear a thick sock.

Seams should be woven and not stitched.

Socks should be 'ribbed,' as this makes them more elastic and better fitting.

Socks should be either all wool or, better still, a mixture of wool and a little cotton. All-woollen socks shrink most ; cotton socks are useless.

Soldiers should know how to darn : a stitch in time saves nine, and on active service it will save much more.

10. *Boots** taken into use for a campaign should be as good as new in the matter of endurance. Never wear boots which are too small or too short. If boots are too large, a good plan is to wear two pairs of socks to fill them up.

Boots should be washed with soap and water *inside* and out, and scraped from time to time, to soften them. When dry they should then be well oiled or greased *inside* as well as outside. Wear a different pair of boots

* See also Chapter VIII., p. 247.

each day if possible. The fatigue of a long march is greatly relieved by washing the feet and changing the socks, or, if a second pair is not available, turn the socks inside out, and change into a fresh pair of boots. If feet become blistered or sore, change into another pair of boots for the following day's march. To make boots less hard and board-like, bend the soles upwards and downwards a few times, this will make the boot more supple. To dry boots never place them *near* the fire, as that will harden the leather and cause it to rot. To dry top-boots, fill them with bran and let them stand overnight. The bran will absorb the moisture.

If time and opportunity permit, troops should be instructed in the art of mending their boots.

11. *Chilblains.*—These are caused by want of proper circulation of the blood, either by cold or more frequently by tight boots pressing on the bloodvessels and stopping the supply of warm blood to the toes. The best cure for chilblains is to avoid tight boots, wear warm dry socks, and take plenty of exercise. It is also good to rub the parts affected. Do not go near fires when the feet are cold.

Regulations of the German Army concerning Marching.—'By far the most important factor affecting the efficiency of troops for war is their power of marching. The march is the keystone of all operations, and the success of every undertaking depends very largely on the accuracy of the arrangements made for its performance. In many cases the arrival of a body of troops at the right place at the right time, and in good fighting trim, may be the decisive factor in the situation.'—*Vide* 'Field Service Regulations of the German Army,' paragraph 303.

'However well trained troops may be in the art of marching, they cannot be expected to continue efficient in this respect unless they are spared every demand on their powers of resistance not absolutely necessitated by the object for which the march is made.'—*Vide* 'Field Service Regulations of the German Army,' paragraph 306

See also Question 3 on p. 336.

CHAPTER X

PHYSICAL EFFICIENCY

Personal hygiene—Baths—Haircutting—The teeth of the soldier—The toothbrush—Dental treatment—Cigarette smoking—Physical training—Gymnasia.

THE physical efficiency of the Army is dependent on many factors, all of which have an important bearing on the future, should it be necessary to put the Army to what it is made for—namely, the test of war. The first factor to be considered in this relation is efficient recruiting. The recruit must be medically, physically, and mentally fit, or else he will not be worth his rations. Having been passed fit, he must be carefully trained and developed to endure strenuous work if called on. This part of his education is carried out at recruits' drill and physical training in the gymnasium. Having become a trained soldier, he must be kept fit, and this is done by giving him plenty of suitable work, such as route marches and gymnastic exercises. Closely associated with general efficiency are personal hygiene, cigarette smoking, and physical training.

PERSONAL HYGIENE.

Strict attention to the cleanliness both of person and clothing is essential from every point of view, and must never be relaxed either in barracks or on field service, otherwise health will suffer. In no walk of life is cleanliness more important than in the Army, where men living an active outdoor life find themselves more or less collected together at the termination of their day's duties, either in barrack rooms or tents. The action of each man's skin being increased by exercise leads to the excretion of a considerable quantity of sweat, which must be removed by washing. The irritation of the skin caused by heat, perspiration, and contact with soiled clothing, hardened by sweaty epithelial débris and dust, are all frequent causes producing skin diseases, the commonest of which is *tinea versicolor*. In barrack rooms or tents the organic emanations from unwashed bodies and clothing will considerably pollute the air, and not only become one of the chief causes of 'barrack-room sore throat' and tonsillitis, but also tend to reduce the vital resistance of each of the occupants to the onset of disease.*

Baths.—Every man in barracks should have a *hot* bath at least once a week. The following parts of the body should be washed daily: (1) The feet and toes; (2) between the buttocks; (3) the armpits. Sweat accumulating in these places causes chafing, and to avoid this it is most important to wash them after any exercise that causes perspiration. Bathing should be encouraged as much as possible. Besides being cleanly, it is invigorating; but it should always be avoided for at least two hours after each meal, or when very fatigued or in profuse perspiration. Men should not remain in water long enough to feel chilly, and great care should be exercised carefully and completely to dry the ears afterwards, as neglect of this is a frequent cause of ear disease.

Haircutting.—Lord Wolseley† is of opinion that in the field no man's hair should exceed ½ inch in length; this is essential for the well-being and cleanliness of

* See also section on 'Baths and Lavatory Accommodation in Barracks,' pp. 18-19.

† *Vide* 'The Soldier's Pocket-Book for Field Service,' by Field-Marshal Viscount Wolseley, K.P., etc.

soldiers. It can only be carried out successfully when the example is set by officers. None except those who have worn their hair after such a fashion can appreciate the luxury it confers on service. No man can have that smart bearing which is the outward mark of a soldier who allows his hair to remain untrimmed. A well-cropped head is the first great step towards cleanliness. 'Hair is the glory of a woman,' says Lord Wolseley, 'but the shame of a man.' Want of cleanliness is a sure source of disease at all times, but especially so when a large number of men are living together in crowded tents. On active service, when shaving may not be possible, the beard and whiskers should be cut close about once a week.

THE TEETH OF THE SOLDIER.

The perfect mastication and insalivation of the food have been proved by experimental investigations—notably those of Sir Michael Foster—to produce not only great economy in general nutrition, but also a remarkable improvement in the condition of the gastro-intestinal tract. During recent years considerable attention has been directed by the medical authorities of the Army to the subject of dental sufficiency for recruits, and a fairly uniform standard is gradually being evolved. It has to be borne in mind that a recruit for the regular Army must be fit for the average conditions of European warfare, and that recruits for the reserve forces (formerly termed the Militia) must be fit for the average conditions of warfare in the United Kingdom, a safe rule being that the poorer the physique of the recruit, the higher the standard of teeth to be demanded of him. Each recruit should have the equivalent of one of the following minimum standards, each tooth being either sound or efficiently stopped. The teeth in the upper jaw only are named, and they must *correctly oppose corresponding sound or efficiently stopped teeth* in the lower jaw.

(1) Wisdom and second molar on one side of the mouth; (2) first and second molar on one side; (3) first molar and both bicuspids on one side; (4) first molar and second bicuspids on both sides; (5) first molar and second bicuspid on one side of the mouth and both bicuspids on the other side of the mouth; (6) both bicuspids on each side of the mouth; (7) one molar on one side and both bicuspids on the other side. The remainder of the teeth are left to the judgment of the recruiting medical officer. Loss or decay of teeth causes yearly the largest number of rejections for any one cause in recruits for the Army. In 1908 no less than 3,279 recruits were rejected for this cause; in 1907, 2,861; in 1906, 3,719; and in 1905, 4,824. Approximately, 19 per cent. of all recruits rejected on inspection by recruiting *medical officers* are lost to the Army owing to deficient or defective teeth, and this estimate does not include men who have previously been rejected by recruiting agents. These figures are of the utmost importance when it is remembered that the possession of defective teeth goes with a good quite as often as with a poor physique.

During the South African War a number of men were found to be unable to consume the hard biscuit of the field service ration owing to lack of efficient teeth, and so many men had to be invalided that recruiting medical officers have since then very rightly paid particular attention to the standard of masticatory efficiency. There is no doubt, however, that some of the inefficiency attributed to defective teeth during the war was over-rated. A fair proportion of it was really due to the effects of scorbutic taint and lowered vitality, brought about by a prolonged campaign in which 'freshness' of food was at a minimum. Men tired of prolonged active service also sometimes made use of bad teeth as an excuse for not being able to eat the field rations and for going to hospital. As a result of the number of men who had to be invalided, the standard for the masticatory efficiency for recruits was increased to such an extent that the pendulum swung rather too far in the direction of increased efficiency. No account was taken of the large number of almost toothless soldiers who, under the exceptionally trying conditions of the war, not only remained in good health, but did their duty alongside their comrades, who, although better off in teeth, were eating hard biscuit with difficulty. A less stringent standard for teeth was adopted in 1906-07, and a diminution in the number of rejections followed. Many recruits were passed into the Army by the aid of dental treatment at the public expense who would otherwise have been rejected, upwards of 1,700 men being gained under these conditions in 1907 out of 5,849 men enlisted for the Army. In the Northern Command alone 915 recruits were brought up to the standard by the dentist in the year, and in the London district 295 men were similarly rendered efficient during the seven months in which the regulations for dental treatment were in force. It was, however, noticed that in the London District and in the Eastern Command the ratio of rejections for defective teeth increased after the introduction of the system of dental treatment for recruits. This was found to be due to recruiting agents bringing up candidates with very inferior teeth, in the hope that they might be accepted by the help of dental aid.

When the question of invaliding serving soldiers for dental inefficiency is considered, it will be found that before the South African War* defective or deficient

* 'The number of men invalided from South Africa during the war from defective teeth was 2,451. There is no information to show how many were invalided in that country. The subject of improving the dental condition of the rank and file in the Army is receiving careful consideration. Appointments of dentists were made during the war, and we are at present awaiting the experimental measures which

teeth caused very little invaliding from the Army ; in fact, this cause of invaliding was of so little importance that it was thought by the authorities not to merit mention in their annual reports. During recent years the official statistics show that in 1906, of 1,792 men discharged from the service on medical grounds, no less than 147 were invalided for caries of the teeth ; in 1907, of 1,685 men invalided, 58 were discharged from the same cause, the diminution being partly due to a less rigid standard of dental sufficiency, and also as a result of greater care being paid to the preservation of the teeth. In 1908, 67 men out of 1,486 discharged on medical grounds were invalided for dental caries. The very fact that soldiers have to be discharged in such numbers from the Army for caries of the teeth seems to indicate that greater attention should be paid in barracks to this matter, and that careful examination of the men's teeth should be made from time to time, so as to check the progress of caries by dental aid.

