A PORTABLE STEAM FIELD DISINFESTOR.

By Major ROBERT G. W. OLLERENSHAW, M.A., B.M., M.R.C.S.,
Royal Army Medical Corps.

The present situation of the troops at home entails the accommodation of detachments of varying sizes in an astonishing variety of billets, requisitioned houses and converted mills.

While there are many units and formations which are large enough to justify the installation of a permanent disinfestor of one of the recognized commercial types, it has been found that there are many more, such as the detachments guarding vulnerable points, where the numbers do not justify the expense of a permanent installation. Moreover, it is just these small isolated detachments which are most liable to infestation by pediculi or scabies as they are frequently very badly placed in regard to bathing and laundry facilities.

It has not been found a practicable proposition to employ the Millbank Portable Disinfestor, with its trained staff, in cases where there are less than, say, a hundred men to deal with and the construction of a fixed field disinfestor, such as the Serbian Barrel, at each vulnerable point or group of requisitioned buildings has been found to lie beyond the capacity of the majority of units, many of which are extremely scattered.

It therefore occurred to me that a simple portable steam disinfestor which, while being within the capabilities of the average unit to construct, was yet compact enough to be moved around their various detachments and sufficiently foolproof to be worked by unskilled regimental personnel, would be a useful and desirable piece of equipment.

General Description.

From past experience of several improvised field disinfestors, a variety of points arose which it was desired to incorporate, with a view to increase of operating efficiency.

The standard ten-gallon oil drum was the obvious choice for the boiler; the five-gallon drum has been found to be inadequate when anything larger than an ordinary beer-barrel is used as the clothing container. Moreover, it was considered desirable to make the steam generating plant sufficiently large to feed a bigger container, since we had been informed that a substantial number of hundred-and-fifty-gallon wine-casks, which would each take up to sixty blankets at one time, were available for purchase. In any case, the larger boiler will always feed a smaller container.

The standard ten-gallon drum measures 21 inches by 14 inches overall and it is these dimensions which settle all the others for the steam generator.

The firebox, the top part of which forms both the cradle for the boiler and the smokebox, is constructed of any available stout sheet metal, bent and riveted as described in detail on page 251.

It was decided that the entire apparatus must be able to be constructed from stock fittings and materials ; no workshop intervention must be essential. This is not to say, however, that the co-operation of a Field Workshop would not be extremely valuable.

The chimney is a section of standard three-inch stovepipe, such as is employed with the slow-combustion stoves which are being fitted in hutted camps. The loose chimney of the old pattern " Soyer " cooker may be used in place of this pipe. The modern pattern unfortunately has a fixed chimney. Steam piping is the standard iron gas " barrel " and all elbows, unions and backnuts are standard and from stock. Ordinary angle-iron, such as may be obtained from many salvage piles in the form of old bed-sides, provides the supports for the baffle-plate and for the firebars and firebox lining.

This baffle-plate is situated between the firebox and the boiler. It is not included in the fixed Serbian Barrel as described in the Army Manual of Hygiene and Sanitation (1934) [1] but it has been found by experience to be necessary. The thin metal (lead-coated iron of approximately 20 S.W.G. in thickness) from which most oil-drums are made will not stand up to the direct heat of the flames without burning through in a short time, which varies from drum to drum but which in one case was as short as a fortnight. Should unskilled attendants allow the generator to boil dry the life of the drum may be even shorter. The baffle, while admittedly increasing the time needed to get steam up, takes all the " burning "—and can be scrapped when it gives way, being easily replaced by any stray piece of thin sheet iron—which cannot be said for the boiler, with its carefully brazed pipe-unions.

The same simplicity of replacement is the principle underlying the loose lining and the firebars. The bars rest in notches cut in their supporting angle-irons and can be replaced in a moment by any odd pieces of railing picked off the scrap-heap while the lining of the firebox is simply sheet metal with two right-angle bends.

This tendency of parts to burn out has in the past been the great bugbear of the improvised field disinfestor. The present model overcomes this difficulty by making the vulnerable parts easily replaceable and by lining the sheet metal sides of the firebox itself with asbestos sheeting, such as is used to protect the woodwork of huts behind the stoves, and which is fairly easily obtainable from the Sappers, in addition to the loose metal lining described above.

