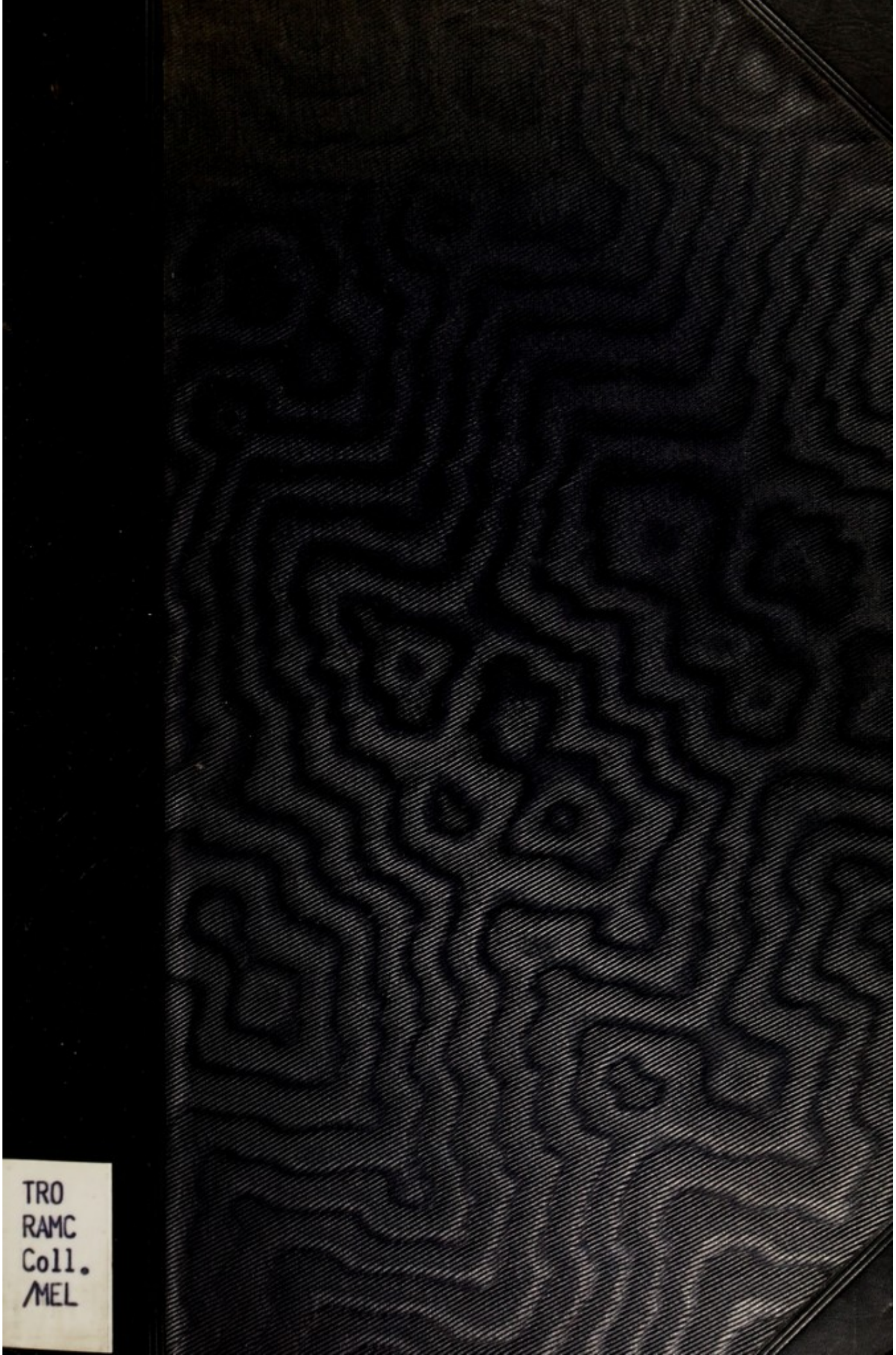
Course of lectures on army sanitation / by C.H. Melville.



The Royal Sanitary Institute.

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Course of Lectures on

ARMY SANITATION.

BY

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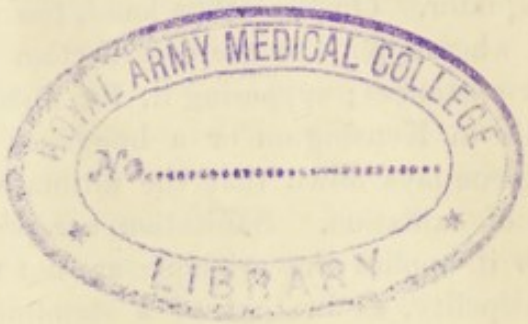
1911.

Presented by the Author.

[Excerpt from Vol. XXXII., No. 3 (1911) of the Journal of The Royal Sanitary Institute.]



Course of Lectures on Army Sanitation,

by Lieut.-Colonel C. H. Melville, M.B., C.M., D.P.H., Professor of Hygiene, Royal Army Medical College (fellow).

PREFACE.

THE series of lectures here published were delivered in October and November last at The Royal Sanitary Institute at the request of the Council, and were intended primarily for sanitary officers of the Territorial Army. A general knowledge of hygiene and sanitation was therefore taken for granted, and many points were naturally omitted which, in the case of a less instructed audience, would have demanded treatment. In publishing them, also at the request of the Council, the author desires to state that they make no claim to being a complete handbook of field sanitation; their only object is to lay down clearly the general principles of that art as they appear to him, and they naturally, therefore, sound a personal note to an extent which would be out of place in a more formal text book.

General principles of sanitation and of military sanitation in particular. Modification of methods necessitated by peculiar conditions. The part played by sanitation in strategy.

I shall begin these lectures by defining exactly the scope of my subject, which is concerned more particularly with Army Sanitation in the field.

In the first place, I propose to lecture on Sanitation, not Hygiene. The distinction may seem to be meticulous, but it is indeed a very essential one. Hygiene I take to be a pure science, whose laws, like those of all other sciences, are everywhere and immutably true. Sanitation is an art, whose practice is based on the laws of hygiene indeed, but severely

limited by the accidents of time and place, by the nature of the population concerned, and so on. A very simple instance will suffice to illustrate this: The science of ventilation is based on the physical law that hot air rises and cold air descends, and that fact is equally true at the North Pole and at the Equator. On the other hand, the rules observed by the art of ventilation, when applied to the construction of a house, vary considerably with circumstances; supposing it, for instance, to be a question of building a villa in Kensington or a bungalow in Madras. Again, the science of hygiene lays down that the ultimate disposal of excreta must be by means of oxidation. Sanitation accepts this law, but the rules through which it applies the principle are not the same in the case of a sewered municipality, as in that of a standing camp. The science of hygiene is, I may assume, familiar to you all; the rules of sanitation also familiar to each, under the precise conditions to which each man is accustomed, in his daily work. I do not, therefore, propose to lecture on that which you already know, or that with which I am absolutely unacquainted, the various sanitations, trade and otherwise, that form the work of the civilian sanitary officer. My lectures will be concerned with the sanitation with which I am most familiar, and you, I take it, least acquainted: military sanitation, and more particularly with that sanitation as we apply it in war.

In the first place, then, military sanitation is a trade sanitation, and like all other trade sanitations is conditioned largely in its practice by the age, sex, etc., of the population with which it is concerned. I shall begin by defining this population. It consists, then, of young male adults free from organic disease; specially selected, that is, as being sound in wind and limb; living under a communal system of housing and feeding, and leading ordinarily a life of moderate physical exertion; liable, however, to be exposed suddenly to conditions of extreme exposure and exertion, both mental and physical, which we sum up under the words field service. In the case of the Regular Army this population is also liable to exposure to climatic conditions to which its component individuals are previously unaccustomed. In the case of the Territorial Army, it is necessary to add that the exposure incidental to, and inseparable from, field service fall on the soldier at a time when he is suddenly called on to change all his general surroundings, to pass in some senses, as I shall point out, from the sanitary status of the civilized man to that of the savage, and more important still almost, to pass as suddenly from the individual life of the civilian to the corporate life of the soldier. The first of these two changes affects indeed, though to a much less extent, the Regular, the latter applies only to the Territorial Army.

The fact that the population consists of young male adults, free from organic disease, limits very severely the number of diseases one has to be

prepared for, whilst at the same time one class of disease to which such a population is peculiarly exposed, the venereal diseases, are by national practice excluded from the purview of the sanitarian. In any case, these diseases are rarer in a mobilised army than in one on a peace footing.

The next important point to note is that the diseases with which military sanitation has to deal are those only which are due to causes operating on the body from without. This is true to a greater or less extent of all sanitation, but peculiarly true as regards military sanitation, since here we start with a population certified at the outset as being free from all organic, that is, internal disease. But if there is no internal disease, then obviously all disease must come from without, be due, that is, to the interaction of the surroundings of the individual or population, on the individual or corporate economy. The definition of sanitation then as the art whereby man adapts himself to his surroundings is more true in the case of the army than of any other trade.

Now we may divide all such external causes of disease into two general classes, first, those which, whilst originating outside a man's body, always remain outside, and second, those which originating outside that body are nevertheless capable of entering into that body; and which, moreover (and this is the important point) unless they do so enter in can produce no disease in the body. The former class consists of the conditions under which a man lives and works, his food, his clothing, his housing, the exertions entailed by his trade and so on, the latter class briefly of disease germs. Now, speaking merely from the point of view of the military sanitarian, we may say that disease can not be produced by any one of these causes, nor by any number of them as long as they all belong to the same class. A soldier may be hungry, ill-clad, overworked, but unless he ingests certain specific disease germs he will not on those accounts, merely, develop enteric fever or cholera. In the same way it is not necessary for a man merely to ingest a specific germ to contract the disease peculiar to that germ, he must at the same time have his resisting power to that germ lowered in some way before it can, so to speak, take root. Of course I am speaking on broad lines only. In individual cases a man may have a naturally low power of resistance to enteric fever or cholera and succumb to a comparatively weak attack, but speaking of the mass of men the statement may be taken as true. It is only necessary to point to the fact that even in the severest epidemics the majority of people exposed to infection escape disease.

Tuberculosis gives us another illustration. It is well known that the great majority of people of mature age who die from other causes, if their bodies be examined post mortem, show signs of having at some time or another been attacked by the tubercle bacillus, which has

actually managed to make a lodgment in the tissues, but has been overcome by the natural resisting powers of the body. Accepting the above statement that no one class of cause can by itself produce disease, it is obvious that our plan of defence must be so drawn as to repel attack in two directions. We must strive so to maintain the resisting powers of the individual that he shall be able to overcome the attack of the organism if that make a lodgment, and we must also at the same time attack the latter and destroy it, or at least prevent its entry into the body. Now I want to insist that, dealing with military sanitation, the former method of defence is far more important than the latter. In the first place we start fair: our population is a selected population. In the second it is, if not impossible, at least enormously difficult under the conditions of life in camp, to prevent occasional infection of the individual by the germs of the diseases which chiefly affect the soldier in the field. What these are I shall come to later. We can minimize the strength of the attack, and we can diminish its frequency, but it would be utopian to suppose that we can ever absolutely prevent it. To use a military metaphor occasionally our first line of defence will be pierced, and we must rely for victory on the strength of our reserve. I will begin, therefore, by considering the causes which chiefly lower the soldier's resisting power, and how these may be obviated, which I shall call the preservation of health, and later go on to consider the actual prevention of disease, that is the attack on the actual disease germs, the ultimate exciting causes of disease. For this purpose my next lecture will deal with the important subject of marching, and all that word entails, since here we shall find the causes which more than any others lower the soldier's resisting power. My later lectures will be directed to a study of water supply, and removal and disposal of excreta, dealing that is with the channels by which disease germs pass from the body of the infected to that of the healthy man, under those conditions of life which we term field service.

But before entering into these matters it is necessary that I should devote a short time to a consideration of the position of military sanitation in the great system of strategy. Sanitation, especially military sanitation, is an adaptation of man to his surroundings, and sanitation must obviously therefore begin by adapting itself to the surroundings in which it has to work, by accommodating its activity to the working of the other arts which all go together to form the great art of war. I speak here only of war, since the Territorial Army does not exist as an organic whole except in time of war. Now in ordinary life, and indeed in the life of the army during peace, sanitation is an end in itself. Its great object is to keep the community healthy, and this is recognised to a great extent in the fact that offences against sanitary law are punished as what is termed nuisances, things harmful or

annoying to the community. In the army, for instance, in peace time the soldier is learning his work, and for this purpose he must be kept healthy, and everything, even his work, gives way to the recommendation of the medical officer. In war time all is changed, and for this reason: The soldier is no longer learning his work, he is practising it, and that work is of such enormous, such paramount importance to the State, that no consideration of the health, or even of the life, of the individual must be allowed to conflict with the achievement of that work, the defeat of the country's enemies. The object of the military sanitary officer in time of peace, like that of all health officers, is the maintenance of the health of the population committed to his charge. The object of the military sanitary officer in war, as of every other man in the army in war, from the Commander-in-Chief to the last-joined recruit, is the defeat of the enemy. The enemy must be defeated be the army healthy or not. It is our duty, and our honour, to keep the army healthy, as long and as far as the exigencies of the service admit, but we must always recognise the object for which we keep it healthy.

Success in war has to be purchased by loss of life; in the well known phrase of Napoleon, "One cannot make omelets without breaking eggs." That necessary loss of life may be due to the bullets of the enemy, or to exhaustion and disease, that is for the commander to decide. On one very well known occasion in 17.0 the great Duke of Marlborough, by a forced march during which men fell down dead from sheer exhaustion, managed to pierce a series of lines which his opponent, Marshal Villars, had boasted would prove his "*ne plus ultra.*" His losses on the actual march were considerable, and no doubt many a man died afterwards from the fact that his exhausted body could no longer resist the attacks of dysentery or ague. He chose to buy his victory in that manner, and it was undoubtedly cheaper bought so, than by the losses inevitable in a formal assault. Again, of the great "Stonewall" Jackson, Colonel Henderson says: "His victories were won rather by sweat than by blood. Solicitous as he was of the comfort of his men he had no hesitation, when his opportunity was ripe, of taxing their powers of endurance to the uttermost. But the marches which strewed the wayside with the footsore and the weaklings won his battles. The enemy, surprised and outnumbered, was practically beaten before a shot was fired, and success was attained at a trifling cost." Jackson himself said, "I had rather lose one man in marching than five in fighting," which seems to point to the relative price he considered he would have to pay under the two methods of purchase. I have referred to these great leaders because they were both of them particularly distinguished for their care for their men. Of Marlborough it is related that on one occasion he allowed a footsore soldier to ride in his carriage; and of Stonewall Jackson that on the march to Bull Run he himself stood

sentry over his exhausted troops sooner than that they should be disturbed. Neither of these two great men then wantonly trifled with the lives or health of their men; they knew the price that had to be paid for victory, and they paid in the way which cost their nations least. Now it may seem as if this saying minimised the work and importance of the sanitary officer, since it implies that at certain junctures all his aims and wishes must be disregarded. On the contrary, it exalts his work and importance. The better the health of the men, the freer the army is from disease, then the less the cost of any such victories as I have just been referring to will be. If I may say so, our duty is not to object to the expenditure, but to see that the currency is not depreciated.

I will go even further. It is in reality a mere commonplace to say that without sanitation and its effects, increased efficiency and health, there can be no successful war, in the long run, in fact, there can be no war. History abounds with examples in which campaigns have been utterly wrecked by disease; but even far short of such catastrophes, there are thousands of cases, where, though victory has been eventually attained, it has been purchased at a price in human life and suffering far higher than need have been paid, or it has been delayed far longer than necessary, simply on account of want of sanitation. It is true that many of these instances date back to a period when no scientifically-grounded system of disease prevention existed. That indeed minimizes the blame to be apportioned to the generals and cabinet ministers responsible for the conduct of those campaigns, and their medical advisers. It increases, on the other hand, a thousand-fold the responsibility of those who will arrange the campaigns of the future, should they disregard the aid which sanitation can afford, now that such a scientifically-grounded system of disease prevention does exist.

So far for the importance of the prevention of disease. The preservation of health is no less important. All the schemes of the strategist, and all the plans of the tactician, are ultimately founded on the assumption, that the flexor and extensor muscles of the legs of a certain number of infantry soldiers will contract and relax, in a normal and efficient manner, over a certain period of time. In the words of Marshal Saxe, "Victory is a question of legs." On this assumption they calculate that certain bodies of men will, at a definite time, arrive in fighting trim, and in definite strength, at a certain place. It is needless to point out that the health of the men is in reality the deciding factor in the solution of all such strategical and tactical problems. A general may take that factor for granted if he so chooses, but he is not justified in so doing unless he has done all in his power to ensure its existence. If he has not done so he may still rely on the assumption, but if the resultant calculation prove incorrect, he will only have added one more name to the long

list of those who have arrived at wrong conclusions from not making sure of their premises.

There are other considerations which limit the work of sanitation in war, as well as in peace, which must be mentioned briefly. They are pecuniary considerations, and what for lack of a better name I shall term economical considerations. Pecuniary considerations are as you all know paramount in peace. They are in fact the only considerations which impose a final limit on the activity of the health officer. In war they are less important. But what I call for want of a better word economic considerations are of great importance. These considerations may be summed up in the word practicability. They constitute the dead wall of fact that makes us realise that we live in a world where things are as they are, and not as they should be, and, more important still, speaking of active service, where all the old landmarks are lost, and things are, not merely not as they should be, which is common, but not at all what we are in the custom of expecting them to be, which is extra-ordinarily disturbing. In the regular service we get broken into this state of affairs by our experience in India and the Colonies. We learn there that what is hygienically correct, and sanitarily feasible in Middlesex, may be the former still, but by no means the latter in the Punjab, or in the Transvaal. It will be harder for you, I think, to recognise that what was feasible for the medical officer of health of the Borough of Grantchester on Monday, is no longer feasible for the sanitary officer of the territorial division in which that county lies on Thursday, merely because mobilisation occurred on Wednesday.

The ultimate responsibility for sanitation, as for all discipline, must always rest with the commander, whether we are dealing with a company of infantry or an army corps. The sanitary officer can only recommend. Except in those cases in which the commander delegates his executive sanitary powers to the sanitary officer, the latter has of himself no executive authority. It is important to remember this, and the consequences that it logically entails. One sometimes, though not so frequently as formerly, hears sanitary officers say, that since their functions are advisory and not executive, they are not concerned with the practicability of their recommendations. The contrary is in fact the case. The sanitary officer is the only man who can really judge if his recommendations are at the same time practicable and necessary, since he is the only man who can see the problem from the side of the soldier as well as from that of the hygienist. If he cannot do the former, then he may be an excellent hygienist, or a first-class medical officer of health; he is no use, and can never be of any use, as a military sanitary officer. It is therefore one of the first duties of a man who wishes to grasp the duties of a

sanitary officer in time of war, to familiarise himself, as thoroughly as may be, with what war means. This he can only do by reading about war, and more especially about personal experiences in war. The fascinating study of military memoirs is a prominent duty of all who aspire to success as military sanitarians. For remember that sanitation is the art of adapting oneself to one's surroundings. A knowledge of the surroundings is therefore just as necessary to the sanatarian as a knowledge of hygiene. You must remember, too, that the regimental officer and man with whom you will have to work already knows those surroundings well enough, and to that extent has the start of you. The sanitary officer who makes recommendations that are incompatible with those surroundings, or which are on account of them impracticable, may be forgiven once or even twice for his mistake, but a repetition of the offence will lead to his occupying that most humiliating of all positions, that of the discredited expert: a man who officially holds a position of authority, but in the estimation of his comrades is merely what the French term a useless mouth.

I shall now detail very briefly the sanitary organisation of the army as it exists in peace and in war. At the head of the organisation is the Director-General of the Army Medical Service, who is assisted by the civil and military experts on the Army Medical Advisory Board at the War Office, and is the responsible sanitary adviser to the Army Council. He exercises his authority in this direction through a special staff officer, termed a Deputy Assistant Director-General, who is in charge of a special branch of the War Office termed A.M.D. 2. Next in order come the principal medical officers of commands and the administrative medical officers of divisions, who occupy towards their respective commanders the same position that the Director-General bears to the Army Council. Each of these has a specialist sanitary officer to advise on the details of sanitation in his command or division. In each brigade the medical officer senior in rank acts as sanitary adviser to the brigadier, and in each unit, or group of units, the medical officer in charge acts as sanitary adviser to the officer commanding. The executive sanitary work of a unit is carried out by the sanitary squad of the unit, which looks after the general cleanliness of the barracks or camp. In war there is no change in the above system as regards the troops at the front, but the conditions that present themselves on the lines of communication are so different from these, that some different organisation has to be adopted.

The difference of the conditions consists in this point mainly, that at the front the different units, regiments, batteries, and so on, are in a more or less stable condition. They frequently occupy the same positions for prolonged periods, and except immediately before or immediately after a serious engagement do not as a rule move any very

long distances. From the point of view of discipline they lead a continuous and uniform existence. On the lines of communication, on the other hand, troops are continually passing through, often in comparatively small detachments. Frequently such a body consists of men from several different units, under officers who are strange to them. Again, there is a constant stream of men to the base; sick, wounded, or prisoners of war. These parties stop, as a rule, only one night at any one place, and they have not, with them, the establishment necessary for carrying out the ordinary details of sanitation, more especially as regards conservancy and water supply. Moreover, human nature being what it is, men are less likely to be careful about the cleanliness of a place in which they are merely birds of passage, and of course in the case of the sick and prisoners of war, no work of this kind can be expected of them. Obviously, therefore, if the sanitation of the different posts on the lines of communication is to be properly attended to, some definite person must be made responsible, and must be provided with the necessary establishment to enable him to meet that responsibility.

The entire administration of the lines of communication is under the Inspector-General of the Lines of Communication, who would probably have on his staff a medical director, principal medical officer, or administrative medical officer according to the extent of country involved. This officer would be responsible for the sanitation of the lines in the same way as similar officers are responsible for that of the various larger organizations at the front. Under him would be a certain number of specially appointed medical officers, each of whom would be placed in charge of a definite section of the lines of communication, termed a sanitary district. The base, the railhead, and any specially important post might form a district, and in this way there would be absolute continuity of sanitation from the front to the actual base, in the majority of cases a seaport. Each sanitary district would have allotted to it a sanitary section, consisting of one officer (captain or subaltern) and 25 non-commissioned officers and men. These would form the nucleus of a sanitary establishment, the ultimate size of which would depend very much on the extent of ground that had to be covered, and the nature and magnitude of any work that had to be undertaken. In addition at each post there would be a sanitary squad, consisting of one sergeant and six men, who would in the same way form the nucleus of the sanitary establishment of the post. The duties of a sanitary squad are laid down in Field Service Regulations, Part II., p. 96, as follows:—

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

2. One or more of the men will be specially detailed to supervise the

work of permanent fatigue parties employed for conservancy or other work in connection with sanitation.

3. To act as sanitary police. For this purpose non-commissioned officers and men of the squad are invested with the authority of military police, and wear a police badge.