The Toothbrush.—There can be little doubt that, if men are taught to care for and preserve their teeth by using the toothbrushes which are issued free by Government to each man, much can be done. From the time they enlist, their squad, section, and company commanders should see that they keep their teeth clean. It should be no more difficult to teach them to keep their teeth clean than their rifles. The result will repay any little trouble involved, and the habit once acquired will also repay the men by much personal comfort.

If soldiers are required to use their toothbrushes, and thus keep their teeth clean while in the service, the advantages obtained are far-reaching—not only from the fact that it will preserve what sound teeth they are already

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have been taken to remedy the conditions complained of.'—*Mr. Brodrick, House of Commons, October* 28, 1902.

possessed of, but will also benefit their general health to a very marked degree.

When teeth are not regularly brushed, tartar accumulates at their junction with the gums; food adheres to this tartar, and provides a suitable medium for bacterial growth. This débris in time erodes the dental enamel, and not only causes the tooth to decay, but also causes suppuration of the tooth socket and spongy gums to develop. The fœtid discharge thus produced is swallowed, and, being septic, interferes with digestion, and in process of time with general nutrition. The fœtid breath contaminates what would otherwise be pure air inspired into the lungs. Such men also are liable to tonsillitis, sore throat (barrack-room sore throat), and deafness, from the proximity to the tonsils, pharynx, and Eustachian tube of the pathogenic bacteria they harbour in their mouths. The consequent net result of this condition is that the system is *slowly poisoned* by septic absorption; the soldier gets thin, and will not fatten on his food; his health becomes lowered, and such men on field service, from lowered vitality, become very much more liable to enteric fever, dysentery, and scurvy, than those who have cleanly mouths. The question of being able to masticate field rations, although important, is of quite secondary importance to that of the slow poisoning that occurs from swallowing the fœtid discharge from a filthy mouth.

Such men obtain a new lease of life when they get their mouths cleaned up. Coming to the question as to the best kind of toothbrushes, the following advice may be offered: For a clean mouth with sound teeth a hard brush may be used; but for any man who has not systematically used a brush, and has neglected his teeth —the gums being almost invariably tender, spongy, and liable to bleed—the best—in fact, the only possible—brush to use is a soft one, preferably one made of badger hair and of small size. These are inexpensive, and can be obtained, either at the Army and Navy Stores or at good druggists' establishments, for 8d. A small, soft, toothbrush will not make the gums bleed, and has the advantage of its hairs being able to get into the spaces between the teeth. An antiseptic powder must also be used, such as Calvert's carbolic tooth powder, and used twice daily—*i.e.*, morning and *before bedtime,* the latter time being the more important. Lastly, fruit or acid drinks should not be partaken of before bedtime, as acid fumes from the stomach appear to erode the dental enamel.

Dental Treatment.—The system of dental treatment by stoppings at contract rates by civilian dentists is proving successful, but it is to the early education of the recruit in the care of his teeth in barracks that we must look for an improvement in the dental efficiency of the soldier. Non-commissioned officers who have completed twenty-one years' service, and who are entitled to take their discharge after three months' notice, are not supplied with artificial teeth at the public expense. With regard to other cases, the general rule is that artificial teeth are only supplied at the public expense when it is considered desirable to retain men whose service with the colours would otherwise be terminated on account of medical unfitness.

CIGARETTE SMOKING.

Lieut.-General Sir L. J. Oliphant, C.B., commanding the Northern Command, recently issued special orders prohibiting excessive cigarette smoking by young soldiers serving under him, and directed medical officers detecting cases of injury to health produced by cigarette smoking to draw the attention of Commanding Officers concerned with a view of prohibiting the use of cigarettes by the men in question for a specific period. Restriction of cigarette smoking amongst the rank and file of the Army has only of late years attracted the attention of some of our military commanders, foremost amongst whom may be mentioned the name of Field-Marshal Lord Grenfell. This distinguished officer, while Commander-in-Chief of H.M. Forces in Ireland, during his visits to military hospitals, was struck by the harm that the increasing prevalence of cigarette smoking appeared to be doing to the health of the Army, and alluded to it in general orders as not alone a military question, but one of national importance. Lord Grenfell appealed to the Irish Command to give earnest thought to combating the pernicious habit in question which, he thought, was gradually but greatly affecting the efficiency of the troops, and he directed all Commanding Officers to impress on those under their control the evils that invariably result from this excess. With a view of helping men to overcome the habit, the Commander-in-Chief ordered that cigarette smoking was to be prohibited at certain times when, on the other hand, no similar restriction as regards pipe smoking would be made. For instance, the smoking of cigarettes was not to be permitted when men were on fatigues or under arms on any occasion, including field operations and manœuvres. There can be little doubt that excessive smoking of ready-made cigarettes is encouraged by their cheapness, and it may be to some extent responsible for cardiac affections. It is generally agreed that tobacco smoking has a toxic effect upon the heart, although this effect varies greatly in intensity in different individuals, and at the same time causes increased resistance to the blood-stream by contracting the small arteries of the systematic circulation. The average British recruit is on enlistment younger and in poorer physical condition than the recruit of any other civilized army. He is very often an inveterate cigarette smoker, and may have enlisted after a period of privation, not being in the best of condition to face even the present modified system of physical training. Recruits undergoing their first drills at the regimental depôt are very receptive; this is probably the most impressionable time of their service, and it is then that the first attempt might be made with some success to teach them to be moderate in cigarette smoking. Following on the same lines as Lord Grenfell's appeal, it would be a good thing for the health of the Army if all Commanding Officers were equally firm in drawing attention to the harm of over-indulgence in smoking. It may be noted that the officer commanding the 1st Seaforth Highlanders started a campaign some time back against the practice, and directed in battalion orders that cigarettes should never be smoked by any officers or men of his regiment when on duty of any kind. The examples quoted are, it is believed, more or less isolated, but they are valuable. Over-indulgence in tobacco is harmful, and the ready-made cigarette, being cheap to buy and convenient to smoke, is an inducement to such over-indulgence. To smoke it entails but little sacrifice in money or trouble.

PHYSICAL TRAINING.

In January, 1907, the Army Council changed the entire system of physical training of recruits and young soldiers by the introduction of the Swedish system; physical drill with arms was abolished, and physical training under the gymnastic staff was limited to one hour a day. Running drill was continued as before. The chief defects under the old system were—

1. It was overlooked that when the recruit was enlisted he was often in a poor condition from under-feeding. The food of a recruit in this condition is often insufficient for a growing lad, and youths too often lose weight during their first month's attendance in the gymnasium.

2. Much of the physical training (running drill) was carried on when men were clothed in closely-fitting uniform and often before breakfast.

3. The recruit was as a rule kept at physical training for two hours a day for five days weekly, and very often had running drill and ordinary military drill as well. The combination of poor condition, under-feeding, inappropriate clothing, free use of tobacco and beer, all put a strain on the heart.

4. The training was devised to develop a few large muscles by acrobatic feats, heavy dumb-bells or clubs, at the expense of the heart. It was not generally recognized that a man is only as strong as his heart, whatever may be the size of his arm. It was thought that recruits could be more quickly converted into strong men by increasing the time spent daily at physical exercises and by making their exercises more arduous. Great faith was placed in heavy dumb-bells and in pulling the body up to horizontal bars by sheer strength of arm.

The muscular efforts made in performing the majority of the exercises laid down invariably stopped the respiratory movements of the chest, congesting the flow of blood through the right side of the heart, and continuation of this condition tended to dilatation of the chambers and strain of the heart muscle. In more protracted cases the left side of the heart became first hypertrophied and then dilated, and in some cases valvular lesions ensued. Even in robust men undergoing such exercises the condition known as 'athlete's heart' and aortic incompetency may occur. The present system of physical training aims at what may be termed the harmonious development of the whole body without strain to muscle, respiration, or circulation. The object aimed at is physical exercise of the muscles, and not their abnormal development. Abnormally large muscles of either the arms or legs are only produced by hypertrophy and brought about by exercising a constant strain on the delicate muscle fibres.

Under present regulations the physical training of recruits is considerably modified, and is now very gradual and of a mild character, the Swedish system being adopted, as well as running drill, and being invariably carried on under the supervision of gymnastic instructors, and observation of Royal Army Medical Corps officers. It should never take place before breakfast, nor be practised for more than one hour a day. The men should be in their shirtsleeves and without braces, belts of broad webbing and shoes being used when undergoing exercises. No recruit should begin the more active exercises of physical training until he has had one month's service, as by this time he will have benefited by good feeding and grown accustomed to the regular hours and discipline of barrack life. It is desirable that recruits should be passed from a lower to a higher squad *individually*, and a medical officer should ensure that no weakly man is so advanced beyond his strength. No part of the training should be carried to the point of causing distress, and in most cases this will mean that the pulse beats should not exceed 130 per minute. The old regulation position of attention has been abolished, as it was a position of bodily and mental strain, the movements of the chest, and hence respiration, being seriously checked in the effort to keep the chest expanded.

If too much time is passed in the attitude of attention, the chest walls become more or less fixed in a position of expansion, and the range of expansion becomes diminished. The mental strain consists in the men having to be ready to carry out an order smartly and promptly, and having to anticipate this with strained attention. The new position of attention relieves both of these : it is a position of readiness, and there should be no strain whatever on the chest.

Under recent orders the War Office have appointed specially trained medical officers to certain of the larger military gymnasia in the United Kingdom for the purpose of carefully medically examining the recruits and trained soldiers at their exercises, and suggesting modifications or improvements in the various courses.