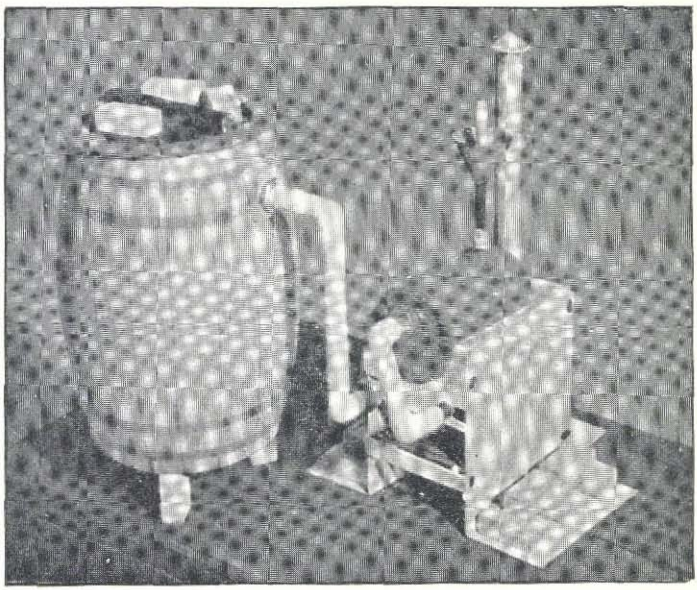
The generator is coal-fired, in view of the present difficulty in obtaining wickless oil stoves or petrol burners or their fuel, although these types of heater have many advantages, were they more easily obtainable.

The clothing-container, or Serbian Barrel proper, which is ideally made

from one of the large wine-casks referred to above, can at a pinch be made from any steam-tight container, on the lines of the Packing-case Disinfestor or the Lelean Sack, although in cold weather this last loses too much heat to be really satisfactory.

The principle of sectional construction, which is to be described in detail, renders it possible to pack the entire plant inside the barrel which can then be moved from point to point by unit transport with considerable ease.

The lagging by a bank of earth, as described in the Manual for the fixed Serbian Barrel, is obviously out of the question in a portable model and, in any case, I have found that its value, especially in weather such as prevailed in the winter of 1939-40, is problematical. During that period the bank



Photograph of original scale model of Portable Disinfestor.

froze solid, and tended to refrigerate the barrel rather than to conserve heat.

The portable barrel has therefore been *internally* lagged with a layer of blanket, nailed firmly around the top and bottom edges, and tightly stretched. This procedure leaves an air-space between the blanket and the curved wall of the barrel. The air-space, being a poor conductor, provides a measure of insulation which I have found to be more efficient than the bank of earth.

The blanket is turned six layers thick over the top edge of the barrel, and the lid is covered on its under surface by two layers. The contact between these two padded surfaces is excellent, and when the lid is weighted

by a few bricks the joint is to all practical intents steamtight. Half a dozen bricks are also needed to raise the perforated bottom of the barrel off the ground and thus allow free exit for the spent steam. The necessary bricks can usually be found on the site.

Where the ground conditions are suitable, it may be found possible either to sink the barrel into a pit, leaving several inches clearance all round, or to raise the steam generator off the ground on old masonry. If this can be done, the total run of steam piping may be reduced by the elimination of the vertical limb (*see* fig. on page 250).

The drawing in the Manual shows the steam feed-pipe led only just through the wall of the barrel, near the top. While this provides the essential downward feed, it has been found that there is a tendency, if the blankets are unskilfully packed, for an air-pocket to form near the top, at a point opposite the entry of the pipe. This is avoided by delivering the steam through a rather longer feed-pipe, so that it escapes at the mid-point of the diameter and as near the top as possible through an upturned elbow. The steam, after impinging on the under surface of the lid, is evenly distributed all round. This apparently small point can prevent the escape of a few lice in the top blanket and the subsequent reinfestation of the whole batch.