4. If the 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 work of a section would be practically the same as that of a squad, and in the case of either unit would vary indefinitely with local conditions. As a rule, the work of the section or squad would be largely supervisory, the actual labour being supplied in all probability by the local civilian population.

The duties of the district sanitary officer are analogous to those of a medical officer of health. It is very important that he should keep as far as possible in close and friendly touch with the local municipal and medical authorities. The privation and distress amongst the lower classes of the civilian inhabitants, inseparable from a state of war, is very apt to lead to the outbreak of infectious disease amongst them, which must in every possible way be kept from spreading to the troops. Without the co-operation of the local authorities this must inevitably be very difficult.

The sanitary officer in charge of the base occupies an extremely responsible position, and he will in all probability need the assistance of several highly trained, and specially selected, assistant sanitary officers. He will act as port sanitary authority, and be responsible that no case of infectious disease occurring on a transport is allowed to pass into the stream of men pushing up the lines of communications. He would have, therefore, to make arrangements for the segregation of all such cases, and also of contacts, if this step seemed advisable. This would be his most important duty, and would demand the exercise of great tact and firmness to avoid friction. At the base, a well equipped laboratory should be formed as one of the earliest steps taken in the organisation of the sanitary service, with a view largely to the early recognition of cases of infectious disease. In a civilised seaport there would be no difficulty in doing this, but, difficult or not, it should always be done. In addition to the organisation detailed so far, a special Committee called the Sanitary Inspection Committee, will be formed on mobilization. This will consist of two field officers, one selected from the R.E., the other from the R.A.M.C., as members, with a senior officer, belonging to some other corps as president. The duties of this Committee are laid down in Field Service Regulations, Part II., p. 97. They are, generally speaking, to co-ordinate the work of all branches of the service from the sanitary aspect, and also to assist in co-ordinating the military sanitary system with

that already existing in the country. They would initiate all large schemes of sanitation, and by frequent inspection would insure that the sanitary machine was running smoothly and efficiently. The composition of this committee is designed so that due weight shall be given to the different aspects from which all sanitary questions have to be regarded in war, the principal authority resting with the president as representing the combatant (that is, the decisive) point of view.

In the case of the Territorial Army there would be no difference from the Regular Army as regards sanitation in so far as the field force is concerned. Divisional sanitary officers, and medical officers in charge of regiments and other units, would perform their various duties precisely as they do in the case of regular troops. Duties analagous to those of the district sanitary officers on the lines of communication would, probably, to a certain extent, be carried out by sanitary officers on the *à la suite* list. These officers would be peculiarly fitted for these duties, being invariably public health officers, and therefore thoroughly acquainted with local conditions. They would probably find little difficulty in organizing units corresponding to the sanitary sections and squads from local sanitary subordinate officials, inspectors of nuisances, etc. Of course, where sanitary companies are in existence, these bodies would take on the duties in question. This short sketch of the sanitary organisation for war gives the general idea of the lines on which that organisation is formed. I need hardly say that though it is possible to lay down a scheme of organization in advance, it is impossible to say what work exactly that organization will have to undertake, since no one knows in advance what even a few minutes may bring forth in war. And this must be more than ever true in the case of a war following invasion of this country, where we have no precedents and no recent history to guide us. A good, well arranged, organized body of men will soon shake down under any circumstances, and meet all emergencies with probably fair success. No amount of skill on the part of individuals will be of any value without that organization.

The sanitation of the march. Physiological aspect of marching. Regulation of temperature, manner in which this may be impeded, or facilitated. Halts. Accoutrements. Forced marching. Supply of water on the march. Care of the Feet.

THE subject of my lecture is Marching. As you all know, an army in war is either at rest, that is in camp, or on the move. As a matter of fact, in all wars troops spend a far greater part of their time in the former state, performing what I have heard described by a Staff College lecturer as the important military operation of sitting still. From a sanitary point of view it is, as I shall point out to you later, an extremely important and in the past has been a very dangerous operation. To-night, however, we are concerned with the other part of life on service, that of troops on the move. Now there is one very important distinction between life in camp and life on the march, and that is that during the former the causes which lower the powers of resistance of the soldier to infectious disease are reduced to a minimum. There is no reason why, especially in a climate like ours, soldiers in camp, even in time of war, unless actually in contact with the enemy, should not be adequately fed and sheltered. From this point of view life in camp should in fact be not less favourable to health than life in barracks. The causes of sickness in camp are the result of the accumulation of waste products in the vicinity of the camp, and the consequent multiplication and intensification of the direct causes of disease. When an army is on the move, on the other hand, it avoids these last-named dangers to a great extent, but is now exposed far more to the causes which attack a man's powers of resistance, exposure, hunger, thirst, fatigue, and so on. So much is this the case, that a long march is an extremely serious matter. Colonel Henderson, in the first volume of his "Life of Stonewall Jackson," says:—"A march of 80 or 100 miles into an enemy's country sounds a simple feat, but unless every detail has been most carefully thought out, it will not improbably prove more disastrous than a lost battle. A march of two or three hundred miles is a great military operation, a march of six hundred an enterprise of which there are few examples." Now I suppose there is no man of the military age, that is between 20 and 30, who would see much to be afraid of in a seven days' walking tour covering a hundred miles, or indeed in a four weeks' tramp covering three times that distance. I myself, to speak without undue boastfulness, have achieved close on 800 miles in ten weeks, and been all the better for it, at a decidedly later age. There must be something therefore different between the civilian walking by himself and the soldier marching with an army to account for the great difference in the ease with which the one and the other respectively perform these feats. The difference lies in the fact that the latter marches as one of a

communal population, whilst the former walks as an individual. Many of the difficulties entailed by this difference are due to complications of staff work, supply, etc., which do not concern us here, but many are also the result of the effect of the communal life on the physiology of the individual, and it is this last point, the physiology of marching, that I now wish to deal with.

I need hardly impress on you the importance of the subject. The most important arm of the service is the infantry, and the most important individual the private in the ranks of that arm. Whatever skill in the use of his weapons this man may possess, at long range with his rifle or at close quarters with his bayonet, it will be of no avail unless he possess also that power of marching which alone will enable him to get to the spot where he can bring his skill at arms to bear on the persons of his country's enemies. I think you will agree, therefore, that I am justified in placing my lecture on the sanitation of the march the first in this series.

An army that can march well may be said to possess, over one that cannot, an advantage comparable to what in the days of the old naval wars was given by the weather gauge of the enemy.

What then is marching? It may be defined (from the point of view of the infantry soldier) as "Walking: carrying a certain load, disposed on the body in a certain manner, wearing certain clothes, arranged also in a certain manner, at a pace regulated not by the physical necessities of the individual but by those of the body of troops of which he forms a part." That seems rather a complex definition of a simple matter, but all the complexity, the facts that a man has to carry a load not as he would wish to but in a manner that leaves his limbs unencumbered and his hands free for fighting, that he has to walk at a certain pace so that the unit he belongs to shall arrive at its destination still a formed military body, and not a straggling mob, the fact that he has to wear a certain uniform so that he may be distinguished from the enemy, and recognised as a person entitled to bear arms, all these combine to make the difference that exists between the civilian who says, "Let us go for a walk," and the soldier who is ordered to march a definite distance, in a definite time, and for a definite purpose.

I shall now return to my definition, and discuss from a physiological point of view its different parts in order. And first with regard to walking. Walking is the result of muscular effort, that is of the contraction of certain muscles. Now when a muscle contracts three things ordinarily happen: shortening, visible movement, and the production of heat. There are cases in which a muscle may contract without any visible movement resulting, as when a man strains to lift too heavy a weight, but these are exceptional. It is important to realise that the contraction, the visible movement and the heat are all three absolutely

interdependent. You cannot have the heat without the contraction, or the contraction without the heat, or, in the case of walking at least, either of these without the visible movement. If you will allow me I will give you a precisely parallel analogy. In the case of any internal combustion engine we have an explosion in the cylinder, with the production of heat and the visible movement of the piston. Here, too, the visible movement and the production of heat are absolutely interdependent. You cannot have the one without the other. The two cases are precisely parallel even to the fuel used. In the internal combustion engine this consists of carbon and hydrogen combined in the form of petrol, in the human muscle of carbon and hydrogen in the form either of glycogen or dextrose. In the case of the muscle the combustion is also of the nature of an explosion. The only difference is that in the one case the explosion is the result of an electric spark and in the other of a nerve stimulus.

Now, if only one group of muscles is contracted, as when I flex my forearm on my upper arm, the amount of heat produced is so comparatively small that it does not materially affect the general temperature of my body. But if I contract a whole series of muscles, and keep on contracting them, as in the case of walking, the amount of heat produced is so considerable that the temperature of the body is materially raised, it may be a degree and a half or more. Thus, for instance, in a series of experiments in which 359 observations of the temperature were taken it was found that the average rise in temperature was 2·3 degrees on a comparatively short march of only seven miles on the flat. It is important to recognise that this elevation of temperature is absolutely physiological and normal, and, even more, that it is actually beneficial. You all know the practice that obtains in racing of giving a horse a preliminary canter, and the phrase "getting warmed to one's work" is also familiar to all. These are the practical expression of the general experience that until the temperature is slightly raised muscles will not work efficiently. In this particular the body again resembles an eternal combustion engine, since that also needs to get warm before it can run satisfactorily. This change is, as I have said, physiological, and not only that but beneficial; still, there is one point to be remembered: There is a danger point beyond which the body temperature must not rise, no matter what the cause may be. This point is constant, and though the rise of temperature due to exercise is physiological, still it brings the individual nearer to the danger point, whatever that may be. The margin of safety, as regards temperature, which is, about six degrees when a man is at rest, is reduced to about four degrees when he is at work, marching for instance, and the whole science of marching, from the physiological point of view, consists in preventing that reduced margin from being further encroached upon.

Naturally, if a man continues to produce temperature in his body, he must either get rid of the heat, or after a certain point his engine will, like any other engine, become over-heated, and, to use a technical expression, "seize," or, in other words, he will suffer from heat stroke. Normally the increase in temperature is kept in check by three means. These are the evaporation of the perspiration, the evaporation of the moisture of the breath, and direct convection from the skin. The latter is of little importance in temperate climates, in the case of a man wearing ordinary clothes, and of the two remaining the evaporation of the perspiration is the more important. If we wish to prevent the margin of safety being encroached on, we must then do nothing that will interfere with the evaporation of the moisture either from the skin or the lungs, and, at the same time, we must prevent an undue evolution of heat in the body, an evolution, that is, with which the cooling apparatus cannot keep pace.

If you will recall the rather complicated definition I gave of marching, you will realise that all those distinctions that mark the difference between the soldier marching and the civilian walking either increase the production of heat, or interfere with the proper dissemination of it in the two ways I have already described.

I will take the production of heat first. The amount of heat produced is directly proportional to the amount of work done, and if a man has to carry a weight this increases the work, and therefore the temperature. But a soldier has not only to carry a weight, but to carry it in a certain manner, namely, in such a way as shall leave his limbs unencumbered, and his hands free for fighting. Every increase in weight, not only means an increase in work, but after a certain time, a very considerable increase. Thus, whilst to carry ten pounds may perhaps entail only twice as much exertion as to carry five pounds, to carry twenty means more than double the work involved in carrying ten, to carry forty more than twice what it means to carry twenty, and so on, till at last we come to a limit beyond which any increase in weight means that a man's whole energies must be exclusively devoted to carrying a load, without leaving any margin for fighting, which, in fact, reduces him from a soldier to a baggage animal. What that limit is, has never been quite settled, but it is usually taken as being somewhat above one-third of his body weight. Thus, a man weighing ten stone, the average weight as a matter of fact of the British private, should not carry more, or at least not much more than 47 pounds. As a matter of fact, he does carry a little more, but only a few pounds. But the way in which the load is carried is of just as much importance as the amount. Under ordinary circumstances, all a man's framework is accustomed to the evenly distributed pressure of his live weight. Immediately you begin to load him, his framework has to accommodate itself to the altered balance that the increased load entails,

and in the case of the soldier, who has to keep his arms free, and therefore must carry his load mostly on his back, this altered balance is of great significance, especially in the case of the untrained man. This is not the place to go into the many interesting questions of equipment that are concerned in this matter. I can only ask you to remember that the two facts that a soldier has to carry a load, and to carry it in a certain manner, both increase the production of heat in the body. The pace at which the load is carried is also of importance. Obviously, if I carry a certain load a certain distance at a certain pace, and then again the same distance at twice that pace, I produce the same amount of heat on both occasions, since I do the same amount of work on both. But since I produce it in half the time on the second occasion. I naturally have only half the time in which to dissipate that heat, and therefore my temperature will show a greater rise on the second occasion than on the first. With soldiers maintaining a uniform rate of speed this is not of great importance, but what is of importance is that the man has to march not at his own pace, but at a pace regulated by the necessities and capabilities of the average man. Any man who is what is called, I believe, an "out size" is handicapped therefore by the fact that he has to step out or step short to suit his comrades, and whether he has to do the one or the other, he has to work his engine uneconomically, that is, produce a greater amount of heat for the same amount of work. In this case, as in that of carrying extra loads, practice is of the very greatest importance, and this is obviously a weak point in the case of the Territorial force. Quite apart from any questions of sore feet, or other accidents, the marching powers of the freshly mobilised Territorial army will be seriously affected by this want of practice, and it is a point which officers commanding infantry units should keep very well to the front of their minds.

We have now to consider the conditions which interfere with the proper dissipation of temperature. The first of these is the clothing. The mere fact that a man wears clothes at all interferes, of course, with the dissipation of heat by convection, but it also interferes very seriously with its dissipation by evaporation. The mere fact of unbuttoning one's coat may reduce the temperature by as much as half a degree. This is obviously of great importance. If a civilian is walking on a hot day he can adjust his clothes to suit the temperature of the day to a very considerable extent, even whilst he is walking. But the soldier has only one uniform, and therefore he has no latitude of choice as to the thickness of his clothes, and he has for obvious reasons to wear that uniform in a certain manner. With the new pattern infantry equipment it is possible to unbutton the coat, and thus make a good deal of evaporating surface available, and in the case of selecting any pattern of equipment for Territorial Infantry this point should always be considered.

Again, the fact that the soldier has to form one of a large body of men interferes with the evaporation of the moisture both from his skin and his breath. The leading men of a column breathe fresh air, but every man behind has to breathe air that already contains the moisture exhaled from the lungs and skins of the men in front. On a bright, windy day, especially if the wind blow at right angles to the line of march, that is of not so much importance, but if there be no wind, or a following one, the matter becomes serious on even a comparatively cool day, more especially if the air is from meteorological causes already nearly saturated. Of course, the weather is beyond even the commanding officer's control, but the unbuttoning of the men's coats and the opening out of the ranks are not, and these precautions should always be taken. Naturally, it is only on exceptional days that the temperature of the soldier will go so high as to result in heat-stroke, but there are a good many degrees of disability this side of that serious condition, and it must never be forgotten that every decimal point of temperature that a man's temperature goes up unnecessarily is so much superfluous energy expended, and fuel used up, that may be needed later. Just as a good engineer will nurse his engine so a good commanding officer will nurse his men on the march. The one is quite as practicable and necessary as the other. There is no point on which a sanitary officer can more usefully render advice than this.

There is one corollary of this production of heat by exercise, and regulation of temperature by evaporation, that is of enormous importance. Since the temperature is lowered by evaporation of moisture, obviously a certain amount of fluid is actually lost from the body during the process. This is evidenced by a sensible diminution in weight, which may even on short marches be very considerable. Thus on one occasion at Aldershot a man in good training lost as much as $5\frac{3}{4}$ lbs. on a seven mile march on a hot day. Obviously this cannot be allowed to go on indefinitely, the lost moisture must be replaced. If it is not, perspiration will cease and the temperature rise. There is also another consideration. A man cannot afford to lose more than one tenth or thereabouts of the water in his body without serious, possibly fatal consequences, since all the vital reactions depend on the presence of moisture.

The ordinary soldier, weighing 10 stone, contains in his tissues generally, altogether, about 95 lbs. of water, so that $9\frac{1}{2}$ lbs. is about his limit of possible loss. The man I have just referred to lost somewhat more than half of this in seven miles, and certainly could not have gone much further without water. The obvious deduction is that if you are going to march men you must water them. There was a very interesting correspondence on this subject in the *British Medical Journal* last year, in connection with a 24 hours' walking race at the Stadium. In this race the men following the usual theory, that fluid is bad for work, limited

their drink somewhat severely. They all suffered considerably from abdominal pain and occasionally vomiting, and this was distinctly attributed by the physiologists observing the race to want of sufficient water to assist in the secretion of gastric juice. In the correspondence that followed the publication of the results of the race in the *British Medical Journal*, the necessity of a liberal supply of fluid during work was strongly insisted on, and one gentleman (Dr. Claude Wilson), an experienced Alpine climber, quoted a saying of a secretary of the Alpine Club, to the effect that "the more you drink the farther you go." The German regulations recognise this fact, and lay down that on hot days mounted or bicycle orderlies should be sent on ahead of the column to tell villagers to line both sides of the road with tubs and buckets of water, so that the men may, even if they are too pressed to halt and fill their water-bottles, snatch a drink as they pass.

The General Omnibus Company have for years realised this in the case of their horses, and in hot weather provide at certain places liberal supplies of water for them. As regards the soldier, there is the difficulty that we do not want him to drink possibly bad water, and we cannot carry more than a certain amount of safe water; this amount is 220 gallons per battalion in water-carts, and $1\frac{3}{4}$ pints per man in the water-bottles, amounting in all to about $3\frac{1}{2}$ pints per man. The soldier I have referred to already lost $5\frac{1}{2}$ lbs., that is about $4\frac{1}{2}$ pints of water, which is rather more than we can afford to carry. I want you to remember that he was a soldier in good condition, at the end of the Aldershot drill season, and that he had marched only seven miles. As you can readily understand, the case would be much less satisfactory with freshly mobilised territorials on, say, a march of 14 miles. The question is a very serious one indeed, and the only solution to it lies in the words "water discipline." The first step in this discipline is to teach the men what being thirsty really means. There are two varieties of thirst, which I call respectively "the thirst of habit" and "the thirst of necessity." The former is the thirst that assails the ordinary unregenerate man, as a reflex sensation resulting from the sight of the "Red Lion" or "White Horse," or some similar visual stimulus. For the civilian there is no particular danger in this thirst, but the soldier must be educated out of it. If he is so educated then he will realize, and what is more important, his officer will realize, that when he complains of thirst it is no longer the thirst of habit but the thirst of necessity, that is, a thirst that is the expression not merely of a dry throat, but of water-starved tissues, a thirst, that is, that must be slaked if the engine is to run any longer. This again is largely a matter of practice. The trained marcher, and by that I do not mean merely the man in good condition or training generally, but the man who has been specially trained in marching pure and simple loses less weight, that is, evaporates

less water, in a given distance than a man untrained in that particular art, however "fit" he may be in the ordinary acceptation of the term. The reason is that in consequence of practice his engine works more economically, that is, consumes less fuel and produces less heat for a given amount of work. But if you are going to demand this pitch of training from your men, the obligation lies on you of seeing that when they really need water they shall get good safe water. For remember, water they must have, and if they cannot have pure water they must have bad. It is possible, doubtless, to train men to resist even the thirst of necessity, though there are few tortures more exquisite, but such a pitch of endurance is not within the reach of the average man, and even if it were so, there is no getting away from the fact that such suffering is merely overtaxing the engine to an unfair extent. Quite apart from any questions of humanity, which I need hardly say do not concern us in war, that is a foolish and wasteful proceeding.

The second step in water discipline, therefore, is the provision of pure water. No march should be undertaken without a very careful forethought as to where good water can be procured and in what quantity. In a well-watered country like England this should present no insuperable difficulty. One of the most important duties that can devolve on those sanitary officers who are on the *à la suite* list, is to furnish this information to any body of troops that may have to march through their districts. In this respect their local knowledge may be of the greatest help. The third point as regards water discipline is to see that there is no waste of water. At the beginning of a march it should be the duty of the company officer to see that all water-bottles are full, and the medical officer's to see that the carts are full as well, in each case with pure water. After that no man should be allowed to touch his water-bottle except by order, and that order should come only from the officer commanding the battalion. Water on the march should in fact be treated as of only less importance than ammunition. Just as no man may use a round of ammunition without an order, so no man should be allowed to take water from his water-bottle without an order. In the regular army we are often faced with the difficulty that we fight in countries where water is scarce, and it is sometimes almost impossible to give the men as much as they require. But in this country that is not the case. I think you could not draw a line of 14 miles along an English road where it would be impossible to get water for a Division, 4,000 gallons to fill the water-bottles and 11,000 for the horses, say 16,000 in all, at one point on the march at least. In Scotland and Ireland it is even easier to find. The only things necessary is forethought, and a good map, aided if possible by local knowledge.

In addition to causing a rise in the temperature of the body exercise also increases the rapidity of the heart beat, and the extent of the pul-

monary ventilation. Both these effects are, however, secondary to the fact that exercise is a process of combustion, and that this demands increased fuel, and an increased supply of oxygen to assist in its combustion. The factors which work together to increase the pulse rate are the same as those which increase the production of heat in the body. The increase is not therefore directly proportional to the actual temperature of the individual, since this depends not only on heat production but also on heat loss. It is hardly necessary to go over the same ground again as to the causes of increased heat production, but it must be noted that after a certain point an increase in temperature, whatever the cause in itself, produces an increased rapidity of the heart's action, so that the effect may become cumulative. In this connection the absence of constricting bands is of great importance, especially round the neck. In the new infantry equipment these are absent.

Just as the muscles demand more fuel, they also demand more oxygen. This is furnished in the case of the civilian in two ways. Either he increases the depth of his respirations or increases their frequency, or more often, first does the latter, and then settles down to the former expedient. In the case of the soldier, however, we are confronted by the fact that he has to carry considerable weights which must inevitably come into relation to his thoracic and abdominal walls, and therefore must interfere to a greater or less extent with either method of relief. Since neither the muscles of the abdomen nor those of the thorax are well fitted to act against resistance, the resource of deepening the respirations is not so freely at the disposal of the soldier as at that of the civilian. He has to rely to a greater extent, therefore, on increasing the number of his respirations. In the bandolier equipment this entails his raising slightly, but incessantly, a weight of 4 lbs. 9 oz. on account of ammunition, of 2 lbs. 14 oz. on account of his filled haversack, and of 3 lbs. 12 oz. on account of his water-bottle. The movement, it is true, is not very great, but when it has to be repeated fifteen to twenty times in the minute it may easily become of serious importance. In the new webbing equipment this is not the case. When this equipment is worn with the belt unbuckled there is in fact the minimum of interference with the respiration that can be hoped for. Any equipment which hampers the movements of the chest sooner or later reacts on the circulation through the lungs, especially on the right side of the body, and this again reacts on the heart and liver. A very decided dilatation of both these organs may be demonstrated after a prolonged and severe march.

The effects on the respiration are in the first place secondary to the increased production of heat, but here again we find that the mere increase in temperature stimulates the respiratory centre, and has thus a cumulative effect.