Physical training should be so arranged that it is interesting to the men, and be carried out as far as possible in the open air, which is essential to men doing hard work.

Gymnasia.—These buildings should have the freest ventilation that can be provided ; all windows should be kept open when the gymnasium is not in use, and it should be artificially warmed in cold weather. Instructors of gymnasia should give their orders in a regular, methodical tone, and clearly articulated, not in a barking manner, which only tends to make recruits nervous, and fail to understand the directions concerning the exercise they are about to undertake.

CHAPTER XI

DISINFECTION AND INFECTIOUS DISEASES

General observations—Regulations of the Army Medical Service concerning infectious and contagious diseases—Occurrence of infectious or contagious diseases in families—Disinfection of army schools—Disinfection of barrack rooms—Disinfection of married quarters—Recurrence of infection—Disinfection of fabrics, etc.—Disinfection in hospital—Chemical disinfectants—Standard disinfectant solutions used in the army—Disinfection by heat—Dry heat—Moist heat—Saturated steam—Superheated steam—Fumigation—Room disinfection—Disinfection of drains, gullies, receptacles, etc. — Disinfection of ambulance waggons—Clothing for patients suffering from venereal disease, enteric fever, tubercle, etc.—Methods of carrying out investigations and making reports upon outbreaks of infectious disease—General considerations—Enteric fever and cholera—Scarlet fever and diphtheria—Smallpox—Plague—Malarial and yellow fevers.

By disinfection is meant the killing of disease germs, and *nothing less* than the death of these germs is disinfection. Fresh air and sunlight are Nature's best disinfectants. Colonel R. H. Firth, R.A.M.C., states :* 'In the majority of cases of infectious disease, infection is conveyed by the person or clothing and bedding, and is not contracted from walls, ceilings, or fittings of buildings. From this point of view we are disposed to regard the routine fumi-

* Vide *Journal of the Royal Army Medical Corps*, vol. x., pp. 372, 373.

gation, or so-called "disinfection," of rooms and quarters after the occurrence of infectious disease, to be unnecessary, a constant source of disturbance, and inconsistent with modern conceptions of the etiology of these diseases. We should like to see it boldly abandoned as a relic of medical empiricism, and the true line of defence against the spread of infection recognized as being thorough disinfection by steam of all clothing, bedding, and other fabrics which have been exposed to infection.'

ARMY REGULATIONS CONCERNING INFECTIOUS DISEASE.

The regulations for the Army Medical Service state that whenever a case of infectious disease* occurs amongst the occupants of any military quarter, the medical officer in charge of effective troops should report the occurrence to the officer commanding the station or corps, and should submit without delay a detailed account (A.F., A 35) for the information of the Principal Medical Officer or Administrative Medical Officer, as the case may be, who will pass it to the sanitary officer concerned. The term 'infectious disease,' as applied to these requirements, includes the following: Smallpox, measles, scarlet fever, typhus fever, plague, diphtheria, cerebro-spinal fever, enteric fever, Malta fever, cholera, yellow fever, erysipelas, puerperal pyæmia, puerperal septicæmia, and tubercle affecting the lungs, larynx, or intestine.

This report should give the following information: Corps, rank and name of patient, age, service, name or designation of quarters or address, disease, date of onset,

* Medical officers should keep themselves in touch with the medical officer of health of the civil authority of the station or district, with the object of obtaining early information of the occurrence of infectious diseases amongst the civil population, and in return should give information regarding outbreaks amongst the troops.

suspected source of infection, sanitary condition of quarters and surroundings, whether to be isolated in quarters or hospital, what measures of disinfection proposed, recent movements of patient, giving stations, dates, etc., dates of preventive inoculation, including vaccination (when applicable), signature of officer reporting case, date and any other information likely to be of service.

The responsibility of representing the precautions which it is proper to take, as regards isolation and disinfection, will rest with the officer who reports the case.

Wherever proper accommodation exists, isolation should be effected in hospital ;* but where this is impracticable, as frequently happens in the case of officers and their families and amongst the families of soldiers, isolation will be carried out in quarters as far as possible ; and when considered necessary, the isolation of other occupants of the quarters will also be effected, until, in the opinion of the medical officer, all risk of their spreading the disease ceases.

Army Schools.—In cases of infectious or contagious diseases special care should be taken to prevent children of the family affected attending school until the medical officer certifies that they can do so without risk of spreading infection. Schools will not as a rule be closed in consequence of the occurrence of cases of infectious disease, but should the outbreak assume an epidemic form, or should the medical officer, for any very special reason, deem it necessary that the schools should be closed, the General Officer Commanding-in-Chief shall order the closing.

* At stations where there are isolation hospitals, cases of scarlet fever, diphtheria, and smallpox, are invariably admitted with a view of preventing the spread of such diseases. Other infectious diseases occurring amongst families are treated in quarters, but such cases can be admitted into hospital under special circumstances.

Army schools will be disinfected during the Christmas and summer vacations in the following manner:

1. The walls, above the dado, and ceilings will be treated with chlorinated limewash.

2. All dados, desks, seats, floors, and other woodwork, will be thoroughly cleansed with cresol solution.

3. The windows will be left open, if practicable, throughout the whole vacation.

4. The ceiling will be re-limewashed or whitened, and the walls above the dado re-distempered.

In case of a chapel school (1) may be omitted, should decoration and paint-work render it impracticable to treat walls and ceilings with chlorinated limewash.

Barrack Rooms.—When a case of infectious disease has occurred in a barrack room, after removal of the case to hospital, the following procedure will be adopted:

1. First deal with mattress, bed, bedding, linen and woollen goods, and articles of clothing, as described on p. 301, for the disinfection of fabrics, etc.—

2. Scrub with cresol solution the floor under the bed and for a distance of 6 feet all round the bed, also the bedstead, and any chair, locker, or other article of furniture that was used by the infected person.

Married Quarters.—Where a case of infectious disease has occurred in married or similar quarters, after removal of the case the same procedure as above will be adopted, but, in addition, the whole surface of the floor of the room and all the wooden furniture therein will be scrubbed with cresol solution.

Carpets, curtains, and hangings to be sprayed with formalin solution and removed into the outer air; when dry, to be dusted or beaten before being returned to the room.

Recurrence of Infection.—Where repeated cases of infectious disease have occurred in a barrack room or in quarters, and there is reason to believe that the later cases are due to infection persisting in the room or its contents, or where, as in the case of smallpox or tuberculosis of the lung attended by copious expectoration, in the opinion of the medical officer in charge, room disinfection is required, in addition to the measures detailed for barrack rooms on p. 300, the room will be disinfected by either of the two methods described on p. 309—namely:

1. Fumigation by sulphur dioxide (see p. 307).
2. Spraying all surfaces with formalin solution (see p. 304).

These measures, as well as those detailed on p. 300, will be carried out by the medical authorities, assisted by such fatigue parties from the unit concerned as may be considered necessary.

Disinfection of Fabrics, etc.—Disinfection of bedding, clothing, and other articles which may have been exposed to infection,* will be carried out† in connection with every case of infectious disease according to the following methods:

1. The mattress and bed will first be sprayed with formalin solution, and then removed for steam disinfection where practicable. Where no steam disinfector is available, the mattress must be opened up, and the stuffing, as well as the covers, well wetted with formalin solution. Particular attention should always be paid to the bedstead and its surroundings.
2. Blankets and woollen articles must be soaked for half an hour in cresol solution before being washed or sent to the laundry.
3. Sheets and articles of clothing made of cotton or

* The personal clothing and bedding of 'contacts' or 'carriers of infection' may, at the discretion of the medical officer in charge, be disinfected in the manner described here.

† The officer in medical charge of effective troops, or on duty at the place where the processes of disinfection are being effected, will be responsible that they are properly and efficiently carried out.

linen should preferably be boiled ; but where this is not practicable, they may be soaked for half an hour in cresol solution before being washed or sent to the laundry.

4. Cloth goods (including articles of uniform) will be removed for steam disinfection where practicable. Leather goods (and cloth articles where steam disinfection is impracticable) must be sprayed with formalin solution, exposed to the air, and sun-dried. Toys used by children in cases of infectious disease should be burnt or disinfected.

5. Any article infected by a dangerous infectious disease with regard to which the medical officer is satisfied that no other effective mode of disinfection is available, must be destroyed by fire, due regard being paid to the following procedure :

When, on sanitary grounds, the destruction of any article of public or private property is deemed absolutely necessary, the medical officer concerned will report accordingly in order to obtain authority for carrying out the destruction ; but in cases where delay would involve risk or danger to the troops he must act on his own responsibility, and be prepared to justify his action in the matter afterwards when making application for covering authority.

Disinfection in Hospital.—The measures of disinfection laid down for fabrics (p. 301) will also be adopted in connection with the bedding, clothing, etc., used by patients suffering from infectious diseases in hospitals, and all soiled bedding, clothing, etc., in intimate contact with the sick will be immediately steeped in cresol solution for at least half an hour before being removed from the ward. Articles which cannot be steeped should be sprayed with formalin solution.

As a special precaution in cases of itch, smallpox, or cholera, or of diarrhœa when cholera is prevalent, *hospital* bedding, bolsters, and pillows will not be used.

The patient's barrack bedding will accompany him to hospital, and the bedding and hospital clothing used by such cases and the clothing worn on admission to hospital will be disinfected as laid down on pp. 301-2 (1 to 5). In cases of smallpox they will be burnt.

Chemical Disinfectants.—Chemical disinfectants act in two ways—either by oxidizing or as direct poisons to the disease germs.

It is important to distinguish between these two actions of chemicals, as oxidizing agents cannot act more than once, after which they become inert (permanganate of potash). Chemicals acting as poisons can go on acting and are not rendered inert.

Oxidizers act without selective action; permanganate of potash cannot discriminate between vegetable matter and micro-organisms.