General Considerations Affecting the Fitting of a Superheater.

While it is well known that superheated steam, being a gas, has poor penetrating properties and is not therefore so efficient a disinfesting agent as current steam, a simple U-tube superheater running through the firebox, between the boiler and the baffle, was fitted for the following reasons :—

In the ordinary type of disinfestor, without superheater, the steam leaves the boiler at 100° C., as current steam, possessing a latent heat of 537 calories per gramme and having expanded some 1,700 times in changing from water at boiling point to steam. During its passage through the piping it cools down considerably and it again cools, very rapidly, with contraction and cloud formation, on its escape into the barrel. There is thus a considerable loss of potential "disinfesting value" at the very outset, as the so-called "steam" reaching the blankets is, to a great extent, water in the form of cloud. In condensing back to water, steam contracts to $\frac{1}{1700}$ of its volume and, in so doing, gives up its latent heat. But since the steam has already partially condensed, the full value of this effect is lost. The contraction, which lowers the pressure within the barrel, not only tends to draw over more steam from the boiler but also, by reason of its tendency to produce a vacuum, increases the power of the steam to penetrate the blankets. The total loss of efficiency from both causes is obvious.

The effect of the superheater is that steam leaves the U-tube at a temperature considerably above 100° C., with the result that it reaches the

barrel at approximately boiling point, the additional heat having served to compensate for the inevitable losses due to cooling in the feed system.

Thus *true current steam* is fed to the infested blankets, having none of the disadvantages of a gas but having the advantage over the simple type of feed that it is truly at boiling point and, in condensing and contracting, it can yield up the whole of its 537 calories per gramme of latent heat to the blankets, with a consequent gain in efficiency and a reduction in the time required for safe disinfestation.

Time Required for Adequate Disinfestation.

No definite time is laid down in the Manual of Hygiene and Sanitation for disinfestation by the Serbian Barrel. The most recent investigations of temperatures lethal to the louse are those of Buxton (1940 *a*, *b*), [2, 3]. The *minimum* time required for the destruction of lice is of academic value since, in the field, an exposure well above this will invariably be given. As Buxton says, practical disinfestors do not regard ova (which are much more resistant than mature lice) as dead until they are collapsed and shrunk, a state which indicates that they have been subjected to a temperature well above the lethal threshold. Mature ova do not shrink unless they are exposed to a temperature of 65° C. for ten minutes. It is probably advisable to allow this period to elapse from the time when cloud is seen to be coming freely from the perforated bottom of the barrel.

This is considerably less than the exposure times and temperatures which were formerly thought to be necessary (Jameson and Parkinson, 1936) [4], and, when the superheater is in use, the safety factor is considerable, even with such short exposures.

It should, however, be remembered that a temperature which will kill lice and their ova will not necessarily sterilize the bacteria or viruses which they may be carrying. The custom of speaking of a Serbian Barrel as a "disinfector," instead of as a "disinfestor" is a dangerous one.