The question of halts is of great importance. A halt after the first half-hour is a good principle. This allows men whose loads are riding uneasily to re-adjust them, and those who have dressed hurriedly, especially in the matter of boot-lacing, to put matters straight. After that a halt every hour, with a longer halt about the dinner hour, is the usual and the best plan. With small bodies of troops it is possible to arrange the halts with reference to the local conditions of shade, comfort, etc., but with larger bodies, *e.g.*, a brigade, halts must be at regular periods, otherwise the column will not preserve its regular distances. At all halts the loads should be taken off the men's backs. This is not always easy with some forms of accoutrements, owing to the length of time necessary to take them off and put them on again. The great Stonewall Jackson used to make his men always lie down at halts, since, as he said, a man rests all over when he lies down. Unless the ground is wet or muddy the principle is a sound one. No halts except the food halt should be longer than five to ten minutes, as the men get stiff, their temperatures run down below the economical working line, and they have to be warmed up again.

I must just touch on one point in connection with halts, and that is conservancy, on these occasions. Details of conservancy should be attended to as carefully on a halt as during life in camp. Men should not be allowed to fall out promiscuously to relieve themselves. A definite place should be indicated in the vicinity of each halting ground, and the different details of disposal attended to by the battalion sanitary squad. What these details are I will mention in another lecture. I merely mention the necessity of attending to them, here, as they are almost invariably ignored.

I may say just a few words on forced marching. This term is as a rule applied to continued long marches of, say, 17 or more miles a day, repeated for several days. The term is also applicable to a long march prolonged over many hours without much rest, such as the march of Marlborough's Army in 1710, which I referred to in my last lecture, of over 40 miles in 13 hours. The march of the Light Division during the battle of Talavera of 60 miles in 26 hours, or of the same Division of 40 miles in 19 hours to Sauroren in 1813, are examples of these. During such marches a considerable number of men invariably succumb to heat-stroke, the result of over-exertion combined with insufficient evaporation, due either to insufficient water, a saturated state of the atmosphere, or too thick clothing. When such extraordinary exertions are demanded of troops, it is inevitable that the weakest must succumb. The numbers of those who do succumb may, however, be materially lessened if the precautions as to the different points which I have already mentioned are observed. Remember always that the fact that a forced march demands a certain

loss of life is no concern of the medical officer. What is his concern, however, is that no man shall so die in consequence of his resisting powers having been previously lowered by any preventible causes. Apart from these extraordinary marches, which are historical, and rare, marches may be forced by reason of their long continuance. Of such was Lord Roberts's march to Cabul in 1880, 16 miles a day for 23 days. The effect of this long continuance is that the human engine, which differs from all other engines in being self-stoking, self-cleansing, and self-repairing, gets no opportunity of performing these necessary functions. Here, again, training is the only remedy. The more economically a man works, the less fuel will he need, and the fewer repairs his body will have to carry out. I need not say anything more about the physiology of marching. A complete discussion of the subject might last over several evenings; all that I have here attempted to do is to show you how extraordinarily important the subject is. But quite apart from the physiology of the march, there is one point which I must not pass unnoticed, and that is the foot of the soldier.

The foot of the Infantry soldier is beyond all question the most important limb, not of only the most important, but of the only indispensable person in the army. On the soundness of that foot all strategy depends. I therefore make no apology for referring to it.

When a man falls out of the ranks footsore, the fault lies in one of three directions, either in the condition of his feet, in the condition of their coverings, that is, the boots and socks, or in a combination of these. I propose to consider these in the above order.

Considering firstly the feet, the fault here may lie either in the formation of the foot or in the condition of the skin. As regards the formation of the foot, it is obvious that except in extreme cases of deformity, as of hammer-toe or ingrowing toenail, not much can be done directly to the foot; the remedy must be sought in the adaptation of the boots to the feet. The importance of the formation of the foot as affecting a man's efficiency in the ranks is apt, however, to be overlooked by recruiting officers; and it is worth while insisting that this point should be given almost more weight in the recruiting of an army that is not intended to be mobilised, except in actual view of hostilities, than in the case of a regular force permanently embodied. If a man should get into the regular army with a badly deformed toe there is always the opportunity of remedying the error by operative measures long before the man is actually required in the field. But with a second-line army this is not so. A man may be able to stand the comparatively easy work of his annual camp with an amount of deformity which would speedily incapacitate him in the earlier days of mobilisation. Hospitals in the field are, it need hardly be said, not intended for the treatment of long-standing deformities,

and the only thing to be done with such a man is to discharge him just at a moment when his services are most needed. The formation of the foot, then, is a point to which the most careful attention must be given during the physical examination of recruits.

If the fault does not lie in the formation of the foot it must lie in the condition of the skin ; and here the consideration which is most important is cleanliness. It may not be true, absolutely, to say that clean feet are sound feet, but it is absolutely true to say that dirty feet are unsound feet. That may be taken as an axiom, and, therefore, the first cardinal point that the medical officer in charge of an infantry unit must insist on (in this connection) is the paramount importance of cleanliness of the feet. The feet should be washed with clean water and soap every day if possible, or if this is impossible, as on Service it may sometimes be, on every possible occasion ; and it need hardly be said that not less important than washing is drying after washing, and especially drying between the toes. It is important also to insist on the necessity for the complete removal of all remains of soap from between the toes before drying. The above measures (the frequent and careful washing, and careful drying after washing, of the feet) are important, their importance must be impressed on all men, and frequent inspections to see that they are universally carried out should be instituted. In some cases this is not sufficient. It is necessary in addition to find out those men who suffer from hyperhydrosis, and these should form the particular care of the medical officer of every infantry battalion. He will probably find about two men in every company, say between fifteen and twenty men in a full battalion, whose feet sweat profusely in spite of periodical washings. These men he should see every day as well as immediately after arrival at camp or quarters at the end of a march. The washing of their feet must be carried out under his immediate supervision, preferably with some mild astringent and antiseptic, such as weak solution of permanganate of potassium, or a ·5 per cent. solution of formaldehyde. The use of astringent ointments or powders of a mildly antiseptic and non-irritating nature is to be recommended in these cases, but far more important than any medicinal application is the close personal supervision by the medical officer of the battalion of the process of cleansing the feet. The feet of the battalion as a whole may be left to the care of the company officers, but those of the men afflicted with profuse sweating must be the care of the medical officer in person.

For obstinate cases the following procedure is to be recommended. On the march some difficulty might be experienced in carrying it out, but when in camp for even a few days it should be eminently feasible. I am indebted for the hint to a paper which appeared in the *Journal of the Royal Army Medical Corps* for June, 1910, written by Major C. H.

Hale. The patient should be detained at the hospital tent, or in the field ambulance, supposing this to be opened, for 24 hours. All his foot-gear, boots, shoes, socks, &c., are sent for. The socks are soaked for one hour in a solution of corrosive sublimate, 1 in 2,000. After that they are well rinsed in hot water, and subsequently washed. The inside of the boot is painted everywhere with a solution, containing 1 oz. of salicylic acid in 4 oz. of methylated spirit. The feet are first well washed, and then painted with the same solution. The chief attention should be paid to the red sodden areas that are so characteristic of the complaint. A clean dry pair of socks should then be put on, and the feet painted again next morning. The disease is in fact treated as a contagious disease, and thorough disinfection practised.

In the German army a mixture of salicylic acid and talc, three parts of the former to eighty-seven of the latter, with the addition of starch ten parts, is used as a foot powder. Drs. Toussaint and Schneider, of the French army, recommend the careful swabbing of the feet with cotton-wool soaked in 10 per cent. solution of chromic acid, a weak dilution being used in the case of excoriations being present. This should be repeated in a fortnight or six weeks. This proceeding is also a regulation one in the German army. Dr. Vaillard recommends the use of formalin in somewhat strong solutions, rising even to 30 per cent. in cases where it is well borne. It need hardly be said that the use of any such solutions should be restricted to cases where it is absolutely necessary, and only be carried out under the personal supervision of the medical officer.

The question of corns may be alluded to; it is not wise to leave these entirely to the care of the battalion chiropodist, even supposing such a person to exist. Unskilful cutting may cause a serious injury, and the operations of the chiropodist should, therefore, be carried out under the supervision of the medical officer.

We now come to the coverings of the feet, that is the socks and boots. In reference to the number of socks a man should possess, no man is an efficient foot soldier who does not start at least with two pairs of well-fitting undarned socks. Two at least he must have, since one of the most important points in the care of the feet consists in putting on a cool, dry pair of socks after the former had been washed. Quite apart from the effect on the skin of the feet of putting on hot, damp, and dirty socks after washing, which this change avoids, the general refreshing effect of clean, dry socks is very considerable. The socks also should be undarned to start with, since while the foot is still unhardened by the march, it is liable to suffer abrasions from the roughness of the mended surface, while in its hardened condition a few weeks later the same effect would not be produced. The socks after removal should be dried and then carefully cleansed of all dust, etc., by shaking and

rubbing, and any hardened patch carefully kneaded between the fingers until the substance of the sock is soft and pliable again. Washing of socks is a matter that has to be performed with the greatest care, and certainly should not be performed very often. Careful drying and cleaning as above described is sufficient for several days at least. The material of which the socks are made should not be too thin, and too thick a material is equally an error. Well-made, knitted, woollen socks of medium thickness are undoubtedly the best. Cheap woollen socks are rarely well made or finished, and invariably shrink in the wash; it is probable that in ordinary weather stout merino socks are preferable. For those who can afford it there is nothing more comfortable than two pairs of thin socks worn one over the other, but of course this entails four pairs in all. Every foot soldier should be able to darn his own socks, and be provided with materials for this purpose, and at the periodical foot inspection, socks should also be examined to see that holes are not allowed to go beyond repair. In the absence of socks, it is worth remembering that an excellent substitute can be made of linen or cotton cloth, or fairly thin flannel. A piece about the size of an ordinary triangular bandage should be taken. The foot is placed on this, with the heel in the centre of one of the sides, at a distance of about 4 ins. from the edge. The edge is then brought up the back of the foot to a little higher than the top of the boot, and the free ends of the bandage folded round the foot. The size of the material should be such that when the edge is on a level with the top of the boot the point should still remain long enough to come over the toes to a spot in front of the ankle level with the edge behind. The use of these foot cloths is not uncommon on the Continent, and I can testify, from personal experience over about 600 miles of rough walking, that if well applied they are quite efficient substitutes for socks. The necessity for a spare pair of foot cloths, to be put on on arrival in camp, is as imperative as in the case of socks. They should be cleaned in the same way. Soaping the inside of the socks is a useful precaution, especially when these are old or rough with darns.

We come now to the consideration of the boots. The question of the supply of boots to men of the Territorial Army is still, I understand, *sub judice*, but in any case every man should be prepared to turn out with one sound pair of walking boots, sufficiently worn for the feet of the owner to be accustomed to them, and in good repair. To start marching with soft feet, in a new pair of boots, is suicidal. The new boots served out on mobilization should be worn for ordinary drills till the feet become accustomed to them, but for serious marching in the early days of mobilization the boots worn should be those to which the feet are accustomed. Every Territorial soldier who wishes to keep himself efficient, and in readiness to turn out at short notice should, if he can afford it, keep always one pair of

good boots in good repair, and in regular use, for this purpose. The best cheap boots with which I am acquainted are the regulation boots issued to the British private. I have tried them myself, and wish for no better, once they are well "broken in." I was interested to meet a Territorial battalion on manœuvres this year, near Salisbury, the colonel of which informed me that he had fitted out all men who wished for boots with these, and that the only men who had fallen out in his battalion were those who had kept their own private supply.

It is hardly necessary to repeat that the boot must be made to accommodate itself to the foot and not *vice versa*. Fitting therefore should be carefully supervised. Boots should conform in plan as nearly as possible to the outline of the sole of the foot, taken by tracing round the foot when planted firmly on a piece of paper. The toes should be bluntly rounded, not pointed, and when laced up there should be room in the boot for the foot to alter its shape freely in the course of the ordinary movements of walking, but without any actual movement in the boot. The heel should be broad and not, it need hardly be said, high. Civilised man has become habituated to having the heel of his foot raised slightly above the forepart, and it is impossible for him to return to the natural condition of the heelless savage. The height of the heel should be limited, however, and not more than twice the thickness of the sole. The addition of a metal plate saves wear, and has undoubted advantages in this direction, but it must be remembered that such an addition adds markedly to the shock felt when the heel is brought to the ground, especially in a laden man not habituated to the carrying of weights. The sole should not be too thick, since this means weight and lack of pliancy. All boots should be sewn, not pegged. The sole may be furnished with nails, but they should not be hobnails, since these are apt to fall out and leave holes which permit of the entry of water. Coming now to the upper leathers, these should be stout and pliable, and preferably cut as in the ordinary shooting boot, with a fixed tongue. They should not be blacked, but dressed with some oil or dubbin. This is most important, since it prevents the leather becoming sodden and hard. It is better on the whole not to have hooks to facilitate lacing. These are doubtless very convenient, but if putties are worn the pressure of the putties on the hooks is apt to cause injury to the ankle. It is, above all things, necessary to keep the boots as light as possible consistently with strength. Viry is responsible for the statement that every additional ounce carried on the boot is equivalent, as regards its effect on the wearer, to a hundred times that weight carried on his back; and though this may savour of exaggeration, it must be remembered that this additional weight has not only to be carried but lifted a height of 340 ft. in every mile.

Sore feet should be looked at from the disciplinary, as well as from the

medical point of view. If a cavalry soldier rubs his horse's back he is not unlikely to hear a few home truths as to his fitness to belong to the mounted arm. If a foot soldier rubs his feet there is no particular reason why he should receive much more sympathy. His feet are as important as the horse's back, and just as much the property of the State. Nine-tenths of foot-soreness is due to dirt and carelessness, and though the man must be treated with a view to his recovery in the interests of the State, there is no reason why any undue consideration should be shown him. Sore feet do not necessarily prevent a man's marching, and marching does not of necessity prevent healing of even a bad rub. In this connection I may refer to a very ingenious suggestion made by a medical officer of the French Army, Médecin Major Coindreau, in the *Archives de Médecine et Pharmacie Militaires* for October, 1910. This officer applies a strap round the foot in such a manner as to form a figure of eight round the ankle and instep. The buckle is fastened fairly tight and lies in front of the external malleolous. By the use of this strap the boot is immobilised on the foot, and any "rubbed" surface gets a rest and is given time to heal. Dr. Coindreau has met with great success by the use of this strap, and the method is worth remembering. I am afraid we cannot escape from the fact that in the earlier days of mobilisation the men of the Territorial Infantry will suffer very severely from sore feet. The medical officer who can keep the number of men so disabled as low, and return men to the ranks as quickly, as possible, will be more useful than the most skilful surgeon whose mind is set on the higher flights of his art.

Writing for professional men, it is hardly necessary to speak of the treatment of injuries to the feet, blisters, abrasions, and so on, but it is important to impress the fact that men should be warned not to treat themselves. Self-treatment of a blistered heel, which usually consists in pricking it with a septic needle, is very likely to result in admission to hospital for a tedious ulcer. A small blister or excoriation of the heel may seem to the enthusiastic surgeon, anxious to show his skill in the treatment of gun-shot wounds, or the keen sanitarian looking forward to dealing with the large problems of disease prevention, matter too trivial for him to expend much time or trouble on, but it cannot be too strongly emphasised that no injury to the foot of a foot soldier can be looked on as trivial. What the total loss to an army from these causes may amount to is rarely realised, the following facts are, however, worth remembering. The German army in the earlier fighting of the Franco-German War lost from killed and wounded rather over 60,000 men. In the same period 30,000 men were incapacitated from duty by injuries to the feet; rather more than half as many again as were lost in the most sanguinary engagement of the war, the battle of Gravelotte.

Sanitation of Camps. Water Supply. Quantity and Quality. Collection, Storage, and Distribution in the Field Purification of Water. Different methods. Conditions affecting choice of methods.

IN my last lecture, I referred to the fact that troops might be considered as being either in movement or stationary, and I pointed out that the two conditions differed materially from the sanitary point of view, since, whilst in the former, though they are exposed to fatigue, hunger, thirst, and so on, to conditions, that is, which tend to lower their resisting powers; in the latter they are exposed to the danger resulting from the accumulation of their waste products. In fact, the sanitary dangers of camp life are due very largely to this last cause, and the keystone of camp sanitation is, in consequence, conservancy. Water supply concerns troops, however, at all times, and therefore I consider it at this stage.

But first, I would like to point out wherein the great difference between sanitation in camp, whether standing or movable, and sanitation in civil life consists. Briefly, it consists in the fact that in respect of two great departments of sanitation, the provision of pure water, and the removal of waste products, the soldier passes from a state of civilization to one of savagery. All that he has been in the habit of having had done for him in his previous life he now has to do for himself. Up till then, in the majority of cases, a municipality or other public body has had to provide him with pure water, and remove his rubbish and excreta. His responsibility in these two particulars has been of the slightest. The turning of a tap, or the pulling of a handle, has been the limit of his responsibility. In camp all is changed. Now he has to see for himself that his water is pure, and that his excreta are properly disposed of, with the full knowledge of the fact that, especially in the latter case, any mistakes he may make, or any individual carelessness on his part, will eventually recoil on the heads of the other men whose communal life he shares.

When we deal with water supply, this is not so much the case. If a man drinks bad water, that is, after all, his own affair. He may, it is true, become a focus of disease by contracting enteric fever or dysentery, but their further dissemination from that focus is, after all, again a matter of bad conservancy. As regards water, the harm he can do is chiefly in contaminating the water supply of others, by carelessness in the processes of collection and distribution, and therefore a good deal of camp sanitation in this respect consists of a method of safeguarding water during collection and distribution.

I do not intend to say much on the general questions of water supply. You are all familiar with the facts that water originally comes to us from aerial sources, in the form of rain, snow, or dew; that it either sinks into the earth, or runs off its surface, is evaporated into the air, or

absorbed by vegetation. Of these the first two alone concern us when considering water supply. If water sinks into the earth we recover it either from springs or wells; if it runs over the surface we obtain it in streams, rivers, lakes, or ponds. Troops in camp after mobilisation may in a large number of cases receive their water from some well-organised municipal system, and in that case of course there will be little difficulty in the matter. In the majority of cases, however, they will derive it from open sources, springs, rivers, ponds, or open wells, and it is with these only that I intend to deal.

The first two questions that arise in connection with water supply, and these are equally the case whether we are concerned with a municipality or a camp, are the quality and the quantity, that is, how much do we want, how much can we get, and will what we get be good, bad, or indifferent. These questions being settled, we next come to the questions of collection, storage, and distribution, and lastly to that of purification. I propose to discuss the above points in detail in the above order.

I take quantity first, simply because one cannot discuss the quality of water, or how one is to make use of it, until one is quite sure that the water is not only present, but present in sufficient quantity. That is fairly obvious. The confusion arises when more than one source of water is available. It is possible, for instance, that a force may be camped in a place where there is an excellent supply available from some municipal source, but this water is only doubtfully reliable as regards quantity, whilst there is at the same time an ample supply of water at hand, say from an open river or lake, which is certainly contaminated. Which water should you choose? Obviously it is open to you to use the safe water as long as that lasts and then go to the bad water, and such a course is justifiable as long as you recognise that the bad water is what you will eventually have to rely on, and make your preparations in advance for its purification. The danger lies in relying on the good, but possibly insufficient, supply, and then being suddenly forced to use the other with no means of purification ready. Personally, in any such case, I should choose at once the bad supply, and arrange for its purification, using the good supply only till I was ready, not until I was forced, to use the bad.

The actual quantity of water allowed in camp is usually laid down at five gallons per man in standing camp, with ten gallons for each horse, but in practice one is reduced to taking what one can get and preventing waste. As an absolute minimum one gallon per man may be laid down; less than this is privation.

In the matter of quality, of course the purer the better. But, dealing with open sources of supply, one must be content to accept the fact that there is no such thing, certainly on field service, as an absolutely pure supply; a supply, that is, which can be consumed without preliminary

purification. About this subject I should like to say two things. The first is that, even though all waters must be looked on as potentially contaminated, that fact does not absolve us from the duty of selecting the least dangerous. The second is that, however dangerous and dirty the water may be, that is no argument against taking all precautions to prevent the addition of any more impurity to it.

There are three ways of ascertaining the quality of a water. One may examine it chemically or bacteriologically, with test tubes or microscopes, or one may examine it by the light of unaided common sense. It is impossible to compare these three methods from the point of view of relative value; each has its own proper *rôle* to play; but I will go so far as to say that the one indispensable method is that of common sense. That is at the disposal of all who possess that rare article. But it is not at the disposal of any man, whatever his laboratory equipment or technical skill, unless he possesses common sense. I should like to give two instances which occurred in my own work which illustrate this point.

In one case I was asked to report on a water supply which chemically was as pure a water as one could imagine, containing no evidence of organic contamination of any kind, animal or vegetable, whilst the bacteriological examination showed it to be nearly sterile. A few years later I had to report on a water which chemically showed abundant evidence of organic contamination, and in addition contained enormous quantities of intestinal bacteria; that is, of the *B. coli*. As a matter of fact, in the former case the water issued from the side of a hill, on which, and within 20 yds. of the spring was a graveyard. The soil was very hard and impermeable, though liable to fissures, and the air temperature was in the neighbourhood of freezing-point all day and of zero at night. It so happened that no fissure had developed affording a direct communication between the spring, and any one of the numerous graves immediately in its vicinity, so that there had been no direct contamination of the water. Equally obviously the spring was open to the risk of such a crevice opening at any time, and I accordingly condemned the water. In the second case the water was collected from a small stream running down a valley, far away from any habitation, but used for grazing cattle. The pollution was largely vegetable in its nature, and, in so far as it was animal, was due not to human excrement but to that of cows and sheep, a fact obvious on even a cursory examination of the surroundings. I accordingly sanctioned the use of this latter source since a few hundred yards of wire fencing was all that was necessary to protect the source permanently. In the case of the graveyard there was no possibility of preventing absolutely the access of human contamination to the water even if it had been closed to further use, a rather delicate proceeding. I may remark that the graveyard was a Mahommedan one, which I need hardly say cannot lightly be interfered with.

I quote these two instances because they illustrate very aptly, in my opinion, the absolute necessity of inspecting personally every source of water which it is intended to utilise, before definitely pronouncing for or against its use. In any case, it must always be kept in mind that the utmost one is justified in saying after making a bacteriological or chemical examination of a water supply, is that in such and such a quantity of water, usually about 10 ozs. in the first, and 2 to 4 pints in the second case, one was or was not able to find certain dangerous bacteria, or their companions, or certain chemical substances which usually point to organic, and therefore possibly specific pollution. On these slender grounds we have to form our opinion as to whether a water supply, running to hundreds of thousands of gallons, is sufficiently pure to be safe, or sufficiently impure to be dangerous. Chemical and bacterial tests are of enormous importance as elucidating the results of personal inspection, or when it is desired to keep a watch on a supply that has already been found to be pure, to guard against casual contamination. To rely on them, and them alone, is one of the most dangerous mistakes a sanitary officer can make. I venture to press this matter somewhat strongly, because one used to read in the daily press during the late war in Manchuria of Japanese medical officers riding with the advanced guard with microscopes (and I believe I am right in saying test-tubes) to examine the water before their troops arrived at the camp-ground. I should be very loth to believe that the sanitary officers of the Japanese Army are not sufficiently instructed to be able to recognise, without any such recondite methods of research, the possibilities and probabilities of any particular supply being dangerous or not. Remember that on service we are not dealing with certainties. In the case of a large municipal installation it is necessary to know accurately exactly what there is, or is not, in a water; since on that knowledge depends the decision as to whether large and expensive purifying installations must be put up. On service this is not so. The possibility of contamination is sufficient to demand purification; and the safest rule, the only safe rule in fact, is to look on all open sources of water as being dangerously contaminated.