Carbolic acid acts as a direct poison; it will kill disease germs, and goes on acting. It will destroy germs in the presence of organic matter as long as it comes in contact with them, but in the presence of such matter it should be used more freely. It is impossible to disinfect solid fæces thoroughly by chemicals, as these substances do not sufficiently penetrate the central parts. For this reason, solid fæces should be broken up by some mechanical means before a chemical disinfectant is added. In selecting chemical disinfectants for use in *barracks*, it is always advisable to choose those repulsive in taste and smell, to avoid accidental poisoning by those who may be likely to meddle with them. Chemical disinfectants may at times be used for disinfecting clothing, bedding, etc.; but as penetration may not be complete, it is always safer to disinfect by heat, employing burning for rags, etc., and boiling, moist heat, or steam, for clothing, etc.

Standard Disinfectant Solutions used in the Army.—The following standard disinfectant solutions are used when required:

1. *Chlorinated Limewash.*

Take of—

Chlorinated Lime (B.P.)	...	2 ounces
Quicklime	... ...	½ gallon
Water to	... ...	1 ,,

Mix.

2. *Cresol Solution* (2½ per cent.).

Take of—

Saponified Cresol (Liq. Cresoli Saponatus Fortis)	... ...	1½ ounces
Water to	... ...	1 gallon

Mix.

3. *Corrosive Sublimate Solution* (0·1 per cent.).

Take of—

Corrosive Sublimate (Mercuric Chloride)	... ...	70 grains
Hydrochloric Acid	... ...	3 drachms
Water to	... ...	1 gallon

Mix.

The solution should be tinted with a sufficiency of commercial aniline blue (about 1 grain to the gallon) to make it of a distinctive colour.

4. *Formalin Solution.*

Take of—

Formalin	... ...	8 ounces
Glycerin	... ...	8 ,,
Water to	... ...	1 gallon

Mix. (The resultant mixture contains 2 per cent. of formaldehyde.)

One gallon should be used for every 400 square feet of surface to be disinfected. The temperature of the room must be raised to 70° F.

Disinfection by Heat.—The correct and at the same time the simplest method of disinfecting any form of body discharge (fæces, urine, sputum, etc.) is by heat—burning or boiling.

Dry Heat.—The heat required for disinfection by baking will be from 110° to 120° C., and this should be maintained for a considerable time (one and a half hours at least), and will prove effective, provided there is a certain amount of moisture present. If, however, the air is absolutely dry, efficient disinfection requires a temperature of 150° C., and such a heat will destroy fabrics, and things like mattresses, etc., which are very slowly penetrated, may become brittle or charred. For this reason, baking is not now generally used.

Moist Heat.—This method has many advantages over dry heat, the chief being that it does not damage ordinary fabrics, and that it is possible to sterilize at a much lower temperature and much more rapidly. Steam conveys temperature better than dry heat, and penetration occurs to a deeper extent in the case of bulky articles, such as blankets, but to be efficient the apparatus used must admit of all air being excluded. Moist heat may be used by either of the following methods :

1. *Current Steam at Ordinary Atmospheric Pressure.*—This kills all but the most resistant spore-bearing germs in bulky articles after thirty minutes' exposure. The original 'Thresh' machine is of this type, and has a drying arrangement attached.

2. *Current Steam under Pressure.*—Steam is used at a temperature of 115°-120° C., and all bacteria are killed more rapidly than with steam at a lower temperature. The new 'Thresh' machine is of this type, and also has a drying arrangement attached.

3. *Confined Steam under Pressure.**—One of the best forms of apparatus for disinfection in confined steam is that of Washington Lyons, provided it has a vacuum

* No machine really uses superheated steam. If superheated at first, it is cooled by contact with material to be disinfected, and water condenses. So long as any water remains the steam takes it up and it becomes saturated.

arrangement attached for removing the air from the disinfecting chamber.

All these machines have an oval chamber with double walls, and with a door at one or both ends. Steam is first injected into the space between the walls, and afterwards into the chamber proper in which the articles to be disinfected are loosely packed.

After steaming for twenty or thirty minutes the surplus steam is removed, either by a current of heated air (Thresh machine) or by the vacuum pump (Washington Lyons machine). The doors are then opened and the articles exposed freely to air.

Disinfection by Formalin Gas.—The value of formaldehyde as a gaseous disinfectant has been recorded by many observers. The gas may be generated in several ways, either by the use of special lamps or by chemicals. Colonel R. H. Firth, R.A.M.C.,* recommends the Trenner-Lee vaporizer as well adapted for Army needs; but 'for all-round utility, simplicity and efficiency,' he is disposed to favour the formalin-permanganate method. Colonel Firth, in commenting on this method, states: 'It requires no special apparatus, an ordinary metal pail being sufficient, while the actual reagents used are readily available. It has been much used in the Aldershot command. In camp, or where formalin is unattainable, improvised solutions of formaldehyde can be prepared from the paraform tablets. Whatever solution is used, the amounts laid down for efficiency in buildings must be trebled for camp work, the tent in all cases being saturated with water.'

The Formalin-Permanganate Method.†—This consists

* *Vide* 'Disinfection by Formaldehyde,' by Colonel R. H. Firth (*Journal of the Royal Army Medical Corps*, vol. x., pp. 356-373).

† Suggested by Evans and Russell, 'Formaldehyde Disinfection,' Thirteenth Annual Report, 1904, State Board of Health of Maine, U.S.A.

in pouring formalin quickly over fine crystals of potassium permanganate contained in a pail or other metallic vessel. Vigorous chemical action quickly follows, the liquid boiling and a large quantity of steam being given off. There is ample time for the operator to withdraw from the room. For a space of 2,000 cubic feet 10 ounces of permanganate of potash and 1 pint of formalin are required. The permanganate should be put in the pail first, and the formalin poured on to the crystals. Before disinfection all cracks and holes should be pasted up with gas-tight paper, and room temperature must be over 60° F., preferably at 70° F., and with a percentage moisture of 70. The room should be kept closed for six hours afterwards. For rapid disinfection, clothing, etc., may be treated by this method by utilizing a large box or hanging wardrobe, with a tight-fitting lid, and with all cracks and apertures pasted over with gas-proof paper. Damp the clothing and evolve formalin gas: for every 5 cubic feet of space the use of 2 ounces of formalin with 1 ounce of permanganate is sufficient, or, if paraform tablets are used, twenty of these dissolved in boiling water may be poured on 4 ounces of the permanganate. The box is then kept closed from three to four hours.

Fumigation.—When fumigation is to be undertaken, the following method may be pursued :

Sulphur dioxide in cylinders will be employed at home stations. One of the 20-ounce cylinders may be used for each 1,000 cubic feet of space.

The room to be disinfected should be sealed up in the usual manner, only the doorway being left open by which the operator is to make his exit, that doorway being left ready for immediate sealing up.

The cylinder of the compressed gas must be taken in the left hand, pointing away from the operator, who, cutting off the soft lead vent pipe by one stroke of a strong knife, must at once place the cylinder in a wash-basin, with the outlet inclined downwards, so that the liquid may flow out readily. The liquid gas will evaporate in about a quarter of an hour. The operator should at once escape from the room, and seal up the doorway or other aperture of exit.

At the end of three hours, the room should be re-opened, and the sulphurous gas allowed to escape.

At stations abroad to which sulphur dioxide in cylinders is not supplied sulphur fumigation will be carried out by burning sulphur, thoroughly moistened with methylated spirit, in earthenware or other vessels placed on bricks standing in water. For every 1,000 cubic feet of air space 3 pounds of sulphur will be used, all apertures in the room being closed, as noted above.

It cannot be too strongly insisted on that the efficacy of any method of room disinfection depends entirely on the intelligence with which it is carried out. All such processes will, therefore, be gone through under the personal supervision of the medical officer in charge of the unit concerned, unless, in the opinion of the principal medical officer, the presence of the specialist sanitary officer is necessary.

Fumigation is not to be considered as a substitute for disinfection, and its use will be generally restricted to the destruction of live vermin in clothing.

All processes of disinfection by fumigation will be carried out under the orders of a medical officer, and, if possible, by subordinates attached to a hospital; an experienced N.C.O. will always attend, who will be held responsible for any damage that may be incurred by preventable causes.

All materials for processes of fumigation or disinfection, including quicklime, will be obtained on indent from the officer in charge of barracks.

If any expense in cleaning quarters or rooms prior to re-occupation is incurred, it will be provided for by the officer in charge of barracks.

Room Disinfection.—When it is considered necessary to disinfect a barrack or other quarter (see p. 300), one of the two following methods of disinfection will be utilized—viz.:

1. Fumigation by a sulphur dioxide.
2. Spraying with formalin solution.

In selecting which of these methods is to be used, it will be necessary for the principal or other medical officer directing the disinfection to bear in mind that the use of sulphur dioxide demands a high degree of relative humidity (about 70 per cent.); and that if formalin spray is used, the process should be carried out in the most complete manner, inch by inch, over the entire surfaces it is intended to disinfect, in order that the operation may be efficient. It is calculated that to spray efficiently 800 square feet of wall space with a 'Mackenzie' spray not more than ten minutes are necessary.

Disinfecting of Drains, Gullies, Receptacles, etc.—Complete disinfection of drains, gullies, traps, refuse receptacles, etc., is practically impossible; the most that can be done is to deodorize them. The mere fact that gullies, drains, etc., need deodorization indicates the existence of faulty conditions. These should be looked into and corrected, and reliance placed upon free flushing with water to remove decomposing deposits rather than upon surface disinfection or deodorization by chemical reagents.

Disinfection of Ambulance Waggons.—When it is necessary to move a case of infectious disease to hospital, the medical officer in attendance will make immediate application to the officer in charge of transport for an ambulance to convey the patient, at the same time stating the nature and urgency of the case. The ambulance or other conveyance will be disinfected by spraying with formalin solution before being again used; this will be carried out by the medical authorities.