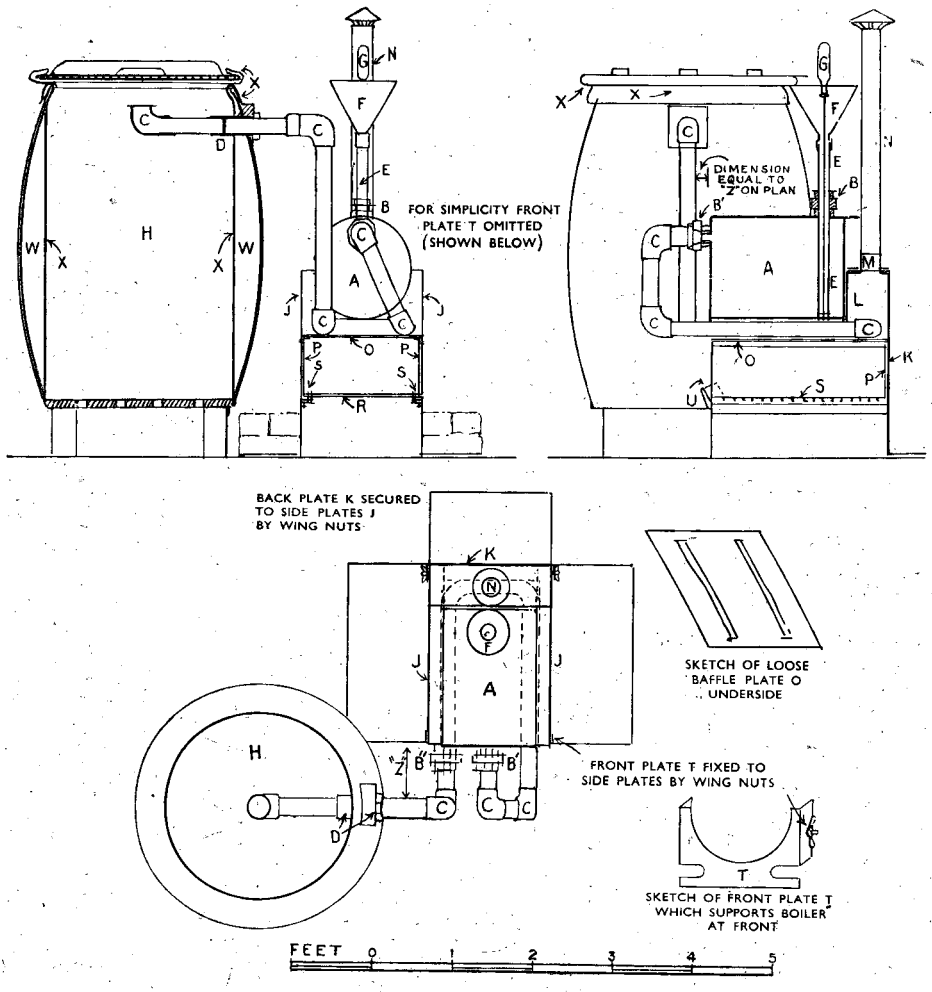
Detailed Description of Construction.

(See Plan. Letters refer to the Key thereon.)

The Boiler (A), a ten-gallon drum, lies horizontally. It is fitted with a *Filler-pipe* (E) made from ¾-inch iron barrel. This is brazed in, and runs to within 1 inch of the bottom of the boiler, extending also 18 inches above the point of entry. It is broken just above the boiler by a screw-union (B) in order to facilitate packing for transport. *The Funnel* (F) may be an ordinary petrol-funnel, soldered to the pipe. In addition to its action as a filler and safety-valve, this pipe will emit a cloud of "steam" when the water level becomes dangerously low, and will warn the attendant to refill, if he is to avoid burning out the boiler.

The *steam-outlet* runs from the uppermost point of the opposite end of the boiler, to which is brazed the female half of a screw-union (B′). This

is of 1½ to 2 inches bore, thus rendering it impossible for the filler and outlet pipes to be wrongly connected. The corresponding male half-union is fixed to the superheater pipe. This runs downwards, as shown, and thence horizontally below the boiler, in the form of a U, lying within the smokebox. At the point where the pipe leaves the smokebox a second screw-union is fitted (B″), again for ease in packing. These joints will stand up to 50



pounds per square inch pressure and therefore no risk of steam leakage is involved.

From this union the pipe runs up to its point of entry into the barrel. The plan shows how the short section within the barrel (D) unscrews from the main pipe by means of a straight socket. The main pipe can then be withdrawn from the barrel for packing. The short section ends in the

upturned elbow previously described. The point of entry into the barrel should be kept as high as possible, in order to secure freedom from air-pocketing. A wooden block is fixed to the barrel wall, in order to keep the inlet hole "square" to the pipe. An ordinary backnut beds up against this and ensures a reasonably steam-tight joint, especially as the wood swells a little when damp.