The next point to be considered is collection of water. This varies in the detail of its arrangement according as we are dealing with a well, a stream, or a pond, and on this I will say a few points later. The first point I wish to insist on is, that whatever the source with which we are concerned, and whatever the methods of collection adopted, there is no hope of success unless a regular system be observed.

One man, and one man only, should be responsible for the collection of water. He should have a fixed establishment to assist him in the details of collection (apart from all questions of distribution and purification), and no other man than he should be allowed to direct, and no other men but those told off to assist him allowed to interfere, in the details of collection. No matter what the source of the water may be, well, pond, or river, it is

subversive of all sanitation to allow any man to go at any time, and to any place, to get his drinking water. The issue of water to the troops should be safeguarded just as carefully as the issue of ammunition. In the same way as the filling of the cartridge pouches is not left to the individual's own initiative, so the filling of his water bottle should not be regulated by his own will and pleasure. Good water is not so easy to obtain on service that any waste of it can be permitted, while at the same time no man should be allowed to drink any other. If we are going to insist on this last point, and as far as it lies in the limits of possibility we are bound to insist on it, then it is our duty to see that there is a sufficiency of good water to satisfy the soldier's real necessities. We are not called on to do more than this. Active service is not intended as a period of luxury, and no man has a right to complain, or break the rules of water discipline, as long as his reasonable wants in this direction are satisfied. The only way in which we can insure that the man shall have sufficient water, and that of good quality, is by instituting a regular system of collection, distribution, and purification.

To come now to the details of collection from an open source. The first point is to see that no pollution is added to the water in the process of collection. If you consider the question of getting water from a pond, for instance, you can at once see that if a single man wishes to fill a pail, with care he can do so from the bank if the water is deep enough, without dirtying the water; but if a string of men one after another go with pails to the bank, you will find very soon that what with the inevitable slopping of water from pails, and the poaching of the muddy ground by the men's feet, the bank becomes rapidly converted into a mass of mud from which dirty water, containing all conceivable contamination from the men's boots, trickles back into the pond. Obviously since one man, if he is careful, can fill a pail without dirtying the water, the proper precaution to take is to let one man fill all the pails for the others, and pass them back to their owners. But there is a distinct danger in having any coming and going anywhere close to the bank, and therefore the simplest measure to adopt in such a case is to form a line of men to pass the buckets back to the carts, or to the men who are going to distribute the water. If the bank be too high for the man at the edge to reach to the water conveniently, then some mechanical means must be adopted. A very simple one is to swing a bucket on the end of a longish rod, pivoting this latter on a stout stem close to the edge. The bucket can then be swung out, dipped, filled, swung in and emptied or passed on without any unnecessary interference with the bank. Of course, if a pump and hose are available the matter is even yet more simple, but even then no man must be allowed to go near the bank where the hose enters the water, except the man watching it, and he must stand fast there. If the pond has shallow flat edges, then a jetty or rough pier

of stones may be built out as far as possible into the water, and the line of men formed along this. There are numberless other ways, which in a lecture of this length it is impossible to detail. The same principle must underlie all if they are to run on sound lines. Only one man must go to the collecting point, and there must be no to and fro traffic near the water's edge. If water-carts are used, then they must be kept stationary at as great a distance as possible, depending on the method of filling adopted. If this is at all close, say less than twelve feet, draught animals should be taken out and made to stand at some greater distance. The "stance" for the water-carts must be accurately defined by a cut in the ground or a line of stones, and the non-commissioned officer superintending collection should take up his post here. A catch-water drain should always be cut between the place where the carts stand and the place of drawing, to prevent any dirty water trickling back into the pond.

In the case of a stream or river a similar procedure may be adopted, and in the case of a small stream a dam may be constructed to allow of an accumulation of water.

In the case of a well it is necessary in the first place to construct a kerb if none already exist. The next is to rig up some means whereby water can be drawn without necessitating a man standing right over the mouth of the well. A rough windlass of some kind can easily be improvised. Here, again, as in the case of a pond, only one man should be allowed to come to the edge of the well. A string of men to pass buckets back to the carts may be formed. If there is a chance of prolonged occupation, then it would be advisable to rig up a staging over the well, carrying a tank, from which a hose can deliver the water to the carts, or water-carrying party, at some little distance. If skilled workmen and suitable mechanical appliances are available, then more elaborate arrangements can be made. I want to insist, however, again that the methods employed are a matter of detail. The keynote of any method must be system, with a definite fixing of responsibility on one individual. Whatever system is adopted, and no matter what person is made responsible, the rules laid down for collection of water must be rigidly enforced and observed. There is only one way in which this can be insured, and that is by the posting of an armed guard, whose orders should be to fire on any man coming to the immediate vicinity of the supply, after due warning given. Water, as I have already said, should be safeguarded as carefully as ammunition, and it is just as essential in the one case as in the other that the supply should be put under the protection of the only authority that every man, whether he be soldier or camp follower, recognises, that is an armed sentry. Printed notices and paper orders are not sufficient.

It is usual to distinguish between the sources of water that are to be used for drinking, for the watering of animals, and for washing, by placing

different coloured flags (white, blue, and red respectively), at the different points of collection. Distribution is not a matter of great complexity in camp. Each man has to fill his own bottle from the water cart, or whatever purifying installation is in use. I would merely give one word of caution here. Purified water is expensive in camp: not expensive in money, but in labour, and therefore it should be used only for drinking. It should not be used for officers' baths. If water is so dirty that it cannot be used for ablution unstrained, then some simple method of clarification, such as will be described later on, must be made use of. The non-commissioned officer in charge of the purification installation should be made responsible that this rule is observed.

We now come to the great question of purification. Purification of water consists in the removal from, or the destruction in, the water of all substances which cause it to be unsuitable for use by man, whether those substances are causes of disease or not. It is a process that acts not on the water itself but on certain additions that have been made to the water, and this point should not be lost sight of, as in certain methods of purification it has a very important bearing.

The matters which have to be removed from the water may be divided into those which cause the water to be unsightly and unpleasant to the ordinary senses, and those which actually cause disease. The former are usually of considerable size, and consist of twigs, leaves, organic *débris* of various kinds, and mineral matters. These last may, if very small, cause injury to the intestine, and as a result disease, but no other members of this class have been proved to possess pathogenic qualities. The second class of extraneous matters consists of micro-organisms and the eggs of intestinal parasites. We can get rid of the members of the first class only by removal, of those of the second either by removal or destruction.

Removal is effected either by sedimentation, precipitation, or filtration. In the first-named, sedimentation, the matters are allowed to sink to the bottom of the stored water by their own weight. This method though it has a well-marked *rôle* in civil practice is obviously unsuited for service work, and I will not further discuss it.

Precipitation can be effected by the addition of certain chemicals, preeminently alum, to the water. It is merely a form of accelerated sedimentation, but since it is accelerated it can be used under service conditions, and indeed, in combination with filtration or straining is, under certain conditions, that is with certain kinds of water, a very valuable method of purification. The amount to be used is about 1 gr. of alum to the gallon of water. The dirtier the water the more efficient is the process, since the bulky precipitate formed in very dirty water, either drags down with it a large number of germs in the water, or, if subsequent straining be resorted to, forms a thick film on the surface of the straining material and thus

increases its efficacy. It is hoped that advantage may be taken of this fact to facilitate straining of water prior to filtration in the water-cart, but the process is still in the experimental stage.

Filtration is the most usual method of removing extraneous matters from water, and is carried out in a number of ways. All methods of filtration, however, are based on the same principle, and are governed by one law. The principle is that a certain obstruction is placed to the flow of the water through the filtering apparatus, as a result of which obstruction the particulate matter, which it is desired to remove from the water, is held back, and thus prevented from passing along with the water. The finer the matter that has to be removed the greater the obstruction that must be placed in the flow of the water, and therefore the greater the resistance to that flow. The greater the resistance, the greater the force that has to be applied to impel the water through the filtering medium. This law regulates all filtering processes. It may be stated in another way as follows. The greater the purification which it is desired to effect, the finer must be the pores of the filtering medium; in other words, the greater the obstruction that must be placed in the passage of the water. Therefore, the greater the purification desired the greater the force required to pass the water through the filtering medium, and also the less the ultimate output. If we have to depend, as in the field we almost always must, on hand-worked pumps (that is to say, on comparatively weak power), a high degree of purification demands a considerable length of time. Therefore, if water has to be purified rapidly, we must be content with a comparatively slight degree of purification; that is, we can only afford to remove such objects as are, comparatively speaking, of gross size. If we have plenty of time, then we can remove even the smallest particles, in other words, micro-organisms; but for this we must have time. There is another important factor that has to be kept in mind, and that is filtering area. Obviously if our filtering area is represented by the figure 1, and we wish to produce any degree of purification already decided on, the force required to produce that purification may be also called 1. If we double our area, then for the same amount of water we can halve our force and still maintain the same level of output, or using the same amount of force double the output. For any given degree of purification, and any given density of medium, the power required varies inversely as the filtering area if the output remain constant; and the output varies directly as the filtering area if the force remain constant.

In deciding on any method of purification by filtration, the first thing to be decided is the amount of purification required. That being settled, we can next decide the nature of the filtering medium which we will employ. This being fixed, we can calculate from the amount of power available, which on service is limited by the nature of the pump and

the strength of the man who works it, in other words is fairly constant, and from the filtering area available, the output we may expect.

Obviously, then, the first thing is to decide on the amount of purification required, and on this point I should like to point out that there are two grades of purification that must be aimed at, according as the water is required for washing and cooking, or for drinking only. If water be required for washing it need not be sterilized, and if it be required for cooking sterilization is ensured by the subsequent process. In these cases then all that we need do is to deprive the water of its coarse impurities. This can be done very simply by straining through a cloth, especially after admixture with alum. It is unnecessary in either of these cases to try and produce a germ-free water. Experiments have been tried at the Royal Army Medical College, in which alum to the extent of one grain to the gallon has been added to Thames water, and this then pumped through cloth stretched on a wire framework. The result has been most satisfactory, a perfectly clean (though of course not sterile) water, quite sufficiently purified for the purposes of making tea, cooking, or washing, being produced in a very short time. In any standing camp, then, which has to depend for its water supply on a turbid river or pond some means should be adopted by which all water required for these purposes, namely, cooking and ablution, should merely be clarified by coarse straining. The installation for this purpose should be under the care of a non-commissioned officer, who should permit authorized persons only to procure water there. Authorized persons would in practice mean cooks and officers' servants. If the water were already clear, as in the case of a chalk stream or a large ornamental water, then such preliminary purification would be unnecessary, and all that would be needed in such a case would be to tell off a certain spot where water for these purposes could be collected.

For drinking purposes, however, water must be completely freed from bacterial contamination, and at present this can only be done, speaking of filtration, by means of a candle filter made of porcelain or some patent filtering composition. Since a great degree of purification is required, a great resistance must be imposed on the flow of the water, and therefore we must, to get a rapid output, either increase greatly the force used, or the filtering area available. If either or both of these measures be out of the question (as on service is the case), then we must be content to put up with a reduced output; and this last is in fact what occurs. But if the output is diminished in amount obviously waste must be most carefully avoided, and such purified water used only for that purpose for which sterilised water is absolutely necessary, in other words, for drinking. In every standing camp then, where dirty water has to be relied on as a source of supply, and filtration resorted to as a means of purification, there should be two installations, one merely for rough straining and the other

for complete sterilisation of the water. At this last source water-bottles only should be filled, and this rule should be enforced to the letter.

We now come to the actual means employed. For rough straining numerous expedients can be used. The simplest of all is that in which a blanket or large sheet of cloth is suspended by the corners and the water poured into the basin thus formed, with or without the previous addition of alum, the strained water being received in a clean barrel or other receptacle. In the case of a pond or river with a sandy or gravelly bank, a shallow well may be sunk a few feet away from the edge of the water and the straining powers of the earth relied on. Another method is to take two barrels of unequal size, the smaller of which is perforated along its upper edge, and the larger near the bottom. The smaller barrel is now placed inside the larger, the interspace being filled with sand, charcoal, or fine gravel. The whole apparatus is then sunk in the water up to within an inch or so of the level of the upper edge of the small barrel; the water percolates through the straining material between the two barrels, and is sufficiently strained for the purposes specified. Where water is scarce the perforations are made at the lower end of the small barrel only, and the water allowed to pour on to the surface of the filtering material lying in the interspace. It is unnecessary to multiply examples of methods of rough straining, every fresh situation demands slightly different treatment from the last, and methods must be adapted accordingly.

For fine filtration, the only medium at present recognised as efficient is either porcelain, or some compound of infusorial earth, made up in the well-known candle shape. These are used in the regulation filter water cart, and, with due supervision, work satisfactorily. Supervision must be constant, and the candles must be periodically removed and cleaned, and at longer intervals sterilised. A preliminary straining is absolutely necessary whenever these fine-grained filtering media are employed. This is supplied in the case of the filter cart by cylinders packed with compressed sponge. The difficulty about such filters is the slow rate of delivery, with the ordinary man-power available. It would, doubtless, be feasible to increase this power, but in that case, flaws are more likely to develop between the filtering medium and the metal bearings with which it is in contact. We are therefore limited as regards power, and therefore, necessarily, as regards output. It cannot be asserted that the last word has been said as regards this method of purification. A full description of this cart is given in "Royal Army Medical Corps Training," pp. 154-157.

In the army of the United States, the Darnall filter is highly spoken of. In this piece of apparatus, a wire cylinder is utilised to form the support of a sheet of thickish cloth. The whole is then immersed in water, to which alum and sodium carbonate have been added. The water is

sucked through the filtering cloth by means of a siphon tube, a thick scum, depending directly on the amount of turbidity in the water, being deposited on the cloth, and assisting filtration. The suction power of the siphon is not very great, and the amount of resistance that can be overcome proportionately low, being the extent of purification thereby reduced. This filter has been highly spoken of in the United States, and, I believe, Canada, but, personally, I have not found it particularly satisfactory. If the length of the descending arm of the siphon were considerably increased a better result might be obtained.

In the Japanese army, in their last war, considerable use was made of the Ishiji filter. This consists of a large conical bag of canvas, near the apex of which are two short projecting arms, which are filled with charcoal and sponge. The apex of the cone is itself blind. Two powders, consisting, one of potash alum, permanganate of potash, and aluminium silicate, the other of chloride of ammonium, aluminium silicate, and charcoal, are added to the water; the first until discolouration is produced, and the second until this discolouration has been removed. The water is subjected thus to a process of sedimentation, as well as oxidation, and subsequently to one of straining through the lateral arms. Here, the power available is the head of water in the funnel, which is always gradually diminishing unless the cone is periodically or continuously refilled.

In the German and French armies, Berkefeld and similar filters, adapted either for human or wheeled transport, are used.

Water may be purified by destroying the contained impurities, but this method is applicable only to those impurities which are of the nature of living organisms, in short, bacteria and the eggs of entozoa. The methods of destruction employed are either physical or chemical. Under the first head we may include heat and the action of light; under the second, chlorine, permanganate of potash, acid sulphate of soda, and numerous other chemicals.

Whichever method is employed, a preliminary straining process is necessary if the water be at all turbid. This is especially the case where chemicals which work by oxidation are used, or elaborate heat-exchange apparatus made use of.

Heat may be employed in the simplest form by merely boiling the water in a mess tin or kettle. Where each individual soldier does this for himself the process is not unduly prolonged, and cooling takes only a comparatively short period. When, however, it is attempted to boil water in bulk, in the absence of special apparatus, the procedure is of so lengthy a nature, and the time that elapses before even a minor degree of cooling is effected so extended, that the method loses a great deal of its utility. It may, in fact, be said that "the policy of the tea-kettle," as it has often been called, is sound as long as you limit yourself to the

tea-kettle. Once you advance to the cauldron stage it is practically out of the question. Special apparatus is required both for heating and cooling, and the almost universal practice at the present day is to utilise some form of what is called "heat-exchange" apparatus.

In this the heated water as it leaves the boiler passes on one side of a thin metal partition, on the other side of which the cold water passes on its way to the boiler. The heated water then loses much of its heat to the cold water, the temperatures of the two masses tending to approximate.

In this manner not only is cooling facilitated but fuel economised. There are many examples of heat exchange apparatus, all working on much the same lines. The Germans use a large travelling steriliser on wheels, weighing 48 cwt., with an output of 1,000 litres (over 200 galls.) per hour. They have also a small portable steriliser, adapted for man-carriage, weighing only 10 lbs., and the Kade steriliser, intended for Colonial warfare, weighing 50 lbs. and giving about 200 pints an hour. The French have similar forms of apparatus, working on the same principle of heat exchange. In all these the water is raised up to boiling point; in the large German apparatus as high indeed as 110° C. By these means complete sterilisation is effected. As a matter of fact, complete sterilization is a work of supererogation. There is no object in heating the water one degree higher than the temperature necessary to kill the ordinary disease-producing organisms, that is the micro-organisms which cause enteric fever, cholera, and dysentery. It has been proved experimentally that these germs die after a momentary exposure to a temperature of 80° C, and, as a corollary, it is not necessary to heat the water to a greater extent than this. This system has been adopted in our army, with the Griffith's steriliser. (For a detailed description of this apparatus, see "Army Medical Corps Training," pp. 158 and 159.) In this the water passes into a boiler the exit from which is controlled by a small valve. This valve is operated by a capsule containing a certain mixture which boils at 80° C. When this temperature is attained, the capsule expands and the water is allowed to pass through to the cooler. If at any time the temperature should fall below 80° the capsule collapses and the valve is again closed. This apparatus is made in two sizes, the larger of which can give an output of 200 gallons per hour of water at a temperature but little higher than that of the ingoing water, and sterile as regards all disease-producing organism. A considerable saving in fuel is effected, by doing away with the extra 20° of heat. The disadvantage of all heat systems of sterilisation is the need for fuel, and the fact that, except where good roads are plentiful, it is impossible to set them working before the arrival in camp. They are not in their present shape utilizable for troops continually on the march, since they can only begin work after arrival in camp. This applies, of course, particularly to warfare in savage countries. The fuel also adds to the transport. The *rôle* of these machines is certainly at the base and the

different posts on the lines of communications. On the other hand, the filter cart is suitable for troops where good roads are available, and can be modified for mule or coolie transport under less favourable conditions.

Quite lately the ultra-violet rays of the spectrum have been utilised for the purpose of sterilizing water. The method is undoubtedly efficacious. It demands a source of electric power, and an expensive and somewhat fragile lamp. As in other cases, the water must be clarified first. I have not seen a portable form, but I believe this exists, or has at least been suggested, in the German Army. The efficacy of this method, its rapidity of output, and the small amount of supervision required, combine to give it great value, especially under certain circumstances, such as in standing camps, general hospitals, etc. This method possesses in addition the great recommendation that it in no way alters the composition or taste of the water. A full description of the Westinghouse Steriliser, working on this principle, may be found in the *Journal of the Royal Army Medical Corps*, for February, 1911.

Various chemicals have been used for the purpose of sterilising water. Amongst these may be mentioned permanganate of potash, sulphate of soda, and the haloids (chlorine, bromine, and iodine), evolved from salts of these elements.

Permanganate of potash has been widely used in India. In the absence of any other oxidizable matter it appears to have a certain inhibitory effect on the growth of bacteria. It cannot be relied on, however, except in quantities which render the water unpleasant to the sight and taste. Acid sulphate of soda, in a strength of 15 grs. to the pint, can be relied on to kill the ordinary disease producing organism. It is obvious, however, that if a man drinks at all freely of such water, he at the same time ingests a distinctly large amount of a possibly injurious drug. Such a dose might be tolerated for a few days, but prolonged use would undoubtedly result in digestive disturbance.

Chlorine is, as a rule, evolved from bleaching powder, bromine from tablets of the bromide of potash, and iodine from the iodide and iodate of soda by the action of tartaric acid.

In all cases some means of reabsorption of the free chlorine, bromine, or iodine, is necessary before the water can be considered fit for consumption. Thus, for instance, in the case of iodine (Vaillard's process), two tablets, one containing iodide of potash and iodate of soda, and the other tartaric acid, are added to the water. Free iodine is thus evolved, and after ten minutes have elapsed a tablet of hypo-sulphite of soda is added to absorb the iodine. The complication of this process is sufficient to condemn it for general use. The ordinary soldier cannot be expected to remember the exact order in which the tablets are to be added, nor if he is very thirsty is he likely to be meticulously observant of the length of time he allows for the evolution and action of the iodine. On a large

scale this objection disappears, but in this case an even greater difficulty arises, and that is the question of mixing. If you wish to sterilise water by means of a chemical, then you must be able to guarantee that every bacillus in that water shall come into contact with a poisonous dose of that chemical. In other words, the chemical must be completely diffused throughout the water. On a small scale, *e.g.*, in a water bottle, this can be guaranteed by vigorous shaking, but on a large scale it is difficult, if not impossible, without mechanical appliances. And if these appliances are available, then probably some other method, free from the reproach applicable to all chemical methods, namely, that of "drugging the water," would be feasible. Chemicals, then, are not advisable for use on the large scale, nor on the small scale for the ordinary man in the ranks, nor for prolonged periods for any men. They are, however, of great use in the case of small parties of specially trained intelligent men, such as a small signalling party or a reconnoitring patrol, under the immediate supervision of an officer. Under such circumstances, which in the nature of things are not of long duration, the carelessness of the individual man is less likely to come in the way, or can, by supervision, be overcome. In my opinion the use of chemicals is severely limited to cases such as I have described.

I feel inclined to sum up on the whole question of purification as follows: For troops on the move, filter carts, or filters carried by pack or human transport. For stationary units and standing camps, either some form of heat or perhaps the ultra-violet rays. For small detached bodies of intelligent men for short periods, chemicals.

It is unnecessary to say much about storage and distribution. Under camp conditions the former is rarely practicable or necessary. At a post on the lines of communication it might be advisable to have a constant supply of purified water ready for issue to small detached parties passing through. Under such circumstances the measures adopted would depend on the local resources available.

Distribution in camp again is merely a matter of system. Men should be allowed to fill their water bottles at certain hours of the day only; cooks and officers' servants to draw their requirements at certain fixed hours. The most important point, however, which has already been alluded to, is to see that water which has undergone a laborious system of purification is issued for drinking purposes, and for these only. It is naturally impossible in a single lecture to cover all the details of a subject such as water supply, and I have, therefore, not attempted to do more than roughly sketch the outlines of the question.

The keynote of a good water supply is system. Without system in collection and distribution, the most elaborate mechanical schemes of purification will be inefficacious.