Clothing for Patients with Venereal Disease, etc.—A supply of sheets, pillow-slips, shirts, drawers, handkerchiefs, and towels, distinctively marked with the letter 'V,' will be set apart in hospitals for the use of patients suffering from venereal diseases, and a supply of bedding and clothing distinctively marked with an 'I' for the use of patients suffering from infectious diseases. When no steam disinfector is available, the articles marked 'V' will invariably be steeped in cresol solution for at least half an hour, and subsequently thoroughly rinsed in clean water before being sent to the laundry or contractor for washing. The articles marked 'I' will be dealt with as laid down for fabrics on p. 301.

Enteric Fever.—All utensils—*e.g.*, feeding cups, bedpans, urinals, etc.) intended to be used by enteric patients shall be marked 'E.' The bedpans and urinals shall invariably be disinfected by washing with cresol solution; and their contents, if so ordered by the medical officer, will be mixed with an equal quantity of cresol solution for half an hour before being thrown down the slop sink.

Tubercle.—Cases of tuberculous disease will, if possible, be treated in separate wards, and special care will be taken to prevent fouling of floors or walls with expectoration or other discharges from the patients. Cresol solution will be kept in all vessels used for receiving expectoration or other discharges, and the handkerchiefs and other soiled articles must invariably be placed in cresol solution before removal from the ward.

INVESTIGATIONS AND REPORTS ON OUTBREAKS OF INFECTIOUS DISEASE.

The following are some of the chief points which should receive consideration in investigating and reporting on outbreaks of infectious disease:*

* *Vide* 'Regulations for the Army Medical Services,' Appendix VI., p. 76.

General Considerations.—The history of the outbreak; the facts connected with its origin and spread; sequence of cases with chronological data; order in which barrack rooms, quarters, or tents became infected; spot map of infected area, showing barrack rooms, quarters, or tents in which cases occurred; the relation of each case to pre-existing cases of disease; grouping of cases; factors which cases present in common; results of investigation of the known pathways of infection for the particular disease; sanitary details; condition of barracks or camps and their surroundings; water-supply; food; latrines and urinals; drainage system; disposal of excreta and refuse; flies or other insects; animals, etc.; isolation of cases; observation of contacts; disinfection; other preventive measures.

Enteric Fever and Cholera.—General considerations in so far as they are applicable. Water; milk; other foods; dust; personal infection; segregation of cases; observation of contacts; observation of cases of diarrhœa; mild and ambulant cases; measures for early detection of disease; agglutination test in enteric cases; condition of latrines and urinals; soil pollution; precautions adopted in connection with the disposal of excreta and urine; investigation of the ordinary sources of food and drink supplies to barracks or camps; measures for the protection of water and food supplies; hawkers and their supplies; disease amongst civil population; *search for 'carrier' and 'ambulant'* cases; possibility of spread of disease from soldiers visiting native quarters, or from natives bringing disease from infected areas into barracks or camp; placing infected areas out of bounds; the removal of troops from infected locality.

Scarlet Fever and Diphtheria.—General considerations as far as applicable. Personal infection; milk; animals; segregation of cases; observation of contacts; isolation of suspicious throat cases; examination of throat swabs in suspected cases of diphtheria; antitoxin prophylaxis in connection with diphtheria; freedom from throat and nasal affection before patient is discharged; general preventive measures adopted.

Smallpox.—General considerations as far as applicable. Particulars regarding vaccination in the case of those attacked; isolation of cases; re-vaccination of contacts; disinfection; other preventive measures.

Epidemic prevalence is not likely to occur in any military community if the vaccination regulations are strictly observed. When the disease is prevalent in epidemic form in the neighbourhood of barracks, vaccination of all persons not previously vaccinated, and re-vaccination of all persons who have not been *successfully* vaccinated within the last five years, should be carried out. At such periods eruptions resembling chicken-pox demand particular attention, especially if preceded by marked febrile onset two or three days previously.

For the isolation of any case that may occur, preparations will be made on the following lines, unless other satisfactory arrangements have already been made:

1. If there is a civil isolation hospital for smallpox cases in the station or its neighbourhood, arrangements should first be made for the reception of military cases therein.

2. If the above arrangement is impossible, a tent or tents should be provided for the treatment of the case.

3. If from climatic or other causes tents cannot be used, and there is a military isolation hospital, the patients, if any, should be removed and the smallpox case treated therein.

Persons who may have been exposed to smallpox infection need not be segregated, but their clothing and persons will be disinfected, and they will be re-vaccinated. They will be seen daily by a medical officer for a period of not less than seventeen days. On transfer of a 'contact' to any other station, a notification of the facts of the case will be sent to the senior medical officer, with report of the action already taken. The period during which a 'contact' requires to be most carefully observed is after the tenth day, and transfer to another station should be held in abeyance from the tenth till the seventeenth day.

Careful disinfection of ambulance waggons will be carried out under the supervision of a medical officer whenever a smallpox case has had to be conveyed in one, and the regulations on the subject of disinfection generally will be strictly adhered to.

Should a case arise amongst the women and children at stations where no provision is made for them in civil infectious diseases hospitals, or in isolation wards on the lines indicated above, the case will be isolated in the quarter, and the quarter placed under quarantine restrictions.

No one should under any circumstances be placed in attendance on a smallpox case unless he or she has been recently successfully re-vaccinated.

Plague.—The following measures have been drawn up by the Army Medical Authorities in conjunction with the Local Government Board:

1. Under the Cholera, Yellow Fever, and Plague Order of November 9, 1896, the Port Sanitary Authorities at all ports of disembarkation are responsible for declaring a vessel infected; and medical officers in charge of troops on board, as well as the disembarking medical officer, will give the Port Sanitary Authority's medical officer or other officials every assistance to enable them to carry out their duties under that order.

2. When a ship is declared infected, the medical officer of the Port Sanitary Authority classifies the persons on board as follows:

(*a*) Cases of plague.

(*b*) Suspected cases of plague.

(*c*) Contacts—*i.e.*, persons who are considered to have been directly exposed to infection from (*a*) or (*b*).

(*d*) All others on board.

3. Persons classified under (*a*) and (*b*) will be isolated in the Port Sanitary Authority's isolation hospital, or other place appointed by the Port Sanitary Authority; and, in the event of any such persons being under military control, the disembarking medical officer will notify, for transmission to the War Office, the names, etc., of any officers, N.C.O.'s, or men, or members of their families, so isolated; the diseases for which they were invalided, if they happen to be invalids from abroad; and eventually the date of discharge from the isolation hospital. He will arrange for this information being given to him by the Port Sanitary Authority.

4. Persons classified as 'contacts' will be isolated for a period of ten days. In the event of a large number being declared contacts a special contact camp for the troops on board may have to be formed, under arrangements which will be made by the General Officer Commanding; but if only a few individuals require isolation, steps should be taken to have this effected, if possible, by the Port Sanitary Authority in connection with their isolation hospital.

Invalids from abroad, if so isolated as contacts, must be shown on the Weekly Return of Invalids, as required by the regulations for the Army Medical Service, until they are discharged on furlough or sick furlough.

5. In the event of a case of plague subsequently occurring amongst contacts, the patient will be either removed to the Port Sanitary Authority's hospital, or treated in a portion of the contact camp set apart for isolation and treatment of cases of plague, under instructions issued to General Officers Commanding. But if isolation can be more readily effected in the isolation wards of any civil or military hospital in the neighbourhood, steps will be taken accordingly.

6. Persons classified under (*d*) will proceed to their destinations, but the disembarking staff officer will im-

mediately send information to the effect that they have disembarked from a plague-infected vessel, as follows:

(i.) In the case of invalids proceeding to hospital, to the General Officer Commanding the district and the medical officer in charge of the hospital.

(ii.) In the case of officers or men proceeding on furlough or sick furlough, to the medical officer of health of the Sanitary Authority of the district in which they intend to reside.

(iii.) In the case of officers and men proceeding to a military station, to the General Officer Commanding the district and to the officer commanding the station.

7. Medical officers concerned will keep under careful observation, with a view to the early detection of plague, all persons included under (i.) and (iii.) of the preceding paragraph for at least ten days; but should any invalid in hospital be sufficiently recovered before that period elapses to be discharged, he need not be detained in hospital, provided the notification detailed under (ii.) and (iii.) of the preceding paragraph is carried out.

8. Should any case of plague or suspected case of plague occur, either amongst persons under observation, or amongst any others in barracks or under military control, the medical officer in charge, in addition to carrying out the requirements of the regulations for Army Medical Services, will at once place himself in communication with the medical officer of health of the civil authority who has received instructions from the Local Government Board regarding the methods of collection and despatch of materials for the bacteriological confirmation of the diagnosis by the Local Government Board experts. In Scotland and Ireland steps will also be taken for verification of the diagnosis in conjunction with the Local Government Boards of those countries.

Malarial and Yellow Fevers.—General considerations as far as applicable. Investigations of the surroundings of barracks and camps; subsoil drainage; vegetation; location of collections of water likely to be breeding places for mosquitoes; prevalence of disease among civil population; conditions likely to favour spread of disease from sick to healthy; preventive measures adopted.

The spread of malarial and yellow fevers can be most effectually controlled by anti-mosquito measures, and by the protection of both sick and healthy against mosquito bites.

In order to obtain the best possible results from the destruction of mosquitoes and their larvæ, the labour must be organized, and the work must be carefully planned and systematically and persistently carried out. Attention should be paid to prevent collections of standing water in pools or ditches. Rain gutters, surface channels, and open drains should be kept clear and clean. Wells and cisterns should be kept covered, and no water should be allowed to stand about in open receptacles of any kind. Marshy ground should be drained, if possible. When pools or streams cannot be otherwise dealt with, they should be deepened at the margins, and stocked with fish or regularly treated with petroleum. Systematic search should be made for breeding places, with a view to their clearance and the destruction of larvæ.

The prophylactic issue of quinine is useful where malarial fevers are prevalent.

Protection from mosquito bites is most important in the case of both sick and healthy. Mosquito nets are the usual means employed, but in specially exposed places gauze windows and doors may be required.