The Firebox consists of two side-plates (J), a back-plate (K) and a small front-plate (T). All these are bent-up from sheet metal, which should be of about 16 S.W.G. The back and sides have each a large flange which rests on the ground, a vertical part—the firebox wall proper—and a smaller horizontal flange at the top, extending inward to touch the end and sides of the boiler respectively. This top flange on the *back-plate* overlaps the flanges on the *side-plates* and carries, riveted to it, the short *stub* of pipe for the chimney (M). To the front of this flange there is secured by a wing-nut the *bracket* (L), supporting the rear end of the boiler. This is simply a 2-inch strip of sheet metal, bent twice at a right-angle, as shown in the plan (side elevation). The back-plate is also flanged up the edges, in order that it may be secured to the side-plates by wing-nuts. Reference to the plan will make the above points much clearer than can be done in text.

The front-plate (T) is sketched separately. The deep notches at the sides are cut to clear the superheater pipes and will therefore vary with the size of pipe available. This plate also forms the support for the front end of the boiler. It is secured to the side-plates by wing-nuts.

Asbestos sheeting is fastened by rivets to all four of the above plates, on their inner surfaces.

Six sections of light angle-iron are now required, the length of the side-plates. Two of these are riveted on as supports for the baffle-plate (O). Two others are deeply notched at $1\frac{1}{2}$-inch intervals to take $\frac{1}{2}$-inch firebars. These are now riveted "back-to-back" with the remaining two sections, and these in turn are riveted to the side-plates at (S). The two elevations in the plan make the arrangement clear. All angles should be fixed *after* the fitting of the asbestos lining.

The addition, by wing-nuts, of a small plate (U) to prevent the coal falling out completes the firebox proper.

The chimney (N) is a push-fit on the stub (M).

Replaceable Sections.

These are three; the baffle-plate, the firebox liner, and the firebars.

The baffle-plate is sketched at (O). It lies on the upper angle-irons, and is slotted below the superheater pipe. The slots may be quite rough, and simply knocked through with a cold chisel. It will be noted that the only way from the firebox to the chimney is through these slots, and that therefore the full heat plays on the superheater, while the centre of the plate protects the boiler.

The firebox liner (P) is made from a single piece of sheet metal, bent to form three sides of a rectangle rather smaller than the firebox. It rests on the lower angle-irons (S) which also support the seventeen *firebars* in the notches described above. Almost any scrap rod or bar will serve for these bars.

The barrel (H) should be the largest that can be found. It is not the steaming that takes time but the constant packing and unpacking of a small barrel with clothing.

The bottom is freely perforated with a large auger and the barrel itself supported clear of the ground on bricks.

A plain flat lid, preferably fitted with a handle, is well lagged with blanket nailed round the edge. In use, it should be weighted with bricks to secure good contact.

The lining of the barrel with blanket is clearly shown at (X), leaving the air-space (W). The fitting of the feed-pipe to the barrel has already been described.

Finally, a *dipstick* (G) will be found to be most valuable. It should be notched to show the correct water-level, and the attendant warned not to exceed this; the risk of water flowing over into the superheater is thus avoided. Should this happen in spite of precaution, uncouple the screw-unions, when the pipes can be easily cleared.

General Notes.

Extreme of constructional detail has been avoided, as much will depend on the local availability of material.

By the use of wing-nuts and screw-unions, it has been found possible to make the entire plant so dismountable that it can be packed inside the barrel. A pair of handles fitted to the sides of the barrel make transport a matter of the utmost simplicity.

It is advisable, where this material can be obtained, to lag the exposed steam pipes with asbestos yarn; in the absence of this, strips of blanket or hessian will serve but are not such good insulators.

Summary.

(1) A steam field disinfestor, based on the Serbian Barrel, is described. It can be constructed, by local resources, from material which can be mainly "scrounged." It is entirely dismountable, so that it can be packed within the barrel intended for the clothing, and moved from site to site.

(2) This is of especial importance in the present situation where there are large numbers of troops employed in small isolated detachments, often with poor bathing and laundry facilities, and with increased liability to infestation.

(3) A superheater is included and the rationale of this is discussed.

(4) A feature is the simplicity of replacement of parts liable to burn out.

(5) The use of standard wing-nuts, screw-unions and different sizes of piping make the apparatus as nearly foolproof as possible. It can most certainly be operated by the personnel who transport it without constant expert supervision.

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