Camp conservancy. Danger of flies. Different methods of disposing of excreta and rubbish. Difficulties in billets.

THE subject which I wish to attack this evening is that of Conservancy, namely, the disposal of the waste products of human existence; in other words, of excreta and rubbish. The chief differences that exist in this connection between civil practice and military practice in war are, firstly, as I pointed out in my last lecture, that the responsibility for the efficient carrying out of any schemes that may be laid down lies now with the individual soldier and his officers, and no longer with any public body; and secondly, that the great question of removal, which in civil life affects so importantly the question of disposal, does not arise in camp life. There can be no question of removal to a distance; disposal must be carried out in the immediate vicinity of the living place of the troops. As a corollary disposal must be immediate. It cannot be deferred for a single instant since, with regard to fæcal matter and urine, every second of time that these remain undisposed of means an opportunity for potentially infective matter to get abroad from the latrine or urinal, and thus to the food or water supplies of the men; whilst as regards rubbish, any accumulation means an encouragement for flies to breed, and it is to flies, principally, in my opinion, that the transfer of infected matter from the latrines to the kitchens and tents of the men is effected.

To take fæcal matter and urine first. There is ultimately only one method by which these can be disposed of, and that is oxidation. This can be achieved either slowly by the action of nitrifying organisms in the earth, or rapidly by fire. Fire has the great advantage that it not only oxidizes with great rapidity all putrescible matter, but also that in doing so it destroys any disease germs that may be present. It has the disadvantage of needing apparatus and fuel, and also of demanding a separate establishment and a good deal of supervision; in addition, if carelessly carried out, it may cause a great nuisance. Burial has the advantage that it can be carried out by each individual for himself, that is immediately, that it demands no special apparatus, and can therefore be carried out anywhere, and at any time; and lastly, that, with the minimum of supervision, it can be carried out without any nuisance. It has the disadvantage that it does not with any certainty destroy the bacteria of intestinal disease. I cannot here enter into the much debated question of the viability of *B. typhosus* in earth; various periods are given by various authorities. In any case it survives for a certain length of time, its destruction is not immediate, and therefore, if we use burial, we must accept the fact that we are retaining, for a longer or shorter period, potentially infected matter in the vicinity of the camp. It may be

accepted, however, that as long as this matter stays buried, it is impossible for it to do any harm. Bacteria are not endowed with any automatic mobility, and can only traverse any distance, such as ordinarily separates the latrines and urinals from the rest of the camp, if provided with some means of transport. These means of transport are three. First, the persons of the men themselves (this, of course, applies to every form of latrine, and is not peculiar to the burial or earth latrine system); second, loose latrine paper; and, third, flies. These last two are the especial dangers of earth latrines, and the proper management of these installations consists chiefly in preventing dissemination of filth particles by their agency. The means adopted are two. The first (without which no other can be considered efficient) is immediate burial; and by immediate burial I mean immediate. The man must bury his own excreta, and at once. Not in a quarter of an hour, or five minutes, or even one minute, but at once, directly they have left his body. This is the cardinal principle of all camp sanitation, without the observance of which there can in fact be no sanitation in the proper sense of the term. I do not care what other system of disposal you use under certain conditions, which may perhaps offer peculiar facilities for more elaborate methods of procedure, there will always be occasions in war when earth burial, and that alone, will be possible (whilst actually on the march, for instance) and for that reason, if for no other, I consider the constant drilling of the men in the details of this particular system absolutely necessary.

There are two patterns of latrine generally used for this purpose, which we may call the long trench and the short trench respectively. In the former, which is the old pattern, in general use up to within the past few years, a trench was dug 4 ft. deep, 3 ft. broad at the top, 2 ft. broad at the bottom, and 5 yds. long for every hundred men. This is a bad pattern; it inevitably becomes fouled by fæcal matter and urine, at the edges and the sides, and it is difficult to ensure the complete covering up by earth of the fæcal matter in the trench. This pattern should, in fact, never be used.

In the short trench system a number of trenches are dug, each 3 ft. long by 2 ft. deep and 1 ft. broad. This is the ordinary rule, but I am indebted to Major Caldwell Smith, of the 2nd London Sanitary Company, for the very useful suggestion that the trenches should be broader at the bottom than the top, say 1 ft. 3 in. at the bottom. As can be seen at once, this protects the sides of the trench from fouling. I am indebted to the same officer for the suggestion that the upper edge of the trench should be, as it were, rebated, leaving a ledge about 6 in. broad and 4 in. deep on each side of the trench; this not only prevents the soil at the edge from crumbling in, but gives a certain purchase for the feet when the soldier is in the squatting position. The

essential point about these trenches is that they shall be used in this position, as by so doing all fouling of the back, front, or sides of the trench is prevented. The earth taken from the trench should be heaped up either in front of or behind the trench, on no condition at the sides, and will then be available for covering over the fæcal matter. In a stiff soil the earth must as far as possible be broken up, or if necessary some drier, more friable soil brought from some little distance. It is rare that even in the stiffest soils the upper three or four inches are not friable. Close

LATRINES.

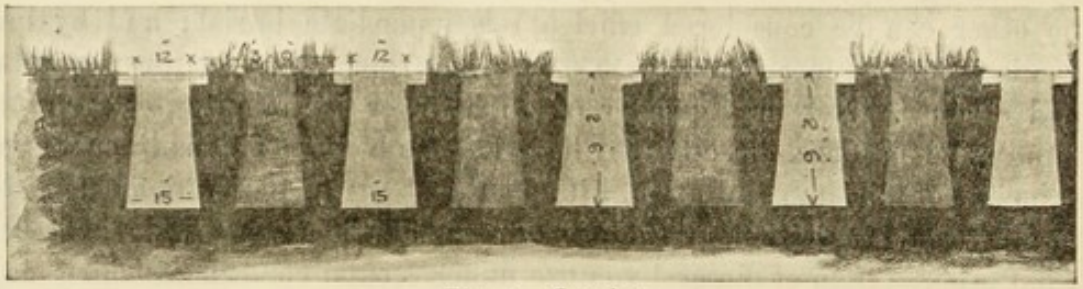


Fig. 1.—Section.

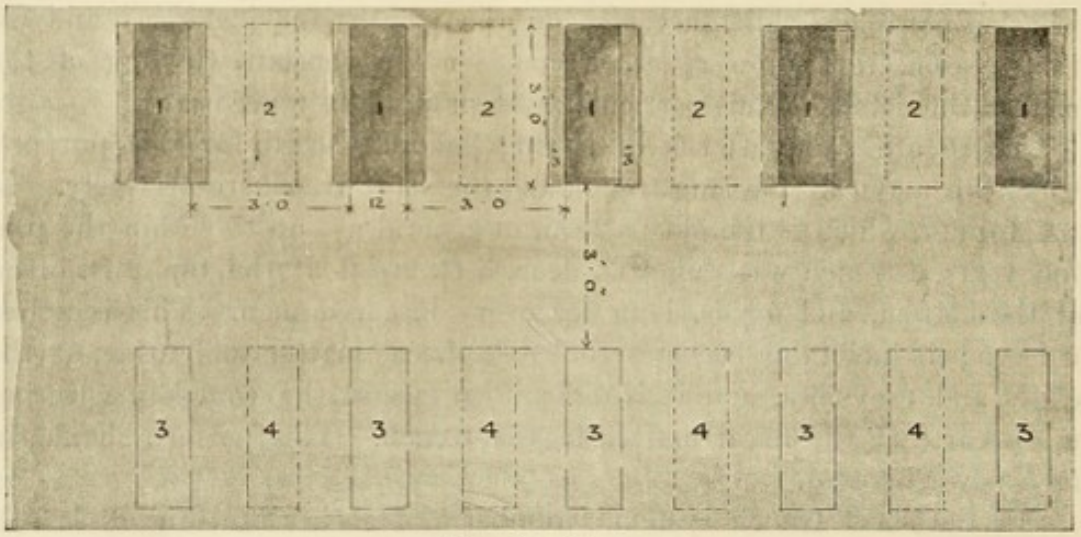


Fig. 2.—Plan.

to this heap of earth must be placed the sod, removed when the pit was dug, which must be carefully replaced when the trench is filled. In the case where latrines have been dug on arable land this may be impossible. In such a case the earth must be well stamped down and levelled.

The distance between trenches is of importance. This should be either 3 or 2½ ft. Personally, I am in favour of the former measurement, which is that most generally allowed. The only objection to this space is the total amount of ground taken up by the latrines. The usual rule is to

allow one trench for every 20 men, that is, of course, 5 per cent. of strength. For small numbers this allowance may be necessary, but for any number over 200 it is excessive. Some graduated scale might be fixed. Major Caldwell Smith has very sensibly suggested that the Factory and Workshop standard, as laid down by the Home Office, might be followed. This would give, if the force were less than 500, say a cavalry regiment, or a half battalion or battery, 4 trenches for the first hundred men, and 1 for every additional 40 men, or odd number less than 40. This works out at 7 for 200, 9 for 300, 12 for 400, and 14 for 500. For a cavalry regiment with a strength of 526 men 15 might be allowed. Captain Tilbury Brown, who has paid considerable attention to this question, suggests 3 per cent. for 500 and over. For larger units, that is for infantry battalions, the Workshop and Factory rules would allow 1 seat for 60 men or any odd number less than 60. That is for a battalion, 17 trenches. Personally, I should regard this as rather low, and would prefer a 3 per cent. allowance between 500 and 750, and a $2\frac{1}{2}$ per cent. allowance above the latter figure. The difficulty about a high allowance is the restricted area available in camp for digging trenches in. The rule is to place these at the rear of the camp, and they cannot of course extend beyond the lateral borders of the camp. In an infantry battalion this allows only 65 yds. If we calculate 4 ft. for each trench, viz., 1 for the trench itself and 3 for the interval, that amounts to 200 ft., almost 67 yds., for the fifty trenches allowed on a 5 per cent. basis. With a $2\frac{1}{2}$ ft. interval between trenches one could, it is true, fit the whole fifty in, but naturally there is no object in digging more than are absolutely required. With smaller units, especially those which are mounted, the same difficulty does not arise, owing to the larger camp frontage available. Thus for instance in the case of a cavalry regiment 526 strong, the frontage is 161 yds., and for a battery 200 strong, 75 yds., but here again labour is scarcer than in an infantry battalion, so that on that account it is necessary to limit the number of trenches to the lowest limit possible. I have given the depth of trenches at 2 ft., and this is the usual practice. With such a depth, and good management, one set of trenches can be used for as many as four days. If trenches are needed for one night only, 1 ft. in depth is sufficient. Personally, I should prefer using each trench for one night only, but as I have already said, with good management they can if necessary be used for four days. The question here again is one of space available.

The following instructions, modified from a paper by Captain Tilbury Brown, which appeared in the *Journal of the Royal Army Medical Corps* in July, 1909, are worth notice, in reference to the laying out of a latrine area. Taking the right rear corner of the camp area as a base, fix a tent-peg 3 feet in front of this, and draw a line from it parallel

to the base line of the camp. Measure off, first, 1½ feet along this second base line, and, after that, alternate spaces of 1 foot and 3 feet, till the full number of trenches minus one has been marked out. Beyond this mark measure off 1 foot for the last trench, and then 3½ feet beyond that again, place a peg to show the furthest lateral extension of the latrine area. This will give you 3 feet between trenches, with a margin of 1½ feet to the right of the first trench, and of 3 feet 6 inches to the left of the left trench. The trenches can then be dug and the screen placed round the latrine area, the two pegs already mentioned fixing the lateral limits of this screen. The screen should be 3 feet clear of the back of the line of the trenches and at least 6 feet clear in front of them, the total depth of the screened area being thus 10 feet. At the conclusion of the period through which you intend the latrine to continue in use, whether that be one day or four, dig a second row of trenches in the intervals of the first row. The right trench of this new row will be between the first and second trenches of the first row, and the left trench 1 foot to the left of the left trench of the first row. At the end of the second period these trenches must be closed up, and a fresh row dug 1 foot in front (that is, nearer the camp) than the first two rows, corresponding in position exactly with the trenches first dug. It is not necessary to shift the screen, since there will still be 2 feet clear in front of the new rows of trenches, but it can be done if wished, and, for reasons given later, should generally be done. The length of time you can afford to use these various rows of trenches will obviously depend on the space available. Each pair of rows takes up 4 feet in depth, and, in addition, you have 3 feet behind the original row of trenches. Thus in two days if you dig daily trenches, or in eight if you use each trench for four days, you will have used up 7 feet in depth; and in four or sixteen, as the case may be, you use up 11 feet. If you adhere to the plan of daily trenches, in a fortnight you will have used up 55 feet in depth, say 18½ yards. As a general rule the trench system should not be used in camps which it is intended shall be occupied for more than a fortnight. In such cases some pail system of removal should be instituted, and proper wooden latrines erected. I will return to this later.

There are one or two minor points concerned with the working of trench latrines which I must touch upon. In digging new sets of trenches you must always come nearer to camp, not go further away. Men will not in that case have to tread on dirty ground on their way back to their tents. Trowels or scoops should be provided in the same proportion as trenches are dug, if possible. If this proportion cannot be observed for any reason, then half that number must be furnished. If trowels are not supplied, there will be more difficulty experienced in making the men

observe the rule that all excreta should be covered up immediately after being passed. Paper should be provided, and kept in small bags or boxes, fastened to the screens. In addition to the large screen, running round the entire latrine, it is advisable, when possible, to supply smaller screens to run between the individual trenches. It is not necessary to have these at the back of the trench as well if the large screen is always kept well up to the rear of the line of trenches. When troops are on the move, starting at an early hour every day, and some carelessness is apt to occur, I should like to see the surface of the filled-up trench line scorched with fire, to destroy any possibly infectious matter that may have escaped burial. A little straw and some paraffin oil will effect this satisfactorily. One of the greatest dangers of camp life is due to neglect of troops leaving camp early in the morning, especially when the ground has to be occupied by other bodies of men immediately after. Of course, where there is heather or gorse close at hand, great care must be taken to see that the fire does not spread to a dangerous extent, further that is than is absolutely necessary. A thorough burning of the soil is not wanted, merely a short but severe scorching. Officers' latrines should be dug in the same way as men's latrines, and here again individual screening is very necessary. In no case should any form of seat or plank be allowed to be used by the men, they are not only unnecessary, but inevitably lead to fouling. If the ground slopes, a catch-water drain should always be dug on the up hill side of the latrine, and another between the latrine and the camp if the latter be down hill from the former.

Whenever a camp is to be occupied as a permanency then some form of pail or bucket latrine should certainly be erected. The buckets rest on a concrete platform and are well boxed in, in front, and provided with a hinged lid. This lid should be so constructed that it will close automatically as soon as the seat is vacated, with the object of keeping out flies. A double row of seats should be allowed, and the roofs sloped so as to drain on to the concrete platform which is guttered to carry away any washings or leakage. It can be swilled or scrubbed down if necessary; in this case some arrangement should be made for disposing of the washings by means of under drainage. A box is provided for dry earth, and one scoop or trowel for each seat should also be issued. Each seat is in a separate stall, but it is not necessary to provide these with doors, and in no case should full doors covering the entire doorway be provided; a door covering the middle third is amply sufficient. A urinal can be placed under the same roof as one of the rows of seats. This is, of course, not essential, but still very convenient. The disposal of urine in such cases is a matter of very great difficulty. A wheeled tank should, if possible, be provided into which the trough

can drain; the trough may be made of any impervious material, and will be much less likely to become offensive if frequently treated with some mineral oil; this prevents the deposit of urinary salts, and also discourages the presence of flies. It is necessary in all permanent latrines to take very strong measures against flies. In a permanently occupied camp it is extremely difficult to prevent a considerable collection of these insects, but it is possible to prevent their haunting the latrines and urinals, and this must always be done. The principle on which I act is to make the latrines and urinals reek with some smell which is obnoxious to flies. Spraying or swabbing with crude carbolic solution, with frequent scrubbing of seats and tarring of the under surface of these, are good measures. I do not advocate the placing of disinfectant solutions in the buckets, as that interferes with the proper disposal of the contents by burial afterwards. Nor indeed is such a measure necessary. It is, in fact, not a matter of any importance how the flies are to be kept out of the latrines. I always teach young officers that if they can do so by standing at the door of the latrine with a butterfly net they are welcome to do it in that way; the method is nothing, the principle is the important point. I should, if inspecting a camp, judge of the efficiency of the sanitation very largely by the presence or absence of flies in the latrines and urinals.

I enter a caveat here as to the use of dangerous disinfectants in latrines. I lay down, as a rule, that no disinfectant should be utilised under circumstances which, as is necessarily the case in latrines, leave its employment in the hands of comparatively uneducated men, which can either accidentally or maliciously be used as a poison. I recollect a case where a 1 per cent. solution of corrosive sublimate in glycerine was mistaken for castor oil, and one ounce of this concentrated mixture swallowed. Any disinfectant used for latrines should have an odour and an appearance so distinctive and so unpleasant that no accident can occur.

I have already said that excreta in camp can be disposed of by incineration, and this method is in fact very much practised in America. The one most commonly used is the McCall Incinerator. This consists of two combustion chambers at right angles to each other with a common flue or chimney. Each chamber consists of two parts. The lower is of brickwork and is built up in a pit 24 in. deep, of which the bricks form the walls. Above the brickwork is a steel box containing two incinerator pans in which the fæcal matter is received. Above this again comes a removable wooden seat. When it is desired to incinerate the contents of the pans, the wooden seat is removed and the two incinerator pans closed by two hinged iron lids, which when the latrine is in use are raised up and rest against the sides of the wooden seat. The incinerator pans communicate with the common flue and chimney, and in this flue a

grate is placed. In this grate a coke fire is lighted, and after this has been thoroughly started a wood fire is lit in the brickwork chamber underneath the incinerator pans. The coke fire in the grate acts as a secondary combustion chamber for the destruction of unpleasant fumes. Urinals are constructed in connection with these incinerators, and after the combustion is complete, and the fæcal matter destroyed, the urine is run into the hot pans, slowly, and thus evaporated. Though primarily intended for use in standing camps, a portable form has been made in which the brickwork chamber is replaced by a sheet steel firebox lined with asbestos. This weighs 1,800 lbs. for four seats, that is for 160 men at the outside, calculating for the proportion of one seat for 40 men. This adds a weight of 11 lbs. per man to the transport. Other forms of incinerator are the Jones, which is practically an extemporised form of McCall, and the Conley. These, like the McCall, are worked on the intermittent plan, that is the fire is only lighted at intervals. In the Lewis and Kitchen pattern a fire is constantly kept burning and the excreta are from time to time raked into the fire and burned there. An arrangement also exists for the destruction of urine. According to Colonel Havard, of the United States Medical Corps (to whose excellent book on Military Hygiene I am largely indebted for the above descriptions), this incinerator requires unceasing attention to prevent the fire going out or else becoming so brisk as to render the seats uncomfortably hot. The intermittent pattern of incinerator has the disadvantage that the excreta are kept in the vicinity of camp for some hours and may thereby attract flies. This can be obviated by the use of deodorants. Incinerators have not been received with much favour in this country, but in America they are thought highly of. The possibility of their use in large standing camps should be remembered, as it is easy to understand conditions under which other methods of disposal of excreta might be difficult or impossible.

In the November number of the *Journal of the Royal Army Medical Corps* there is an interesting account of a pattern of incinerator used in the 101st Grenadiers, one of the old Bombay regiments, of the Indian Army. This aims at providing a portable incinerator, and as it seems extremely practical I describe it in some detail. Iron pans of $\frac{1}{8}$-inch sheet iron, and intended for the reception of excreta, are provided on a 5 per cent. basis. These are made of various sizes so that they can be packed in nests of six, the dimensions of the outside member of a nest being 1 ft. 2 in. by 5 in. broad and 9 in. deep. Two nests are packed into a large iron box (with a lid) which serves afterwards as a general receptacle. Of these last there are four, containing 48 pans, for a battalion 832 strong. In the inside member of a nest a tin of kerosine (paraffin) oil is packed. The actual destructor or incinerator consists of a truncated pyramid, of which the four sides are hinged to each other, in such a manner that the

whole can be folded flat. The material used is $\frac{1}{8}$-inch sheet iron. The dimensions of the destructor when complete are two feet in height, two feet square at base, and one and a-half feet square at top. There are two rows of square apertures in each face of the pyramid, for ventilation, the total number being 16. This piece of apparatus is placed over a shallow hole in the ground in which a fire is lit. In practice the various pans are placed in holes dug in the ground made accurately to receive them, any interstices being luted with mud. Immediately after use the native sweeper passes one of the pans through a mixture of water and kerosene oil contained in the metal boxes already alluded to as carrying the nests, the faeces being retained in this receptacle. When it is decided to burn the excreta this receptacle is placed inside the incinerator and burnt. It is not quite clear to me how the details are managed, whether the water is poured into a hole in the ground or not, and there are other minor points on which I am still in doubt. Still, the principles on which the apparatus is worked seem sound, and I would suggest that one of the sanitary companies at its next camp might make experiments with some pattern of this nature. Indian regiments benefit much by possessing a regular establishment of sweepers who are by caste and training accustomed to dealing with excreta. The total weight is, it is true, considerable. About 453 lbs., or three mule loads for a battalion 832 strong, rather over $\frac{1}{2}$ lb. per man. It is not stated in the paper, written by Colonel Bethuen, of the 101st Grenadiers, if the system works without nuisance, but he evidently has a great opinion, founded on experience, of the efficacy of its working.

I have spent a considerable time on this question of latrines and the disposal of solid excreta, since I consider that the proper solution of this problem is the keystone of all disease prevention in the field. I will return to a consideration of this point in discussing the prevention of dysentery and enteric fever.

We now pass to the consideration of the disposal of urine by day and by night, for each of which a separate system, and a separate series of structures is demanded.

To begin with disposal by day. The best form of urinal that I know is that described by Captain Tilbury Brown in the *Journal of the Royal Army Medical Corps* for June, 1909. This consists of a pit about 4 ft. square, which is refilled loosely with the earth dug out, or with stones. Into this pit run two trenches each 12 ft. long and 2 ft. wide, with a gradient of 1 in. for each foot of run. The depth at starting should be sufficient to give a distinct beginning to the trench. Twenty-four running feet of trench are enough for a battalion. The earth dug out of the trenches should be thrown to the outside and heaped there, the trenches being themselves lined with small stones. The pit should be guarded with a screen, hedge, or wall, so as to prevent men urinating direct into it.