In cases of yellow fever, protection of the sick from mosquitoes is imperative, and particular care in this respect is demanded in the first three days of the illness, which is the specially dangerous period. The ordinary anti-mosquito measures should be carried out at all times in yellow fever localities. In addition, when a case occurs, systematic destruction of mosquitoes in the room and in quarters in the neighbourhood of that from which the patient has been removed should be carried out. This is best done by fumigating with sulphur or pyrethrum, the stupefied insects being gathered together and burned.

CHAPTER XII

SANITARY REPORTS

The collection of sanitary intelligence—Infectious diseases—Possible camping grounds—Roads—Towns—Medical regulations concerning the compilation of special sanitary reports—Reports on camps—General considerations—Tents—Water supply—Ablution and washing—Field kitchens—Bakeries, aerated-water factories, field canteens, etc.—Latrines and urinals—Horse lines—Slaughtering places—Disposal of refuse—Evacuation of camp—Reports on buildings—General considerations—Permanent barracks, etc.—Water supply—Cookhouses—Ablution and bath rooms—Latrines—Urinals—Drainage—Stables—Sewage disposal—Refuse disposal—Hospitals—Schools—Married quarters—Reports on supplies—Rations—Milk and butter—Vegetables and fruits—Aerated water, beer, and other liquors—Canteens and regimental institutes—Reports on matters of personal hygiene—Clothing, bedding, personal cleanliness, habits, and work of the soldier—Gymnasium training.

THE collection of sanitary intelligence concerning any country or area likely to be occupied or traversed by troops will always be of considerable assistance to a commander in time of war. Even during manœuvres, before proceeding to a camp of exercise, much useful information can be collected, either by personal investigation or by correspondence with the local authorities or inhabitants of the area in which it is proposed to locate units for field training. At camps of exercise, as a general rule, the actual site of any camp, if on War Department ground, is selected and allotted some time previous to the arrival of the troops by the local military authorities, the local administrative medical officer being responsible that the camp is suitable as regards its sanitary requirements before it is taken over. Inquiry too should at all times be made by the medical officers of the force occupying the area from the local medical officer of health as to the prevalence of infectious diseases (including venereal diseases) in the villages, etc., about the camp, and of the name of the nearest hospital for infectious disease in the vicinity where arrangements can be made for treating such cases during a training. A map of the camp area should also be obtained and information collected as to its water supplies, etc.

In collecting sanitary intelligence, information should be compiled on systematic lines under the following headings :

1. **Infectious Diseases.**—Their presence or absence ; if present, their nature, severity, location, number of people affected, and probable sources of infection. Recommendations to place infected houses or villages 'out of bounds for troops' should at once be considered.

2. **Possible Camping Grounds.**—Their position, distance from some well-known town, inn, post-office, or main road, etc., should be clearly stated. The area of the proposed camp in acres, the condition of its surface, whether grass, heather, or under cultivation ; configuration of the site, whether level or gentle slope ; its aspect, whether liable to flooding ; whether sheltered by woods or exposed ; the nature of the soil and geological formation. The water supplies, their nature, whether from wells, stream, or ponds ; the possibility of pollution (each stream should be traced upwards to its source as far as possible ; if pollution exists, its exact position and nature should be noted, and the water supply reported upon accordingly) ; the probable quality and quantity of water available in

ordinary weather should be noted, and the local inhabitants questioned as to its purity and constant supply.

3. **Roads.**—The condition of their surface; the water supplies along each road; the position of the latter; the nature of the water, whether polluted or not, either at the road or above where near it.

4. **Towns.**—Number of inhabitants. The general arrangement of the town; whether sanitary; its conservancy systems; water supplies. Position of large buildings, warehouses, factories, etc., suitable for improvised barracks. Possibilities of putting up sanitary fittings and connections with assistance of local fittings. Houses suitable for billeting troops.

SPECIAL SANITARY REPORTS.

Both during peace time and during active service medical officers are called upon to render special sanitary reports, and the following paragraphs* are intended to serve as a guide in the preparation of these:

1. **Geological and Topographical Details.**—These need only be given when a locality or station is being reported on for the first time. The principal points to be noted are: Geographical formation; physical features; climatic peculiarities; diseases prevalent amongst the inhabitants, especially preventable diseases; vegetable and animal products.

2. **Sites**, whether for camps or for permanent buildings. Conformation of ground; elevation; slope; aspect; proximity to watercourses; nature of soil; natural drainage; source and character of water supply; facilities for disposal of excreta and refuse, stating method or methods recommended; prevailing winds; general sanitary condition of neighbourhood. A sketch or plan of the site should be furnished.

* *Vide* 'Regulations for the Army Medical Services,' Appendix IV., p. 71.

Reports on Camps.

General Considerations.—Area occupied; strength; health of occupants; if any undue sickness (see p. 137), state nature of inquiry and result of precautionary measures adopted; sanitary state of lines and ground surface; measures for prevention of soil pollution; state of surface drainage; collection and disposal of surface refuse (see p. 122); conservancy arrangements generally.

Tents.—Description of and numbers allotted to each tent; cleanliness of interiors; airing of tents and of the belongings of the men; length of time tents have been pitched on the site under report (see pp. 83-88).

Water Supply.—Source; quality; quantity; measures for protecting the supply; means of sterilization; plan followed for distributing safe water both in camp and to moving bodies of troops (see Chapter VI., p. 141).

Ablution and Washing.—Arrangements for personal ablution and washing of clothing; situation of washing places; disposal of waste water (see pp. 125, 134).

The Drying of Wet Clothing.—Whether tents were utilized for this purpose (see p. 127).

Field Kitchens.—Position; cleanliness of cooking places and of their neighbourhood; supervision of cooking and of the distribution of food; disposal of refuse and slop water (see p. 131).

Bakeries, Aerated-Water Factories, Field Canteens, etc.—Sanitary state of all such places and of their neighbourhood; care observed as to the employment of sanitary methods; results of examinations of supplies.

Latrines and Urinals.—Situation; description; extent and sufficiency of accommodation; sanitary state; policing; regular covering of contents; marking of sites when filled up or when camp is evacuated (see pp. 99-120).

Horse Lines.—Position; relation to ground occupied by troops; drainage; prevention of flies; surface cleanliness; care of watering places; disposal of manure, litter, etc. (see p. 134).

Slaughtering Places.—Position; general cleanliness; sanitary state of surroundings; supervision of cutting up and of the distribution of the meat; means of disposal of offal and refuse; inspection of animals.

Carcasses of Animals dying in the Camp.—How disposed of (see p. 127).

Disposal of Camp Refuse.—Incineration; refuse pits; removal to dumping ground at a distance from camp; if pits or dumping ground are means in use, relation to the inhabited areas, cooking places, and water supply should be stated; marking of refuse pits when filled up (see p. 122).

Evacuation of Camp.—Clearing up of refuse; marking the situations of latrines and refuse pits; state in which units have left the ground which has been occupied by them (see p. 136).

Reports on Buildings.

General Considerations.—Description of building; site; dryness of soil; dryness of basements; foundations; exclusion of ground air; access of air and light; materials and condition of walls; construction and soundness of roofs, floors, ceilings, windows, doors, and staircases; evidence of damp at any part; sanitary state of parade grounds, yards, or other areas; conservancy arrangements; sanitary character of the surrounding neighbourhood. A plan or photograph should, where possible, be furnished.

Permanent Barracks, Hut Barracks, Guard and Barrack Detention Rooms, Married Quarters.—Description; dimensions of rooms and how situated; accommodation; number sleeping in each room; state of cleanliness; ventilation; lighting; warming.

Water Supply.—Source of supply ; nature of supply—*e.g.*, stream, lake, well, spring, or rain water ; means of distribution ; constant or intermittent system ; sufficiency ; purity. If from a well, state depth, lining, condition as to covering, sanitary condition of surroundings. If cisterns are in use, note their position, cleanliness, and state of covering. If reporting on a new source of supply, full information should be given regarding gathering ground, intake, possible sources of pollution, means of purification proposed, and results of chemical and bacteriological examination of samples.

Cookhouses.—Situation; sanitary condition ; cleanliness of men employed as cooks ; protection of food from dust and flies; state of utensils, tables, etc.

Dining Rooms.—Cleanliness; diet boards ; varied or otherwise ; restaurant system ; accommodation.

Washhouses.—Sanitary condition of; state of floors, sinks; drying apparatus; ironing rooms, etc., usually used for refuse, such as soap wrappers, orange peel, etc.

Barbers' Shops.—Condition of razors, brushes, combs, towels ; hot water facilities, sterilizers, etc.

Officers' Messes and kitchens.

Riding Schools.—Dust, ventilation, etc.

Ablution and Bath Rooms.—Situation; sanitary condition ; state of fittings ; sufficiency of accommodation.

Latrines.—Situation ; cleanliness ; ventilation ; number of seats. Water closets—kind of apparatus ; if trough closet, how often flushed; if hand-flushed closet, whether carefully used and state of fittings ; source of water supply ; sufficiency of flush. Latrine cradles—whether special instructions as to clearing are carefully followed. Pail closets—kind of receptacle; size of receptacle ; floor level; means of access; whether dry earth is used ; how often and by whom removed ; whether the ultimate disposal of the contents is satisfactorily carried out; supply of proper latrine paper.

Urinals.—Situation; cleanliness; oil treatment; flushing of channel and drain. Night urinals—sanitary condition. Urine tubs—state of urine-tub stands and their neighbourhood.

Drainage.—Roof gutters—condition. Rain pipes—condition; disconnection; destination. Waste pipes from sinks, lavatories and bathhouses; efficiency of traps; disconnection. Gullies—situation; sanitary condition; efficiency of traps. Soil pipes—construction; dimensions; position; ventilation; condition of w.c. traps. Drains—course; construction; dimensions; gradients; ventilation; position of inspection chambers; flushing; cleanliness; soundness as shown by water test, by smoke test, or by chemical tests.

Stables.—Position; construction; ventilation; drainage; disposal of collections of used litter and manure.