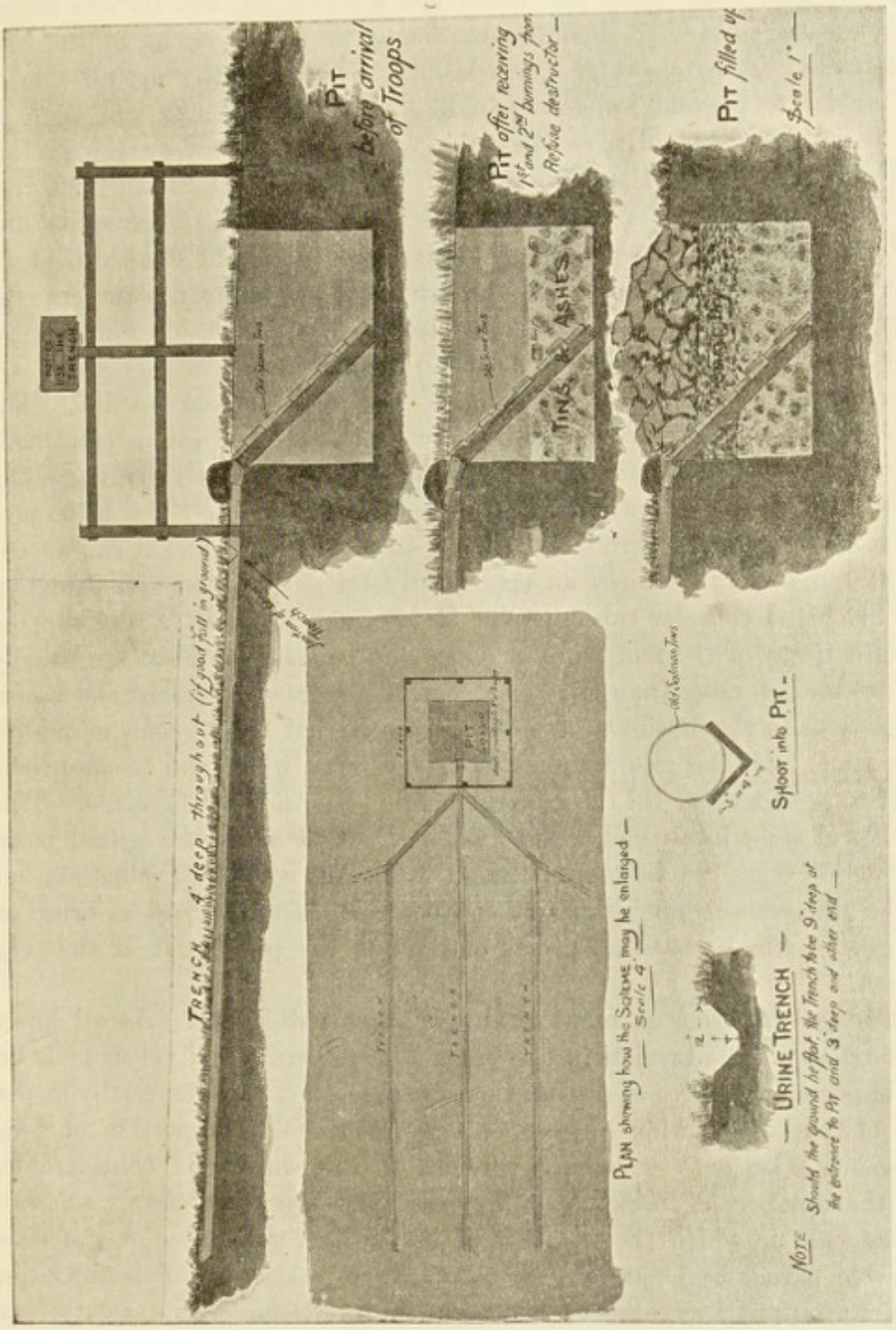


Fig. 3.—URINALS. Material: Picks, shovels, a few old tins, two pieces of board, hammer, and nails.

The trenches may be used for two days, but there is no regular rule. As soon as they show signs of becoming offensive they must be filled in and new ones dug. One pit should last a fortnight, and for any longer period some permanent installation should be arranged, as in the case of latrines. A catch-water drain should be dug on the up-hill side of the urinal to prevent swamping in heavy rain. In heavy soil there is apt to be some difficulty, as the urine will simply collect on the surface of the filled-in pit. I am indebted to Major Caldwell Smith for a very ingenious suggestion for use in this case. The pit and trenches are dug as before, and the latter is filled at first, and to about one-third of its depth, with old tins and burnt rubbish from the camp destructor; the neighbourhood of any works where clinkers were procurable would naturally be of great assistance. On the top of this lumps of dry earth are placed, and on the top of these again dry earth broken up fine. The urine runs along the trench and is received at the end into a pipe made of empty cylindrical tins without tops or bottoms, which runs diagonally downwards to the bottom of the pit on the opposite side. The urine now has to filter upwards through the filling-in of the pit before it can appear at the top, and this affords an opportunity for evaporation and oxidation (see fig. 3). I consider this device of Major Caldwell Smith's, or I suppose I ought to say of the 2nd Sanitary Company (since great ideas are usually the product of more than one brain) one of the most ingenious and useful suggestions in the business of field sanitation that I have come across for some time. He has also designed a simpler form, which can be used for a small body of men or till the more elaborate structure can be made. This consists of a pit into which a steeply-sloped gutter runs, the actual point of junction being the bottom of the pit. The pit is filled in as before, but on the side where the gutter enters a board is placed, at least as broad as the gutter, which closes all access of fluid to the pit except at the very bottom.

Disposal of urine at night is always a great difficulty. As all know the tendency to be careless in this respect is universal, and yet urine is no less important a source of disease than fæcal matter, more especially in the case of that most serious disease, enteric fever. The proportion of convalescents who act as urinary carriers of this disease is considerable, and the numbers of bacilli that they discharge per diem simply colossal. In one case in which the numbers of bacilli were calculated over a considerable period by Captain Fawcus of the Royal Army Medical Corps, the daily output amounted on one occasion to 500 million in twenty-four hours. It is important, therefore, to provide special night urinals, since the day urinals will obviously be placed too far away for use in the dark. It is not very easy to do this satisfactorily. The usual method is to place tubs or buckets on mounds of earth of a suitable height,

with a lamp hung close by. This lamp is essential in standing camps. The difficulty lies in the fact that if the tub is large there is always a certain amount of difficulty in removing it without spilling, whilst if it is too small there is a danger of overflow. A large number of small easily portable buckets is more practical than a smaller number of comparatively large tubs. In carrying these it is worth while remembering that a few leaves of bracken or fern floated on the top of the urine will do a great deal towards preventing splashing. For troops on the move, broad, shallow pans should be dug at the ends of the rows of tents. In loose soil it will be sufficient if the turf is merely taken off or the surface turned over, but in heavier soil a cavity must be excavated.

Where night urine tubs are used, it is necessary to provide a pit into which they may be emptied. For this purpose a special pit may be dug, or the day urinal be utilised. I prefer the former plan, since it allows of the pits getting a rest, and the urine filtering or evaporating away.

Before leaving any camp ground the sites of all latrines and urinals should be clearly marked. I have a predilection for the use of fire for this purpose, wherever it can be done with safety. The mark is distinctive, and the scorching of the ground that results should completely destroy any casual infection that may have escaped burial, and also the larvæ of any flies that may have been deposited near the surface of the ground. Where gorse or heather are in the vicinity of the camp, naturally great care must be taken in the application of any such method.

The essential point about all sanitation, but more especially about this department of it, is to impress on every officer and soldier the necessity of realising his personal responsibility in the matter. I am quite aware that the details of camp sanitation may sometimes be extremely disgusting to those who have to carry them out, but this is chiefly due to neglect and delayed precautions. I have heard it said, though not, I admit, of late years, that to make the soldier attend to sanitation was to make a scavenger of him, and briefly that he enlisted to be a soldier and not a scavenger. Some of you may hear foolish people make the same remark now-a-days, and on that account I will give you two historical instances which bear strongly on this point.

My first instance is a quotation from the Life of Sir John Moore, and runs as follows: "The streets leading to the citadel being dirty, a battalion was ordered to cleanse them. It was represented that the men might object to this, but the order was peremptory, and obedience was insisted on. When the men assembled, and were told what to do, they in anger threw down their shovels and dispersed, saying that they were enlisted as soldiers, not as scavengers. This was passed over, but the battalion afterwards became very troublesome." The second instance is an extract from certain Standing Orders just 100 years old, and this runs

as follows: "In towns, necessaries must be dug in the yards of houses, or in the most convenient situations adjoining buildings occupied by troops. They must be covered over daily, and fresh ones made as often as expedient. Fatigue parties will be frequently employed in removing and covering over the filth, which, notwithstanding these regulations, may have so accumulated as to render parts of the town or ramparts offensive. And if the quarters of any particular corps are found to be dirty, some restraint or additional fatigue duties will be imposed on that regiment." The incident first related occurred in Corsica, when Sir John Moore served there during the Governorship of Sir Gilbert Elliott. The recalcitrant battalion was one of Corsican Infantry, which, if remembered at all, will be remembered only by the disgraceful act of disobedience just related. The Standing Orders from which I quoted are those (I give their full title) "given out and enforced by the late Major-General Crawfurd for the use of the Light Division." The Light Division in the Peninsular War was, I suppose, one of the very finest military organizations that have ever existed, and Major-General Crawfurd was a man who, when he gave orders, made no mistakes about their enforcement, so that you may be certain that the above orders were literally carried out. What was not beneath the dignity of the Light Division to do, is not beneath that of any man in any army, and the question as to whether it is better to be soldiers *and* scavengers with them, or soldiers and not scavengers as the Corsican Light Infantry were, is one the answer to which I feel certain few soldiers would hesitate in making.

Camp conservancy continued. Rubbish. Incinerators. Kitchen Slops. Ablution. Billets. Bivouacs. Battlefields.

THE subject I propose to consider is, firstly, the Disposal of Rubbish and Slops.

The practical importance of the removal of these, lies in the fact that if they are allowed to accumulate they inevitably lead to the breeding of flies, which, apart from their germ-bearing powers, are, if numerous, one of the greatest pests of camp life; disturbing especially those men who after night duty wish to get some sleep in the daytime.

Taking rubbish first, there is only one satisfactory method of disposal, and that is by fire. Rubbish may be divided into two classes. Firstly, tent sweepings and, secondly, kitchen refuse. With regard to the first, in a standing camp it is necessary to have some definite system for collection. Perhaps the best way is to have a bag or tin hung on a pole at the end of each line of tents. The orderly men of the tents then collect each the sweepings, paper, odd fragments of food, etc., from their respective tents and place them in the nearest receptacle. At a definite time each day, or, if possible, twice a day, the bags are all taken to the common destructor and there incinerated. As they are mostly of a dry nature their fuel value is considerable, decidedly greater than that of the heavier kitchen rubbish; and if possible they should be thrown into the destructor at the same time as this latter to facilitate its complete combustion. The kitchen rubbish must be collected in proper bins if these are available, if not, empty boxes or tins covered in some way must be utilised. Periodically these must be taken to the destructor and burnt there, and the golden rule is "sufficient unto the day is the rubbish thereof." No rubbish should remain overnight in or near a kitchen.

The next step is the construction of an incinerator. The best form is that shown in Fig. 4. This destructor is built of sods and is square. Some people prefer to build on a circular plan, or to use brick. The square shape is, however, the easiest to make, and sods are as durable as brick, if not more so, and cheaper. The sods should be 9 ins. broad and about 2 ins. thick. The walls, which should be about 4 ft. high, should be supported by stakes, which can usually be acquired from the fuel issue. The dimensions of two destructors which were built by the 2nd London Sanitary Company for instructional purposes were 2 ft. 6 in. square and 3 ft. 6 in. deep. Air should be admitted by holes left at the bottom of the walls, and these may be converted into long air ducts, by means of corned beef tins placed end to end, projecting, as will be seen from the diagrams, to a varying extent into the area of the destructor. It may be necessary, especially if the weather be damp, to use a certain amount of fuel with some paraffin oil to start

the fire, but subsequently with good management it should be possible to keep the destructor going by means of the rubbish and sweepings alone. Periodical stoking is of importance, as otherwise the fire may die out or may be choked by sudden overloading.

With such a destructor, unless rubbish is allowed to accumulate to an unmanageable extent, there should be no difficulty in disposing of all the rubbish for a battalion provided care in management is exercised.

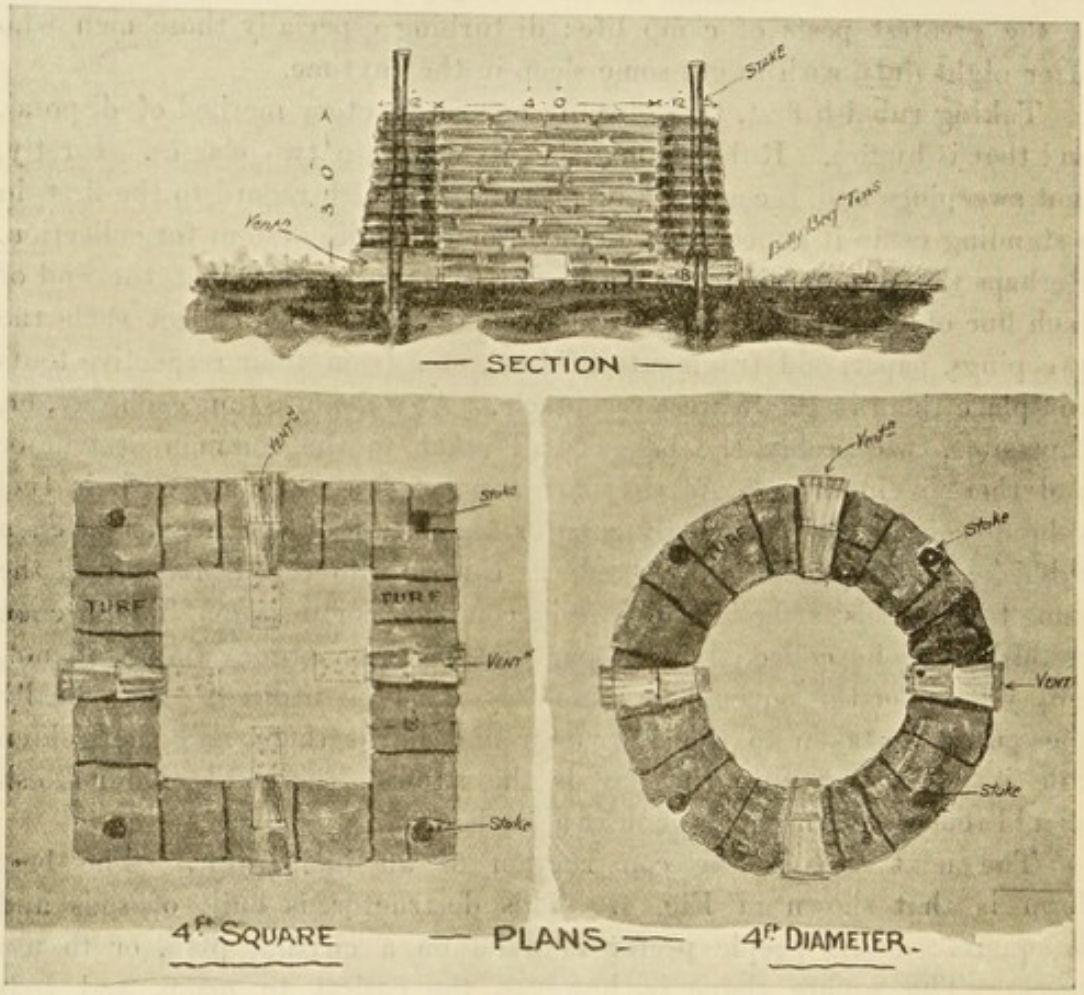


Fig. 4.—TURF REFUSE DESTRUCTOR.
Materials: Picks, shovels, bully-beef tins, and four stakes.

For purely temporary use, such as in a camp occupied for only one night, a semicircular wall may be made of earth and stones with the opening towards the wind; the rubbish is then heaped together inside this enclosure and burnt. The function of the wall is simply to allow of the rubbish being heaped up against it. Burial, of course, may also be resorted to in such temporary camps, and the choice of method, whether burial or burning, may be allowed to depend on the nature of the soil, the labour entailed in digging, the time available, etc.

Colonel Firth suggests a simple pattern of incinerator, in which two trenches are dug at right angles to each other about 9 ins. deep and 5 ft. long. A chimney is built over the intersection and a few pieces of railway iron or other material used to form a grate or grid at the bottom of the chimney.

The "Arnold" or "rock-pile" crematory has been much used in the United States. It is made in the following manner: A circular pit is dug measuring about 15 feet in diameter and 3 feet in depth. The whole of the floor of this pit is paved with loose large stones to a depth of 14 to 16 inches, and on this pavement is built a circular wall, which acts as a lining to the earth wall of the pit, and projects one foot above the level of the surface. Earth is heaped up against this wall on the outside to form a sort of ramp, which provides a sloping access and also prevents surface water entering the pit. In the centre of the pit a pyramid of stones about five feet high is constructed, which thus projects one foot above the level of the wall and two feet above the general surface. This last structure is essential to produce a draught. If the contour of the ground permit it is suggested as an improvement to construct the incinerator close to the edge of a sloping bank, so that an opening about two feet wide may be dug in the circular wall for the removal of ashes and the provision of increased draught. The incinerator is started by lighting a wood fire in it, which heats the stones forming the floor and wall to such an extent that any rubbish subsequently deposited is rapidly dried and burnt; fluid slops can also be disposed of in this crematory.

The choice of structure to be adopted must be largely a question of local circumstances. If a camp were amongst sand dunes near a shingle beach where good sods were not easily procurable, then the Arnold incinerator might with advantage be adopted. Where good sods are available I feel inclined to plump for the square sod built incinerator as already described, and as made by the 2nd London Sanitary Company. The structure is, however, almost the least important part of the question. The essential conditions for success are system and supervision. Without these no improvised incinerator can be expected to succeed. Every incinerator should be protected by a catch-water drain in case of heavy rainfall.

In situations where a more permanent installation is possible a destructor may be built on the lines shown in Fig. 5. This consists of an oblong furnace with chimney at one end, the whole being built of brick. The roof of the furnace is made of corrugated iron covered over with excavated material. The hearth is constructed of fire-bars made from corrugated iron cut into convenient strips. If possible two iron rods should run longitudinally along the furnace to support these bars, and in that case the strips should be cut across the corrugations.

This will facilitate removal of ashes. In the absence of this support, it will be advisable to cut the strips parallel to the corrugations. The actual dimensions of the furnace must depend on the size of the sheets

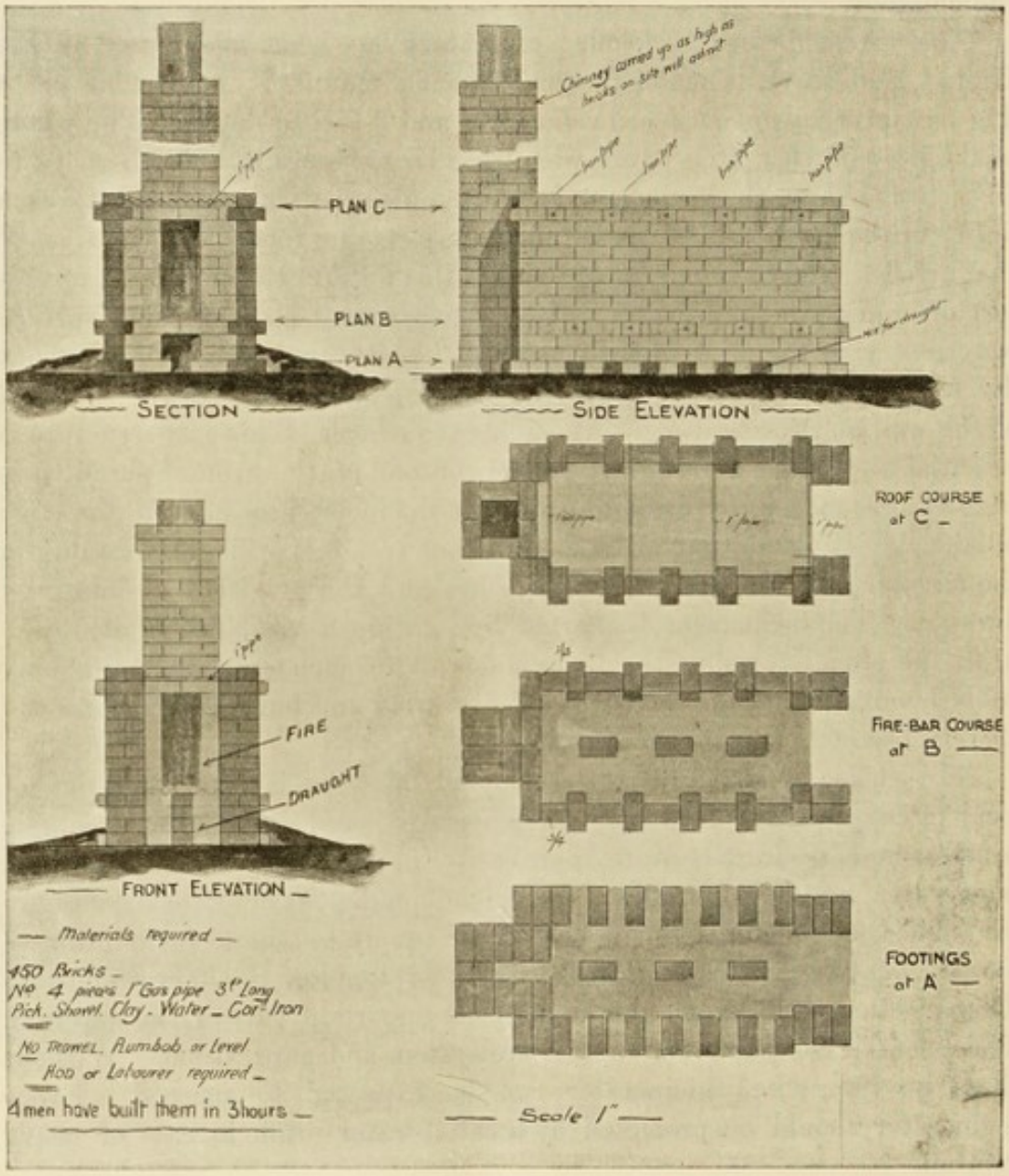


Fig. 5.—BRICK REFUSE DESTRUCTOR.

(Length and width according to corrugated sheets found on site.)

available locally, and the thickness of the walls on the supply of bricks. In the diagram the walls are only one brick thick, and in such a case it is advisable to heap earth against the walls for the purpose of support. A piece of corrugated iron may be used as half door to improve draught after the furnace has been filled and lighted.

The next point to be considered is the disposal of kitchen slops. These also must be disposed of on the spot, and the difficulty consists not so much in their bulk as in the grease present. The problem to be solved is the removal of this grease, after which, in ordinary soils, the cleared water can be disposed of by soaking pits or trenches. The

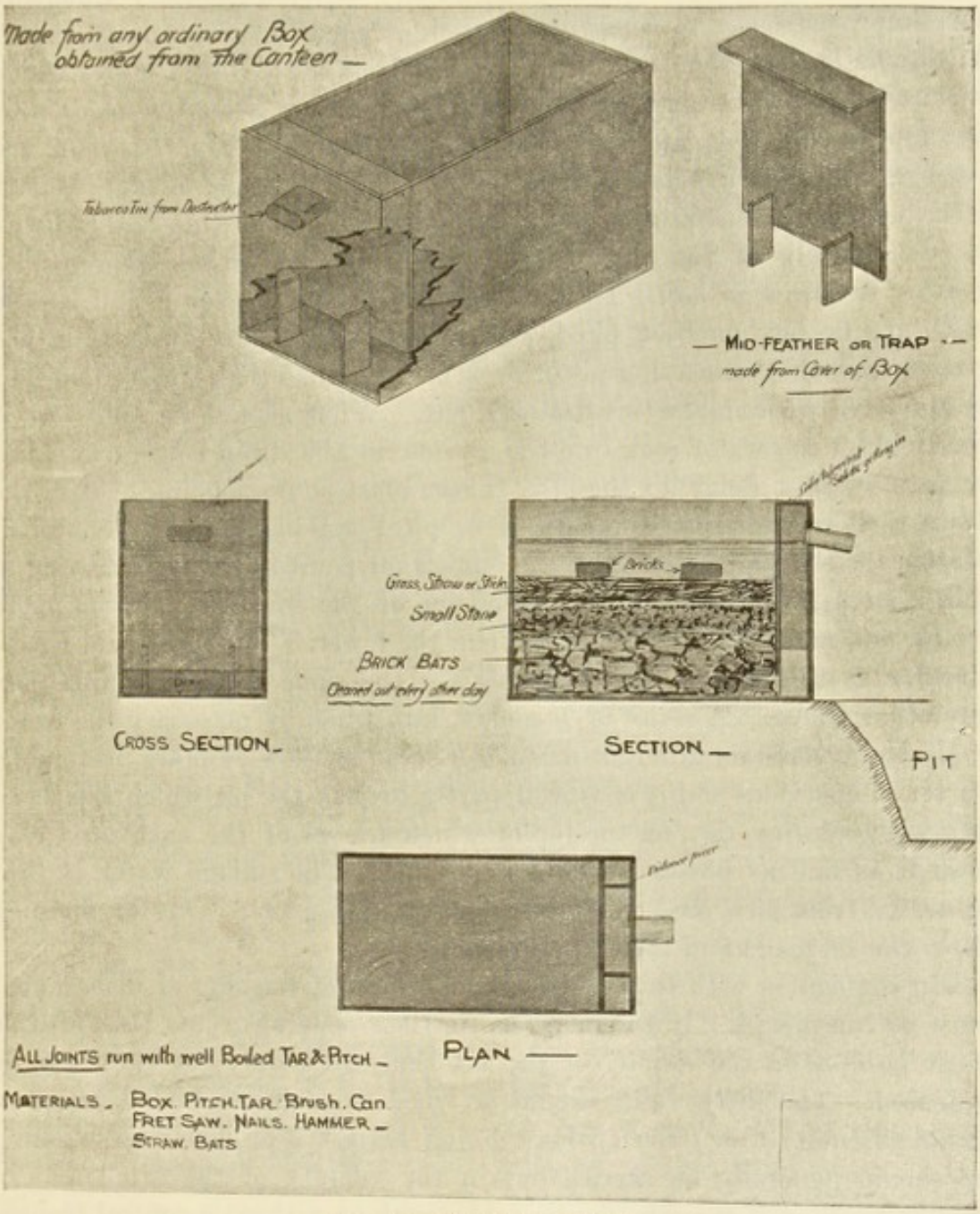


Fig. 6.—GREASE TRAP.

usual type consists of a rough strainer which removes the larger pieces of floating refuse, *e.g.*, potato peelings, &c., that may still remain in the slops, from which these pass into the grease trap. This trap consists usually of a hollow in the ground, or of a tin in which heather, straw, grass or leaves

are placed. The grease congeals on these and the purified water then runs into shallow pans or pits and is absorbed. The greasy heather, or whatever material may have been used in the grease trap, is then burnt, together with the potato peelings, &c., which may have remained in the first strainer. This method has the defect of being somewhat complicated, there being two receptacles to clear out. The 2nd London Sanitary Company have improved on it by constructing their strainer and grease trap in one. A suitable box is taken and filled at the bottom with stones, above which is placed the grease-retaining material. An overflow should be made near the top of the box, and an outlet at the bottom (Fig. 6). In the absence of a box, a small sod enclosure could be made similar to that described for the destructor, and it might be possible in this case to use it as such, merely at the end of the day burning the grease-impregnated heather or straw *in situ*. In the absence of stones the lower half of the enclosure or box may be filled with empty tins. The drain from the grease trap to the soaking pit or area may be lined with small stones, or even floored with empty tins flattened out. What should be aimed at is either to let the water soak into the ground in the drain bottom at once, or pass without delay to the pit. There must be no ponding of it in the drain. As regards the soakage area or pit I am indebted to Mr. A. J. Martin for the suggestion that the important point in the construction of this is area not depth, the upper layers of the soil being always more friable and more readily permeable than the lower. The pit should not be circular as this entails more digging for the same superficial area than any other shape. A series of trenches, into which if necessary the water could be diverted on different days, or a broad shallow pan, are preferable. In very impervious soil it is as well partly to refill the pit which has been dug with old tins, &c., on the top of which a layer of the excavated clay broken as fine as possible should be placed. The sullage water is thus protected from flies, &c., till it has time to soak away. One or more of these can be made and their use alternated.

In connection with this subject the question of washing of dishes, etc., must be considered. If the men feed in their separate tents then all this must be done in the vicinity of the kitchen, where only hot water can be procured. The dirty water should be freed from grease, and disposed of as already described. Even where dining tents are provided the washing up should generally be carried out in the vicinity of the kitchen. In standing camps, if possible, trestle tables with or without a central trough, as described later, should be provided.

An important form of waste water is ablution water. If care be not taken the ground in the neighbourhood of the washing places may rapidly be converted into a disgusting swamp, especially in a clay soil, and the resulting mud carried into the tents. The first point to be considered is

the ablution bench. These should always be constructed in standing camps, and a good pattern is as follows: A trestle table is made, having a V-shaped gutter running down the centre. The men wash in their basins on the bench and then tip the water into the longitudinal gutter. Above this gutter, and projecting slightly into it, should be a plank running longitudinally along the table, which prevents any splashing of the men standing on one side of the bench when basins are emptied on the other. The place where the men stand should be paved either with concrete or loose stones well stamped in. The gutter discharges over a trench in the ground which runs to any convenient distance, and then spreads out into a series of short trenches arranged herring-bone fashion, or otherwise, as may be most convenient. The extent of soakage area required will of course depend very much on the nature of the soil, that is, whether it is readily pervious or not. Here again the water must either soak in rapidly or run away rapidly; the former may occur in loose soil, but, if the soil does not permit of this, then the gutters should be made as impervious as possible, and with a good gradient, to prevent formation of puddles. If a bench cannot be constructed, on account of want of material, or time, or from any other cause, then a canvas trough may be used, or, finally, the men may wash at the actual source from which the water is drawn. I need hardly mention that this must be below the places marked out for provision of drinking water, and for watering animals, if the source be a stream, and as far as possible distant from these, if the source be a pond or lake.

In hot weather it is well, if possible, to provide some sort of shower bath, where actual bathing is impossible. This, of course, demands a piped supply of water, and is only feasible in a camp occupied for a considerable time. The Americans provide five such, in addition to ten feet of washing trough, made of cast iron, per company. Every effort should be made to encourage daily washing of the feet, especially, of course, in the case of infantry soldiers. To enable a man to do this in any comfort, and without wetting his clothes, it is necessary to provide him with some sort of seat or bench to sit on while so occupied. It is difficult to lay down any scale for these; the more the better. With less than fifteen, or say even twenty, per cent., there must inevitably be delay in the process. In all standing camps, special structures should be erected to shelter the men whilst washing, or else marquees or other tents pitched. In cold weather, some arrangement for hot baths should be made. In or close to large towns, it should be possible to make some arrangements with the local authorities for the use of the public baths for this purpose. Near the sea, or where a large lake or river is available, bathing parades should be held in warm weather, not only for cleanliness, but also for instruction in swimming.

The disposal of the excrement of horses and other animals is always a troublesome question, on account of the bulk of material involved. It may, of course, be possible to dispose of this waste product to a contractor, who will be glad to take it for manure. If this be done, very stringent conditions as to regularity of removal should be laid down and enforced. Removal should take place at certain defined hours, and in case of delay beyond a fixed period of grace, the dung and litter should be burnt. Pending removal, these matters must be kept at a spot some distance from the camp, and, if possible, not in the direction of the prevailing wind. As a rule, mounted corps are very apt to be careless in this matter. This is, perhaps, natural with the men from whom a great number of our yeomen are drawn, the farmer class, since they are in the habit of seeing such accumulations of manure close to their dwellings. At the same time, such accumulation must not be allowed in camp, as it inevitably leads to the breeding of flies.

The question of the exact position which should be occupied by these various sanitary installations, latrines, urinals, etc., is of some importance. Fig. 7 shows a suggested arrangement, but it must be looked on merely as an illustration, and not as being in any way an officially recognised pattern. Immediately behind the last row of tents come the kitchen and regimental institutes. Near the kitchen area is a drying tent for clothes. The proximity of these to each other is simply due to the necessity of storing the fuel as much as possible in one place. On the opposite side you see the lavatory or ablution bench with its soak pit. If there were sufficient room outside the camp, the soakage pit should certainly be outside the camp area and not inside. Behind the ablution bench is an area marked drying ground. This is intended for the drying of soiled linen after washing, for which purpose the ablution bench is convenient. The bathing tent is not well placed; it should be nearer the kitchen, so that the men should be able to get hot water for baths. The grease pit should also be nearer the kitchen, as hot water would be needed for washing plates, and it should discharge outside the camp area if possible. In anything of the nature of a permanent camp it is unusual to crowd units together without a considerable margin between any two adjacent camps. The diagram here shown is distinctly overcrowded, but the dimensions have been calculated on the minimum allowance of space for a battalion.

Behind the area already described we come to the horse lines, where the regimental transport is picketed. Behind everything come the latrines and urinals, for day use. A separate urinal should be made for officers. Between the latrines for men and those for non-commissioned officers a separate urine pit is shown, into which it is intended that the night urine tubs should be emptied, the empty tubs or pails being stacked round this during the day. The incinerator is placed close to the latrines, but it is a

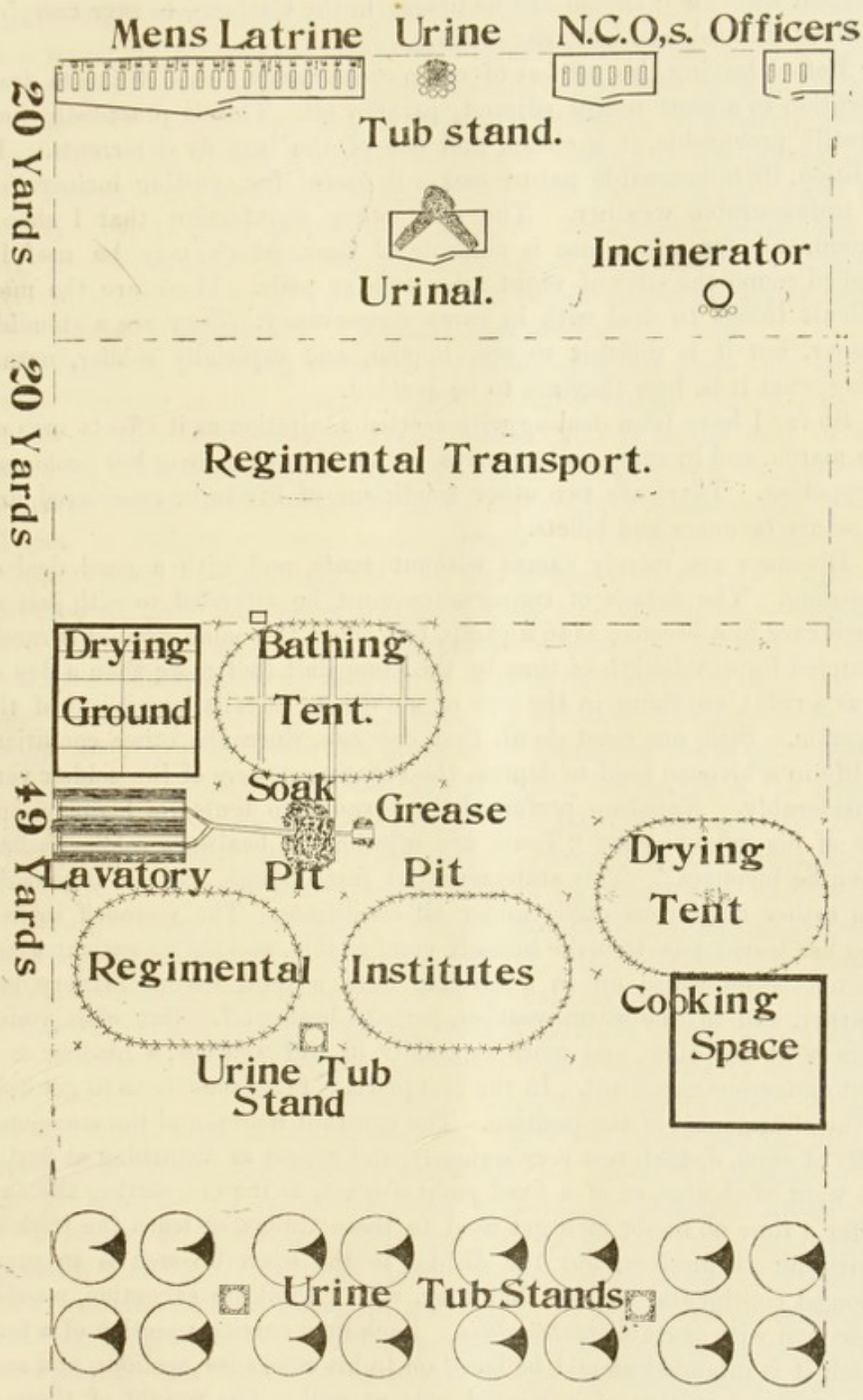


Fig. 7.—SANITARY ARRANGEMENTS FOR BATTALION CAMP.

question whether it should not be nearer to the kitchens, to save carrying about of rubbish and irregular stoking.

Before leaving this subject of camp conservancy I should like to draw attention to a most useful adjunct, paraffin oil. This is practically universally procurable, it is cheap, and one of the best fly deterrents. In addition, its inflammable nature makes it useful for assisting incineration in unfavourable weather. The only other disinfectant that I should recommend for camp use is chloride of lime, which may be usefully applied round the sites of night urine tubs or pails. These are the most difficult things to deal with in camp conservancy. They are a standing danger, but it is difficult to see, human, and especially soldier, nature being what it is, how they are to be avoided.

So far I have been dealing with service sanitation as it affects men on the march, and in camp under canvas, with a view to more or less prolonged occupation. There are two other conditions of life to be considered, and these are bivouacs and billets.

Bivouacs are merely camps without tents, and with a good deal of crowding. The details of conservancy must be attended to with just as much care in a bivouac as in a camp, but since the same ground is rarely occupied for any length of time by the same unit (not more than a day or so as a rule), anything in the way of ambitious installations is out of the question. Still, one must do all that one can, since the other conditions of life in a bivouac tend to depress the resisting powers of the soldier very considerably. Napoleon preferred the bivouac to tents for his men, and one of his maxims runs "Tents are injurious to health, a soldier is best when he bivouacs." This statement has just enough truth in it to make it a rather dangerous guide under all conditions. The seasoned soldier, who has learnt how to make himself comfortable, and rig up extemporized shelter, is no worse off in a bivouac than a tent, except in very bad weather, and in fine warm weather, perhaps better off. But with young soldiers at any time, and more especially in bad weather, a bivouac is a most dangerous expedient. In the first place, it takes some time to get used to the strangeness of the position. The constant noises, and the occasional puffs of wind, disturb rest very seriously, and almost as disturbing at first is the want of shelter, or of a fixed *point d'appui*, as it were, during the day. After a time no doubt men get used to these things, or learn the trick of sheltering themselves, but the dislike to the open bivouac is so great amongst continental nations that they, with I think no exception, provide their men with portable *tentes-abris*. Each man carries a section of a tent which it is intended should be laced on to his comrades' sections, and as a rule carries a section of a jointed pole as well. The weight of these is considerable, 3 to 4 lbs., and they have not been adopted by us in conse-

quence. The great armies of the Continent would hardly carry them if their leaders considered that tents were injurious to health, since the evils of tent life, if any there be, are most certainly in inverse ratio to the size of the tent. Tents need not be injurious to health if properly looked after. There is always a certain amount of fouling of the ground in a tent where sixteen men sleep, and therefore tents should be struck and the ground aired as often as possible. As a rule tents should be pitched on clean ground after a week, but this may entail shifting merely into the interval space to the right or left. Tent boards should always be issued for prolonged occupation or, if possible, huts erected.

Billeting is a method of housing soldiers that has gone into almost complete disuse in this country, but it is fairly certain that in case of serious operations it would be again resorted to. It is the duty of the Sanitary Officer to accompany the staff officer charged with the selection of billets, and to advise generally as to the sanitary conditions of towns, villages, or buildings about to be occupied. Billets are divided into ordinary billets and close billets. In the latter it is merely a case of crowding as many men under shelter of some kind or another as possible, leaving those who cannot get under cover to bivouac. In such a case, stables, cowsheds, anything with a roof to it in fact would be used, and no scale of accommodation can be given. In ordinary billets more or less definite scales are laid down, but much must depend on the length of time it is intended that the billets should be occupied, the nature of the houses available, etc. For one night's occupation the Field Service Pocket Book gives the following scale: In the case of rooms over 15 ft. but under 25 ft. wide, two men to every yard of length; for rooms over 25 ft. wide, three men to every yard of length. Room must be left for the inhabitants, but these will inevitably be severely crowded. Calculating for a longer period it is usual to base one's figures on the existing population. Thus in the case of "billets with subsistence," that is billets in which the owner of the house has to feed his lodgers, any given area is expected to be able to afford shelter to a force equal to twice the ordinary population. In the case of "billets without subsistence," *i.e.*, where the troops are fed by the Supply Department, the numbers vary from ten times the population in rich agricultural districts to five times in towns or industrial areas. It may be taken as fairly certain that in the last named localities, dealing especially with the Territorial Army, use would be made of factories which had closed down owing to the war, or of schools or other public buildings, in preference to splitting the units up into numerous small detachments; this would be of course purely on disciplinary grounds. In this case, in selecting buildings for occupation, those should be selected first which have been built with a view to habitation, or which already possess a certain amount of sanitary appliances. A church or concert hall which

possesses neither of the above qualifications should never be chosen. The amount of accommodation will depend on the weather and the space available. In no case need more than 600 cubic feet of space be given per man, that being the standard allowance for barracks in peace. For a prolonged occupation this should be aimed at. If less has to be given, then great care must be taken to ensure thorough airing of the rooms when unoccupied. It is an axiom in barrack ventilation that as long as the men are not occupying the room every door and window, as far as weather permits, should be open, for it is a matter of absolute certainty that they will all be "banged, barred, and bolted" against any entry of fresh air during the night. In towns of this class, in all probability there would be no difficulty in dealing with the removal of excreta, since there would be skilled labour available, and a regular system of water drainage, which could be extended or adapted to suit emergent needs. In the case of smaller villages, however, the removal and disposal of excreta and rubbish would constitute a decidedly difficult problem. In such a case the men would be scattered in small cottages, each provided probably with a single earth privy, of comparatively small dimensions. Probably the best method would be to build permanent latrines on the outskirts of the village, with a pail system of removal, and to arrange for burial at a short distance. The men should be forbidden to use the cottage privies except by night. Rubbish would have to be burnt in improvised destructors, and military authorities would be well advised to take over the disposal of the village rubbish as well. There might also be some difficulty with water supply in small villages, and measures would need to be taken to supplement local resources by carriage from a distance.

The chief preoccupation, however, of the sanitary officer in charge of a force occupying billets would be the occurrence of infectious diseases amongst the inhabitants. He should at once get into touch with the local practitioners, and also with local sanitary authorities, and get from them a statement showing the incidence of the chief infectious diseases during the past year. He should also keep in constant touch with these functionaries during the period of occupation, and arrange in some way that all notifications of infectious disease should be communicated to him by the local sanitary authority. The whole question of sanitation in billets is one of great difficulty, since our army is unaccustomed to the practice. The sanitary officer would need all his vigilance and all his energy if he would avoid the risk of the troops becoming a danger to the inhabitants, or, on the other hand, of the inhabitants communicating disease to the troops. Any building which is considered dangerous on account of infection, should be clearly indicated, and a sentry placed over it, in accordance with Field Service Regulations.

So far I have been considering the practice of sanitation amongst

troops on service, without any particular reference to contact with the enemy. The immediate vicinity of a hostile force, with the incessant vigilance and extra strain that it entails on the troops, must inevitably play havoc with any complicated schemes of sanitation. It is on such occasions that the benefit of previous training comes into play. An army, the individual officers and men of which have been taught the importance of sanitation, will undoubtedly have a great advantage over an army whose members are careless or untaught in this respect. More especially will this be the case when the force is either stubbornly holding a defensive position, or engaged in a prolonged siege, or in an attack on such a position held by the enemy. In either case it will be practically out of the question to expect the individual soldiers to do much in this direction. In a besieged town, or defensive position, the civilian population that still remains must be encouraged, or if necessary forced, to undertake the execution of sanitary fatigues. The same may be done by the attacking force, though it would be unwise to allow members of a local and possibly hostile population to penetrate to the more advanced lines of the attack. In any case, however, much must be left undone, and the conditions, under which a force closely engaged with the enemy, and fighting with modern weapons, will have to live must inevitably be such as practically to prevent sanitary work being carried on. As a result after a battle the state of affairs will be such that very active steps will have to be taken if illness is not to break out, not only amongst the civil population, but also amongst the sick or wounded, whose condition is such as to prevent their removal from the vicinity of the engagement. In this country it is fairly certain, that if the conduct of the operations remained in our own hands, the supervision of the necessary work would be entrusted to the local authorities, sanitary and otherwise. Sanitary officers on the *à la suite* list would undoubtedly find a considerable field for activity here. The matters to be disposed of would be not only the dead bodies of men and horses, but also the accumulation of excreta, broken meats, &c., the result of the continued occupation of a comparatively contracted space by a population perhaps a hundred times the size of that which ordinarily inhabits that area. Since the inhabitants of the locality would naturally be the people most interested in the cleansing of the battlefield they could very fitly be called upon to assist. Trained soldiers, whether officers or men, would be too valuable to be spared on such an occasion from their duties at the front, and a well-organised sanitary service under the local authorities would constitute a distinct national asset. The first step would be to tell off the ground in definite areas, and entrust the work to definite parties of men under some locally recognised leader. Their duty would be to bury all accumulations of filth or garbage *in situ*. Time would not allow of these matters being collected for cremation, and shallow burial would be quite sufficient. They would

also have to collect the bodies of the dead in groups for burial or cremation.