Sewage Disposal.—System in use; description of installation; management and efficiency; character of effluent; analysis of effluent; position of sewage works, farms, etc.

Refuse Disposal.—Means of storage of barrack and cookhouse refuse; position of ashbins; mode and frequency of removal of collections of refuse; position of incinerators, if any.

Hospitals.—Situation; description of building; dimensions of wards; floor and cubic space per bed; floors, polished or otherwise; window area; ventilation; lighting; warming; position of annexes, and details as to their construction and fitments. Arrangements for washing and disinfecting hospital bedding and clothing. Condition of stores, linen, clothing; how kept. Sanitary state of special buildings, such as mortuary, pathological laboratory, site, etc., of infectious diseases (isolation) hospital.

Schools.—Description of building; dimensions; cubic and floor space; ventilation; lighting; warming; desks and seats; sufficiency and kind of latrine and urinal accommodation; state of playground; sanitary condition of school surroundings.

Married Quarters.—Amount and sufficiency of accommodation for married soldiers; description of buildings; their situation and aspect; sanitary fitments provided and their condition; state of cleanliness of quarters and their surroundings; state of ashbins; state of laundry and w.c.'s (also position of w.c.'s).

Reports on Supplies.

Rations.—Nature and composition; whether sufficient and whether sufficiently varied; how often inspected and by whom; quality of meat; quality of bread or of biscuit; state of bread and meat stores; inspection of bakeries and slaughter houses. Health of employees engaged.

Milk and Butter.—Source of supply; qualitative examination; sanitary condition of dairies or farms; inspection of employees, milk utensils, milk carts, animals, etc.

Vegetables and Fruits.—What kinds are obtainable; average daily amount used; quality. If preserved vegetables are used, quality and quantities should be stated.

Aerated Waters.—Source of supply; supervision of manufacture; quality of water used; means of purification; method followed in bottle-cleaning; cleanliness of employees; sanitary state of factory; health of employees engaged.

Beer and Other Liquors.—Their quality.

Canteen and Regimental Institutes.—Quality of provisions and of food sold in them; size and sanitary condition of rooms and the state of ventilation. Health of employees engaged.

Reports on Matters of Personal Hygiene.

Clothing.—Whether sufficient and adapted for the climate; washing arrangements.

Bedding.—Description ; sufficiency ; state of cleanliness ; how often changed ; how stored and aired.

Personal Cleanliness.—Attention paid to matters of personal hygiene ; use of baths ; bathing parades ; care of feet, especially regular cleansing and attention to corns and toe-nails ; the work carried out by the regimental chiropodist ; good socks and properly fitting boots ; care of the teeth and regular use of toothbrush. Cleanliness of school-children ; their general health.

Habits.—Means available for outdoor and indoor recreation ; the amount of intemperance and of disease directly or indirectly traceable to it.

Work of the Soldier.—Nature and amount of duty or labour performed by the troops ; influence on health ; drills, how often and at what hours ; length of marches and at what hours ; proportion of nights in bed to those on duty ; whether special attention is given to graduation of work in the case of recruits who show signs of overstrain.

Gymnasium Training.—Description of gymnasium ; cubic space ; ventilation ; regular medical inspection of classes ; observation of the effects of the exercises on the breathing, heart, and pulse, especially in recruits. In cases in which overstrain is observed, state in each instance the modification of training recommended and the result of such recommendation.

APPENDIX

QUESTIONS ON SANITATION, ETC., SET AT EXAMINATIONS FOR PROMOTION

All Lieutenants (except Royal Army Medical Corps and Army Veterinary Corps) for Promotion to the Rank of Captain.

1. GIVE some rules to avoid foot soreness.

2. How would you get rid of vermin in clothing?

3. What are the chief agents in ventilating barrack rooms?

4. What cubic space is allowed to soldiers in India and at home?

5. Give a test of the efficiency of ventilation.

6. Give some rules with reference to the care of bedding?

7. What are the sanitary advantages of the tooth-brush?

8. Give some general rules for marches.

9. What are the commonest causes for men falling out?

10. What would you consider a good site for a camp?

11. Write a note on tents.

12. How would you examine tinned foods?

13. Give your views on the use of alcohol by soldiers.

14. Give your views on cigarette smoking.

15. What methods are available for purifying water?

16. Give some account of the new service water cart.

17. What chemicals are used for purifying water?

18. Write a note on the use of wool as clothing.

19. What are the relations between boots and military efficiency?

20. What is scurvy? Give some account of its military importance. How may it be avoided?

21. Draw a rough plan of a camp, showing proper sites for kitchens, latrines, urinals, and ablution places.

22. Draw up some rules for camp conservancy.

23. Name the field units of the R.A.M.C. which will be mobilized for duty at the base and lines of communication; give their composition and duties.

24. Why are horse lines a special source of danger in standing camps?

25. How would you ensure excreta being covered with earth? Why is this procedure necessary?

Lieutenants R.A.M.C. and I.M.S. on Completion of their Course on Probation at the Royal Army Medical Corps College, London.

1. What do we mean by the 'purification of water,' and how is this carried out on (*a*) a large scale, and (*b*) a small scale? What are the chief difficulties in, and objections to, the use of chemicals for purification?

2. Describe briefly the system of drainage, as far as the sewer, of a small house having two water-closets, one above the other. What is a manhole? how many varieties are there? and where are they situated?

3. What is a food? State briefly the part played by proteids, fats, and carbohydrates in a diet, and the average qualities (roughly) of each present in a normal diet. What do you understand by 'nitrogenous equilibrium,' and how is it related to the amount of proteid present in a diet?

4. What is the chief primary effect of marching on the constitution? Is this effect in its essence injurious? or, if not, can it become so? In the latter case, how would you suggest that it should be met?

5. Describe shortly the steps you would take to determine the fitness or otherwise of a water supply. Discuss the relative value of the methods employed and their relation to one another.

Captains R.A.M.C. (Special Subject) for Promotion to the Rank of Major.

1. Describe the various methods of water filtration on a large scale, and discuss generally the efficacy and relative advantages of these methods and of other methods of filtration of water on a large scale.

2. Discuss the various methods in use for the purification of water in the field, stating the difficulties and advantages in each case. What method would you recommend to be adopted in the case of—

(*a*) A division of infantry on service on the line of march?

(*b*) A fortified post on the lines of communication?

(*c*) A signalling party of infantry detached from the main body at some distance for seventy-two hours?

(*d*) A patrol of cavalry on a long-distance reconnaissance?

3. What is meant by natural ventilation? Discuss fully the forces which produce it. What are the ordinary forms of inlet and outlet, and what criticisms would you raise with reference to them? In the case of a large living room, what form of aperture would you rely on?

4. You are in charge of a station, and two cases of cholera are reported from a unit in the garrison in the course of the afternoon of June 15. What recommendations would you make that evening for preventing the spread of the disease? By 10 a.m. on the 16th four more cases are admitted from the same unit. What further recommendations would you make, there being no cases in any other unit?

5. As sanitary officer you are asked to confirm the

diagnosis in the above instances. Describe in detail the procedure you would adopt and that required by any further investigations you may think necessary to ascertain the cause of the outbreak.

Lieutenants R.A.M.C. and I.M.S. on Completion of their Course on Probation at the Royal Army Medical Corps College, London.

1. What is the primary source of all water? What are the chief impurities that water takes up between its original source and the point at which it is collected by man for use? Discuss the significance of each in respect of its power of producing disease.

2. What do you understand by the word 'trap' as applied in sanitary engineering? How would you distinguish between a good and a bad trap? Describe a few of each kind.

3. What is the object of disinfection? Supposing a case of scarlet fever to have occurred in a barrack room, what process of disinfection would you adopt as regards the man's belongings and surroundings? How would you vary the procedure in the case of a married quarter?

4. Define ventilation. How is this effected in an ordinary room? What relation does the cubic space allowed per head bear to the amount of fresh air needed by each man in a room?

5. To what is the discomfort in a badly ventilated room due? Describe in detail how you would proceed to estimate the impurities in such a room, and how you would express your results.

Majors R.A.M.C. for Promotion to the Rank of Lieutenant-Colonel.

1. The following is the present scale of rations for field service:

$1\frac{1}{4}$ pounds of fresh beef, or 1 pound of preserved meat, or 1 pound of salt meat.

$1\frac{1}{4}$ pounds of bread, or 1 pound of biscuit, or 1 pound of flour.

$\frac{1}{2}$ ounce of tea.

$\frac{1}{4}$ pound of jam.

2 ounces of sugar.

$\frac{1}{2}$ ounce of salt.

$\frac{1}{36}$ ounce of pepper.

$\frac{1}{2}$ pound of fresh vegetables, or 4 ounces of dried vegetables, or 4 ounces of preserved fruit.

$\frac{1}{2}$ ounce of lime-juice, with $\frac{1}{4}$ ounce of sugar, on day when fresh vegetables are not issued.

$2\frac{1}{2}$ ounces of rum.*

Tobacco, not exceeding 2 ounces per week, for those who smoke.

Give your opinions, with reasons for the same, on the following points :

(*a*) As to the general sufficiency of the above ration. If you consider it sufficient, justify your opinion by practical experience, if possible, and also on theoretical grounds. If you consider it insufficient, to what height would you raise the caloric value? And state generally which of the alimentary principles you would rely on for the purpose of obtaining this increase, and what articles of diet you would employ.

(*b*) Apart from the question of sufficiency, do you consider the ration a suitable one as regards the various articles composing it? If so, give your reasons ; if not, state what variations you would propose in view of a campaign in a European country where supplies of all kinds are available. (30 marks.)

* At the discretion of the General Officer Commanding, on the recommendation of the medical officer.

The above scale is intended merely as a guide ; a special scale, dependent on the climate and circumstances of the expedition, will be fixed by the General Officer Commanding. The total energy value of the ration may be taken at 3,700 calories.