Undoubtedly the best method is cremation, and it is probable that in the case of the dead of an enemy fighting in this country we should where possible adopt this measure. As regards our own men, sentiment would probably prevent any such course, and the only resource then would be burial in large graves. Military trenches might be used where present, otherwise pits should be dug about 10 ft. deep and 7 ft. broad, so that the corpses may be laid across the trench. Before placing any bodies in the grave some brushwood should be put down to facilitate drainage, and the corpses laid on the top of this to a distance of 3 ft., but not less, of the surface. The earth should then be carefully heaped over the mass, a record being kept of the numbers and other particulars of the men buried in each spot. These duties will devolve very often on medical officers of stationary and other hospitals, and I need hardly remind you that every care should be taken as regards identification of bodies. Every soldier in a civilized army is provided nowadays with an identification disc, and these should be carefully kept until they can be forwarded to the proper authorities, presumably, in case of war in this country, to the Adjutant General at the War Office. These are not, it is true, strictly sanitary duties, but since they will so often devolve on medical officers and sanitary officers, especially those on the *à la suite* list, who will certainly be entrusted with the sanitation of any battlefield in their particular neighbourhood, the divergence is justifiable.

When burning is feasible, and in the case of a thickly-populated country like ours it may be absolutely necessary in the case of the bodies of the enemy, it may be practised in various ways. One method is to make a large pyre of wood and brushwood or other fuel, in which are hidden layers of corpses. This method was adopted by the French in the wars of the Napoleonic era.

After Sedan, in 1870, cremation was resorted to with a view to destroying the corpses already buried but not sufficiently covered over. The following procedure was adopted: The earth was first removed until a dark fetid layer in immediate contact with the dead bodies was reached. This was watered with a solution of carbolic acid, and then the mass of putrefaction was completely uncovered. This was then sprinkled with chloride of lime, after which tar was poured over it and allowed to penetrate in between the different layers of corpses. The tar was set alight by means of straw moistened with petroleum, and as a result of the use of this last ingredient the fire was enabled to spread through the entire accumulation of corpses. The heat rapidly became so great that it was impossible to approach within 15 feet of the furnace, and in a little over an hour the contents of the most crowded trenches were reduced to

about one-quarter of their original bulk. This, of course, must have been largely due to evaporation of moisture. The residue consisted of calcined bones contained in a resinous magma. The earth forming the walls of the trench having been exposed to such an elevated temperature, was freed of all cadaveric odour. A dense smoke was formed, which produced blisters on the exposed skin surfaces of the workers. Gloves and veils should therefore be provided to people engaged in this operation. The flies which infested the ditches were all destroyed at the same time.

The Americans, at Santiago, in 1897, used cremation to dispose of the bodies found unburied when the town was occupied. They adopted a plan similar to that used by the French in the Napoleonic wars already alluded to. Incineration is not, therefore, impossible, even using primitive means, and this possibility should always be kept in mind, especially in cases where burial has been inefficiently carried out and a serious nuisance is likely to be caused. With regard to cremation, one word of warning must be issued. Incomplete cremation, that is cremation undertaken without very careful preparation, and an abundant supply of fuel, is worse than useless, both on sanitary and sentimental grounds.

The bodies of animals present considerable difficulty owing to their greater bulk. The usual plan, if burial or complete cremation is impossible, is to eviscerate the body, bury the entrails, and then light a fire in the cavity of the corpse. Fighting in civilized countries, one has always the advantage of a considerable supply of civilian labour, and since the local inhabitants are the people most interested in the proper cleansing of the battlefield, they can, as already said, fairly be impressed into the service.

Prevention of special Diseases. Enteric Fever and Intestinal Diseases. Other Diseases. Disinfection.

THIS concluding lecture of the series I propose to confine to the study and discussion of the problem of the prevention of infectious diseases; and though I shall direct my attention mainly to the question of how to prevent those diseases which are likely to affect an army in the field in this country, I must begin by a few general definitions and rules applicable equally to all infectious diseases. To begin with: by the term infectious disease is meant a disease due to a specific micro-organism, which micro-organism is capable of being transferred from an infected to a healthy person, directly or indirectly, and of producing the disease of which it is the cause in that healthy person, every such fresh case being traceable more or less directly to a previous case of the same disease. By the words infected person, is meant any person who, whether at the time he be actually suffering from the disease or not, harbours the disease germ in his body in such a manner that it can leave his body either continuously or at intervals and so pass to other individuals.

It is not necessary that the man I term infected should be actually ill at the time. He may either be recovering, or have completely recovered, from the disease, or he may be sickening for it, or affected so mildly by it that he shows no obvious symptoms.

The whole problem of the prevention of infectious diseases is to prevent the passage of the disease germ from the infected to the healthy individual, and this can be done at three points: either at the time it leaves the infected man; or whilst it is actually on its way to the healthy man; or immediately before it enters into the healthy man. The problem of artificially raising the resisting powers of the healthy man by inoculation stands on a somewhat different plane, and though I had hoped to be able to refer to it later in connection with the prevention of enteric fever, I fear there will not be time to do so in this lecture.

Since, as I have just said, the problem of the prevention of disease consists in intercepting the passage of the germ from the infected to the healthy man, it is necessary for us to know, in connection with any particular disease, three things: the channels by which it leaves the former; the methods of its passage to, and the avenues by which it effects an entry into the latter.

Taking first the methods by which micro-organisms leave the body, these may be classified under four heads. They leave the body either:

1. By means of infected excreta;
2. By means of infected sputum;
3. By means of particles of infected skin; or
4. By means of the bites of certain insects.

They enter the body of the healthy man:

1. By means of infected food or water;
2. By inhalation;
3. By direct contact through the healthy, but probably more frequently through the abraded, skin; or
4. By the bite of an infected insect.

Their means of transit from one man to another are of course innumerable, they may be blown in the air, washed along in streams, or carried on the persons of men or animals. I rather want to emphasise this point, because the means of transit are far more numerous than the methods by which germs actually enter or leave the body. Each germ has, as a rule, only one or two ways of effecting these last operations. Thus, for instance, malaria can only leave or enter the body by means of the mosquito, enteric fever leaves by means of the excreta and enters by means of food or drink, phthisis leaves by means of the sputa and enters by inhalation or swallowing, and so on for other diseases. But the bacillus typhosus can travel from the infected excreta to the food or drink of the healthy man by a thousand different ways, and so too with the tubercle bacillus in the sputa of the phthisical patient. It is obvious then, that the modes of exit and entry being limited, whilst the paths of transference are many, it must be easier to intercept the germ either immediately after it leaves the infected man or immediately before it enters the healthy man than whilst on its devious path between the two. And the means of entry are, especially with regard to the most important diseases of camp life, more numerous than the means of exit. Thus enteric fever only leaves the body by the urine and fæces, but it may enter by means of any one of the numerous articles of food or drink that the man consumes. Again, in all diseases the infected are far fewer in numbers than the healthy. It is obvious, therefore, that it is easier to intercept the micro-organism immediately after it has left the body of the infected man than it is to try and prevent its entry into the healthy man. Our first and main efforts then must consider the infected man, must be directed that is to attacking the germ in the excreta or sputum of the infected man, whilst we should of course at the same time not neglect to protect the food and water supplies of the healthy man, or to see that the air he breathes is pure.

Passing now from general principles, the diseases with which we are concerned in the field are comparatively few in number. By far the most

important belong to one class, which we may call the intestinal class, namely, cholera, enteric fever, and dysentery. Of these, cholera is comparatively unlikely to occur in this country. In addition to these, however, there are the exanthemata, and most importantly of all scarlet fever and measles. Of the intestinal class, which I shall consider first, we know a great deal more, as regards the micro-organisms which cause them, and their methods of exit and entry, than we do about the exanthemata, whose micro-organisms have not yet been identified. As a type of the intestinal class I shall take the most serious, enteric fever, the preventive measures which are applicable to it being practically applicable to the other members of the class equally. The first point here to consider, then, is the infected man. Of course one's mind at once turns to the man in hospital, and very rightly; but I should like to make you realize that the man sick in hospital is, or should be, the least dangerous of all men in this respect. The nature of his illness being known, or at least suspected, all precautions as to the destruction or disinfection of his excreta can be taken. It should be impossible for any infection to pass from the fæces or urine of a man in hospital, to the air, water, or food of his comrades in barracks or camp. Even in the most primitive of temporary hospitals a destructor or boiler can be made for this purpose. The method I should adopt is as follows: a large cauldron or copper two-thirds full of water should be kept continuously simmering in some convenient spot close to the tent or room occupied by the enteric patient. Into this the bed-pan or urine-bottle with its contents should be placed, not emptied, and allowed to remain for three or four minutes, completely submerged. There will not be much nuisance caused, but if this is complained of, the addition of a little crude carbolic acid to the water will completely quench any other smell. The water should also contain about two per cent. of washing soda. The bed-pan can be removed, thoroughly sterilised and cleaned, at the end of the short period suggested. I know of no other method more efficacious or less likely to cause unpleasantness than the above. On service, as a matter of fact, one cannot afford to be too meticulous about odours, however unpleasant, unless they result from decomposing animal or vegetable matter.

The danger from the man in hospital then is not great, but that from the infected man outside is considerable. This latter belongs to one of two great classes: (1) Those who have got the disease, or (2) those who have not got the disease. The first class can again be divided into those who are in the early stages of a bad attack, and those who are in the middle of a mild attack, the so-called ambulatory cases. The second class, those who have not got the disease, can again be divided into those who have had the disease and those who have not had the disease but have

been in attendance on cases of the disease, such, for instance, as medical men and nurses, male and female. In the prevention of enteric fever we have to keep all these in mind. It is important to remember that these individuals are not all equally dangerous; for instance, it should not be impossible to identify the men who have lately had enteric fever. It would be a useful bit of work on the part of all medical officers of health to inform the medical officers of all Territorial units of the occurrence of any cases of this disease in men known to belong to the Territorial Army; if possible the excreta of all such should be examined periodically to see if they are harbouring the disease. I do not know how far this would be practicable in time of peace, as a matter of arrangement between sanitary officers on the *à la suite* list and medical officers in charge of units, but I am quite certain that something of this nature should be attempted. In any case, on mobilisation every medical officer should be able to place his hand on every man in his unit who has had enteric fever within eighteen months or two years of that date. According to the Registrar-General's returns for 1905–1907 the number of males of the military age, that is between 15 and 35, who died of enteric fever per annum during that period was 148. Taking the death-rate at 10 per cent., which is rather high, the total number of cases per million must have been 1,480, or amongst the 300,000 men of the Territorial Army 444; thus on mobilisation there will probably be 888 men who will have had enteric fever within the past two years. Subtracting a quarter of these as having had the disease within the last six months, and therefore not likely to turn up at mobilisation, that leaves 666 men that should be traced; not a large number to keep in touch with, but quite enough to cause a considerable amount of danger. Having identified these men on mobilisation, they should at once be isolated from their comrades until it is proved beyond a doubt that they are not "carriers," that is, that they are not harbouring and excreting the micro-organism of enteric fever in their fæces or urine. I look on this step as absolutely essential. By isolation I mean that they should occupy separate tents or billets, and use separate latrines and urinals. These last should be the particular care of the medical officer, who should see personally that the excreta are not only covered with earth, but the trenches are scorched with a little kerosene oil or straw ignited in them every day. Three examinations of the fæces and urine, carried out at intervals of one week, with negative results, should be required before the men are permitted to rejoin their comrades. Meanwhile the military duties of such men need not be interfered with. They can take part in drills and field days, if only they are instructed to take the same amount of care in reference to their excreta on such exercises, that a phthisical patient is taught to take with

regard to his sputum. It is a safe rule to make that no man who is known to have had enteric fever within the past twelve months, whether he be a proved carrier or not, should be allowed to take any share in the preparation or cooking of food. In this connection men in the ranks of the Army Service Corps should not be placed on duties connected with supply if they have suffered from enteric fever inside of two years. I suggest the longer period for these men because the possibility of infection in them involves a much more widely spread risk than in the case of the ordinary soldier, concerned as they are in the issue of food to large bodies of men. As is fairly obvious a "carrier" in a field bakery is a much more dangerous person to the health of the army than one who is merely a private in the ranks of a regiment or battery. I confess that these time limits just fixed by me are purely arbitrary, and have no exact scientific justification. It is a case of merely not running any avoidable risk. If a man is proved to be a carrier there is nothing for it but to discharge him as unfit for further service. The only place where he could possibly be of use would be as an attendant in an enteric fever ward. He most certainly must not live in camp with his comrades.

The next class to be considered is the man who has been in attendance on or living under the same roof as cases of enteric fever. In this country, and more particularly in the Territorial Army, difficulty is not likely to arise in connection with such men, since they will probably belong to the Royal Army Medical Corps, and therefore continue in their employment. Contacts, however, that is men who have been living in a house where a case of enteric fever has occurred, ought to be looked on with suspicion. One examination at least of their excreta should be made before allowing them to go into camp. A careful eye should also be kept on these men to see that they are not suffering from diarrhœa or fever, that is that they are not ambulatory cases, or cases in the early stage of a severe attack. I remember one such case in India, a man who had but lately arrived from home, who lived in barracks for a month suffering from diarrhœa and slight fever without reporting sick. He was the cause of a very severe outbreak of the disease in his station, owing to the latrines becoming infected. Here again it is necessary for sanitary officers to keep in touch with regimental medical officers, informing the latter as to the prevalence of enteric fever in their districts, especially amongst the families of men who belong to the Territorial Army. As regards both these classes of men, those who have had enteric fever and those who have been in contact with or in attendance on cases of the disease, the danger is minimised because they can and ought to be known. How the knowledge is to be acquired and communicated to the medical officers concerned is a matter which would need careful consideration, but there is obviously no

impossibility in it. With regard to the other two classes, however, the men who are sickening for a severe attack, or are actually going through (we can hardly call it suffering from) a mild attack the case is different. The first of these two, the man who is incubating the disease, is the less dangerous of the two. He will probably come to the end of his tether in a few days, and have to give in. As to the other class, however, the question is one of the very greatest difficulty. In all probability the man shows no sign of illness; he may seem a little fagged or pulled down, but that is not much to go on, and he may not show even that. In fact. you may say that you never can identify him, unless under the strain of campaigning his ailment takes a serious turn and forces him into hospital. It is against this man that all your conservancy is aimed. With rigidly careful burial of excreta and disposal of urine the danger may be kept in bounds, but any carelessness in that respect will mean fresh cases of the disease originating from this one man, each of which in turn during the period of incubation, which may be as long as three weeks, and is usually ten days, will act as a reservoir and focus of disease. The problem of the prevention of enteric fever is entirely, I believe, one of conservancy. The poison lies in the excreta of the infected man, and the most dangerous of the infected men is the one who is not too ill to remain at his duty, and who, therefore, passes unrecognised. Since he cannot be recognised, the right thing to do is to look on every man as potentially infected, and to treat his excreta as potentially containing the micro-organism of enteric fever. This potential infection is only dangerous if and when it gains access to the food, air, or water supplies of the troops, and this it cannot do if it is buried at once. And that brings me back to the keystone of sanitation in camp, the immediate burial of excreta, by the man from whom they pass. The modes of entry of the enteric germ into the healthy man are manifold, though the channel is only the mouth. Clean food and water are most important, especially the latter, but it is infinitely more difficult to ensure that a man shall never eat or drink anything that has been contaminated, than to ensure that he shall take steps to prevent his excreta contaminating the food and water of others. Therefore I repeat, and I make no apology for the "damnable iteration," the keynote of sanitation in camp is the burial of excreta.

The prevention of dysentery is practically the same as the prevention of enteric fever. There is just this difference between the two diseases. Enteric fever is a definite entity, whilst dysentery is a name that covers probably more than one individual disease. Of the different diseases that we include under the name dysentery, some most certainly, and these the most virulent of the class, are undoubtedly specific entities just as much as enteric fever is a specific entity. But what is sometimes called dysen-

tery is often no more than a severe intestinal catarrh due perhaps to severe chill, or to mere error in diet, or even to the mere mechanical irritation due to the presence of sand or grit in the water. A large number of cases of so-called dysentery are merely cases of severe non-specific diarrhœa. They must be looked on as serious, since they weaken the powers of resistance to the specific micro-organisms of the severer forms of intestinal disease, and they may certainly be lessened in number by a rigid attention to the cleanliness of food and water.

Cholera must be met by the same measures as dysentery, but since here we are dealing with a disease that is almost certainly communicated from man to man by water and water alone, the problem is simpler. If cholera should occur amongst troops all water must be boiled, and all water, even if it is going to be boiled or not, must be safe-guarded from pollution by the infliction of the most serious punishment, if necessary death, on any person tampering with the water supply. Water should be drawn from certain well-defined sources only, by certain people only, and at certain times only. An armed guard must be placed over the water supply, and all unauthorised persons approaching the source must be fired on, just as in time of war any unauthorised man approaching a gun-park or ammunition magazine would be fired on. Cholera is extremely unlikely to occur in this country, happily, even in time of war, and therefore I will not waste time on going into details as to its prevention. I would only like to add that if cholera does come, the sanitary officers of the Territorial Army will have a glorious opportunity of showing their mettle, and of proving that they are just as ready to face death in its worst form for the sake of their country, as any member of any other branch of the service.

A most important point in connection with the prevention of these diseases is early diagnosis and recognition. In standing camps of any size this ought to be provided for by the institution of a small laboratory, where modern scientific methods of blood and serum examination can be carried on. With troops engaged in active operations this is almost impossible, and the problem of detection is difficult in the extreme. Every man who reports sick with diarrhœa (and their name is legion in bad weather in camp) is a potential case of enteric fever or dysentery. But if on that account a medical officer should send every such case to hospital for observation, the army would rapidly be reduced to the position of a hospital guard. I can give you no rule for guidance. Severity of symptoms is in itself of no value, since a man may have the most violent diarrhœa as the result of a chill combined with some dietetic indiscretion, and recover next day with the simplest treatment, or even no treatment. On the other hand the diarrhœa of the early stages of enteric fever may be so slight as hardly to impress the man that he is sick at all. Experience

is the only possible guide, and at the best a fallacious one. I think even the most war-worn member of the Royal Army Medical Corps would realise the ease with which he might make a mistake in this matter.

Apart from the diseases which I have grouped under the term intestinal, stands the great group of the exanthemata, and of these, three are of primary importance: namely, smallpox, scarlet fever, and measles. Of these the first is, as we know, easily guarded against. One of the earliest duties of the medical officer of a territorial unit on mobilization will be to verify the vaccination of his unit. Every man who cannot show signs of successful re-vaccination, or a record of the same, should be re-vaccinated or discharged as unfit for service. As regards scarlet fever and measles the difficulty is greater. At the same time that the medical officer is satisfying himself as to the vaccination of his unit, he should enquire as to previous diseases so as to know the number of men protected by previous attacks. He should also try to get into touch with the Medical Officer of Health for the district from which his unit is recruited, and ascertain whether either of the above diseases (or any others of the same class) have been lately prevalent in any part of the district. Men coming directly from any part known to be seriously affected must, if military considerations permit, be isolated. I say "if military considerations permit" because, once mobilization is ordered, these become paramount. The responsibility for the decision does not rest with the medical officer, but the officer commanding the unit, or the general commanding the brigade or division. It is incumbent on the medical officer to place the facts clearly before such superior authority, stating exactly the degree of danger that he considers to exist. The gravest error that he can fall into is over-stating the case so as to make things safe for himself. That is, of course, a very easy course to follow, but it is a grave dereliction of duty. The medical officer is the only man who can really appreciate the extent of the risk, and he must not shirk the responsibility that lies upon him, of stating it accurately and without exaggeration to the commanding officer.

If isolation is impossible, then the medical officer must make a point of seeing all men coming from infected districts every day. The first symptoms of coryza, or of sore throat, will justify him in sending such men into isolation for observation, and all such cases must at once, from that moment, be treated as actually infectious. Isolation in such cases means absolute isolation, not the partial isolation that I referred to in speaking of suspected "carriers" of enteric fever.

All sanitary officers, *à la suite*, should make a point of warning officers commanding units of the presence of disease of an infectious nature in any villages, towns, or farms in their districts. This would naturally be done

through the divisional sanitary officer, who should, in fact, himself make it his business to ask for such information.

I have been speaking of these duties being carried out immediately after mobilisation, because the Territorial Army does not exist as a permanent force until that occurs, but I need hardly point out that every medical officer who is in charge of a unit should be possessed of the information as to vaccination and previous diseases long before that day arrives. The fact that the regimental system, under which medical officers belong to combatant units, still exists in the Territorial Army, makes this easy of accomplishment, and it is for these officers to justify their position, by recognizing that these duties exist not only in time of war but also in time of peace.

In connection with infectious diseases I must speak shortly about disinfection of the clothes and belongings of men suffering from these diseases, and also of their disposal. The situation as it will actually confront you is this. A man reports sick with suspicious symptoms pointing to enteric fever. He is, of course, wearing his uniform, which, not impossibly, he has slept in for days; perhaps he has not even had his clothes off his back for weeks. He is served out with a suit of hospital clothing, and the question then arises as to what is to be done with his own clothes. As regards the underclothing, I should certainly recommend its being burnt at once, since in civilized warfare, especially in this country, such articles could easily be replaced. His uniform must, however, be preserved, and it must accompany him till he gets to hospital. One would like to keep it separate from the uniforms of other men also going down the line, sick or wounded, but, as you may suppose, that would not be always easy, or even possible. The difficulty only arises in connection with the doubtful cases. A well-defined case can be at once isolated and sent to the nearest infectious hospital, and there, in all probability, there will be proper resources available for disinfection on some scientific method. The problem is not at all easy of solution in practice, each case must be dealt with on its own merits.

Disinfection in the field is difficult but occasionally has to be carried out. If it were desired to disinfect clothes in the field, and no steam disinfector were available, the following plan might be adopted. A bell tent should be pitched and the articles to be disinfected having been soaked in water, hot or cold seems immaterial, though probably the former is preferable, should be hung on frames or hurdles inside the tent. The ground and tent walls should be thoroughly wetted with water, and an oil lamp or charcoal brazier lit inside the tent. The tent being thoroughly warmed, 5 lbs. of dry potassium permanganate are placed in a metal or earthenware basin or tub, and to them are added about 10 lbs. of com-

mercial formalin. The tent must then be closed as tightly as possible, a wetted blanket being laid over the laced-up opening. Formalin vapour is evolved as a result of interaction between the chemicals used, and if the wetted garments are exposed to this for four or five hours disinfection will probably be completed. If only a few articles have to be disinfected a box or small wardrobe may be made use of, in which case it will be necessary to use 1 oz. of permanganate and 2 oz. of formalin per 1,000 cubic ft. To get satisfactory results the materials and air must be saturated with moisture, and the temperature of the interior of the tent or box about 70° Fahrenheit.

An ambulance waggon that has been used for the transport of infectious cases may be similarly treated, but should in addition be thoroughly scrubbed with soap and hot water.

I have now concluded my course of lectures on the subject of Field Sanitation. I must acknowledge to many imperfections and omissions, but I hope that I shall have succeeded in impressing on my hearers that sanitation in the field is not on the one hand a useless fad, or on the other an art of such complexity that only an expert can hope to tackle the problems it presents. On the contrary, it is an art which needs but little beyond common sense, tact, and perseverance for its practice; and so far from being useless, it is an art on the proper knowledge and working of which the fate of armies and even more, of the nation may depend.