2. Do you recognize any difference between the two injuries known respectively as 'heatstroke' and 'sunstroke'? If so, what? Explain fully your views as regards the causation and prevention (not treatment) of these injuries, referring especially to clothing, equipment, food, and drink, in this connection. (20 marks.)

3. General Stonewall Jackson used to make his men lie down at halts, saying, 'A man rests all over when he lies down.' Do you agree with the above maxim or not? In practice what difficulties do you see in carrying it out? (20 marks.)

4. Give a review of the latest work in connection with the causation and prevention of yellow fever. (20 marks.)

5. You are Senior Medical Officer of a force of 1,500 men about to take a march across an almost waterless stretch of country. The water supply is from wells or ponds at considerable distances from each other, the position of which dictates the length of the various marches and the situation of the camps. There are in all five such groups of wells between the starting point and the destination of the force, at both of which the water supply is plentiful. The point of destination is strongly held by our troops. The length of the various marches and the water supply available at the end of each are given below:

First march, ten miles. Ruined temple eighth mile. First camp. Supply liable to pollution; about 2,000 gallons available.

Second march, twelve miles. Scattered ruins. Second camp. Supply liable to pollution; about 2,000 gallons available.

Third march, eighteen miles. Extensive ruins eleventh mile. Third camp. Supply bad and scanty; only 800 gallons available.

Fourth march, eight miles. Scattered ruins. Fourth camp. Supply good and plentiful; about 10,000 gallons available.

Fifth march, twelve miles. Scattered ruins. Fifth camp. Supply liable to pollution ; about 2,000 gallons available.

Sixth march, twenty-two miles. Ruins of city sixteenth mile.

The amounts of water stated above are those available for drinking water. Transport animals need not be considered.

Carriage can be provided for 250 gallons of water in addition to the amount carried in the water bottles—viz., 2 pints per man.

Draft a brigade order dealing fully and precisely with all details of regulation of water supply. (20 marks.)

State, in addition, but not necessarily in the form of an order, what arrangements of a special nature you would suggest with regard to the water supply at the third camp, and on the fourth and sixth marches.

At what hours should the troops march, and what halts would you suggest? The mean shade temperature at the hottest time of the day is 90° F., with a mean humidity equivalent to 60 per cent. of saturation, and the sun rises at 5 a.m. and sets at 7 p.m. approximately. (10 marks.)

(Total for Question 5, 30 marks.)

Captains R.A.M.C. for Promotion to the Rank of Major.

1. What are your views as to the consumption of beer or spirits by soldiers? Discuss the subject in its relation to service conditions, giving any actual facts bearing on the question with which you may be acquainted.

2. Describe as fully as you can the parts that go to make up a disconnecting manhole (D.M.H.). State their uses, and mention the particular points in a manhole to which you would direct your attention in making a sanitary inspection of barracks.

3. You are in medical charge of a body of troops on the march in a country with which you are unfamiliar. In the absence of means for chemical or bacteriological examination, how would you judge of the fitness for drinking of water from (*a*) a stream, (*b*) a well, (*c*) a spring?

4. Draw up a concise and clearly-worded memorandum of instructions for the troops in regard to *personal* measures of prevention against cholera, an outbreak of which is presumed to be threatening.

5. Discuss the significance of *Bacillus coli* of Escherlich in water. Why is this organism taken as an indicator of excretal pollution, and how would you proceed to demonstrate its presence?

Captains R.A.M.C. for Promotion to the Rank of Major.

1. State your opinion on the following points: (*a*) The disposal of the solid matters in a sewage; (*b*) the relative efficacy of streaming filters and contact beds.

2. What is your opinion as to the necessity for fumigation of a room after the occurrence of a case of infectious disease? What are the physical conditions necessary for the efficient action of formic aldehyde vapour and of sulphurous acid? Enumerate briefly the various methods for the evolution of formic aldehyde vapour, and state which you prefer, and why.

3. What is your opinion on the question of the proper amount of proteid to be allowed in the diet of a sedentary man? Sketch out a diet, furnishing roughly 3,000 calories, for a man, giving not only the approximate principles, but the actual articles of food. If it were necessary to raise this diet to one giving 4,000 calories, how would you suggest that this should be done?

4. What is the essential difference between a 'dry' and a 'wet' system of excreta removal? Under what conditions is the former the only method practicable, and what

are, briefly, the points essential to its proper working in a tropical or a subtropical military station?

5. An epidemic of enteric fever has broken out in the command of which you are Sanitary Officer, and the incidence of the disease seems to point to a certain man as a 'carrier.' Describe in detail the laboratory procedure you would adopt to clear up this point.

Captains R.A.M.C. for Promotion to the Rank of Major.

1. Human respiration affects the chemical composition and physical properties of the air in the room. What are the most important changes produced, and what is their relative importance considered as causes of ill-health? What are the results of (*a*) chronic poisoning and (*b*) acute poisoning from bad air? How is the respiratory impurity of the air in a room estimated?

2. What is the ultimate aim of all modern methods of sewage disposal? State what you know of the various steps in the biological treatment of sewage.

3. What do you mean by the purification of water? how is this effected on a large scale?

4. As Sanitary Officer you are called on to deal with a severe epidemic of enteric fever on a foreign station. What steps would you take to ascertain the cause, and, pending its actual discovery, what action would you take to control the epidemic?

5. In continuation of the above question, describe the laboratory procedure you would adopt to isolate *Bacillus typhosus* in suspicious cases of the disease?

Majors R.A.M.C. for Promotion to the Rank of Lieutenant-Colonel.

1. You are detailed as Principal Medical Officer of a small force proceeding on an expedition to a tropical country of an extremely malarial character. State in

detail what recommendations you would make on the following points :

(*a*) Selection of officers and men, with respect to previous service, age, etc.

(*b*) Proportional strength of Europeans and natives composing force, both combatant and non-combatant. (The military resistance anticipated is trivial.)

(*c*) Prophylactic measures directed against malarial fevers at the base.

(*d*) The same at posts on the lines of communication.

(*e*) The same with troops on the march. (35 marks.)

2. State what you know as to the cause, means of spread, and geographical distribution of kala-azar. (20 marks.)

3. The following paragraph occurs in the Regulations of the German Army on the management of marches :

'The greatest enemy of infantry on the march is heat, and special measures should be taken to protect the men against this, which is one of the most important causes of depletion of the ranks. The best means at our disposal is careful regulation of drinking. Mounted officers or bicycle orderlies should be sent on ahead of a column to warn the inhabitants of villages to turn out and have water ready on both sides of the road for the troops. If possible, a halt of short duration may be made for this purpose ; otherwise, if time presses, the men must snatch a drink as they pass, and, if possible, fill their water-bottles.'

In connection with the same subject, the following paragraph occurs in the Standing Orders of the Light Division, dated 1809 to 1811 :

'*Section II., Article IV.*, 3.—The officers must be particularly attentive to prevent the men from going out of the ranks for water ; when this is required, the battalion or brigade must be halted.'

Comment on the above extracts, and discuss fully the question of water supply to infantry on the march (with reference to quantity only) in the light of recent experimental work on the subject, stating clearly the position you yourself adopt. (30 marks.)

4. The following figures give the average weight of the infantry equipment of our own and some foreign armies :

British	54 pounds.
French	59 "
United States of America ...	59 "
German	59 "
Austrian	63 "
Russian	59 "
Danish	66 "

Discuss the above in view of the maximum weight which in your opinion should be placed on the average infantry soldier called upon to undergo the ordinary exertions of campaigning, and also the smallest amount of equipment, exclusive of arms and ammunition, that a man should take on his person, having in view the exposure incident to a campaign in an English summer. Illustrate, if possible, from your own experience of the Service. (15 marks.)

Lieutenants R.A.M.C. and I.M.S. on Completion of their Course on Probation at the Royal Army Medical Corps College, London.

1. What is the primary effect of marching on the constitution? To what extent is this physiological and beneficial, and under what circumstances can it become pathological? What resources are there at the disposal of the Commanding Officer for preventing and obviating this latter effect?

2. Define a 'food.' Discuss in detail the metabolism of protein in the body. What do you understand by the expression 'protein-saving power,' and what substances possess this power?

3. In what manner does the micro-organism of enteric fever (*a*) leave the body of the infected man, and (*b*) enter

the body of the healthy man? State clearly what men you include under the term 'infected,' and which of these do you consider the most dangerous?

4. How would you set about tracing the drainage system of a barracks apart from the use of plans? Enumerate and describe in detail the various appliances and structures which would assist you in this.

5. A soldier has been admitted to hospital from a certain camp suffering from a disease similar to cholera. The water supply of the camp is obtained from a well, and all water is supposed to be boiled. After boiling, it is distributed to the tents and stored in canvas water bottles for the sake of coolness. Detail the procedure you would adopt with reference to (*a*) the confirmation of the diagnosis, (*b*) the discovery of the source of the disease. The man has not been out of camp for some time.

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THE END

is singularly free from errors and misstatements, and the candidate who masters its very practical pages need not fear any ordinary examination in bacteriology. We know of no better aid to the study of the subject, and there are few textbooks which cover exactly the same grounds. There are none certainly which are so admirably suited to the requirements of the over-burdened examination candidate. It is a veritable *multum in parvo* and a reliable guide.'—*Medical Press.*

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'We can confidently say that the writer has ably succeeded in bringing out an edition which has given full consideration to his subject, filling a long-wanted need for students and others working for the Diploma in Public Health. It embodies notes made by the author while attending the valuable lectures of Sir William Leishman, Professor of Bacteriology at the Royal Army Corps College at Millbank, London, during the course of Captains R.A.M.C. for promotion, besides compilations by the writer while reading for his examination for the Diploma in Public Health, which he obtained with honours. The work is absolutely up to date, and forms a *résumé* of not only the microscopic aspect of the numerous diseases produced in man by pathogenic bacteria and parasites, but also gives a full account of their prophylaxis, and explains vaccine therapy and its bearing on the lines of modern treatment.'—*Indian Medical Record.*

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