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are in part only the methods employed to get the most effective shooting out of a given force, and that the shooting itself is the thing that matters. As the principal function of all field engineering—properly applied—is also to get the most effective shooting from the smallest possible given team, we are on clear ground at once and can proceed to details.

The days have now passed when entrenchments were issued by the yard run conformable to sealed pattern,—in peace time only too frequently as tortuous exercises in mensuration at paper examinations, and in war as "some fad of the engineers" to be carried out under protest by the unwilling troops. Redoubts, even, are no longer planned at the office table and served out in stock sizes, like hats, to be crammed somehow on to the crown of hills many of which have nasty habits, in the Quartermaster's language, of turning out to be "specials." But though we beware of stock type-designs and stock systems, it does not mean that we go hatless because the sealed pattern article does not fit our head.

The spirit of the offensive rightly permeates all manuals of field engineering to-day, and good normal details should accordingly possess inherent adaptability to the purpose of sound offensive tactics. It is therefore difficult to choose a normal tactical peg on which to hang samples of fieldworks; for current tactical conceptions of their use as an aid to good shooting have such a wide range. We have a good ideal in the Japanese idea of placing rows of dummy parapets on a false position, holding them with just enough men to make a sufficient show of resistance to cause the enemy to deploy for attack, and then hurling on the flank of the attack the whole nation in arms—hitherto concealed round the corner! But perhaps this might be a little too advanced for our present purpose.

STRONGHOLDS OF DISPERSED ELEMENTS.

Leaving the main striking forces out of the picture it will perhaps be safer to assume that the defensive share of the fighting is to be done by a relatively small number of troops *placed in charge of*, not "posted for the defence of," a zone of resistance, which, starting from the smallest beginnings, develops its strength from hour to hour to meet the particular stresses to which it is being subjected. The backbone of such a defence may consist in some of the troops judiciously posted in a chain of mobile garrisons, of strength proportionate to the estimated difficulty of their tasks, and within co-operative distance of each other. Their business is not to repulse attacks but to encourage them, and to be a terror to the neighbourhood; to be a hornet's nest when stirred with a stick, and yet able to roll themselves up into the prickliest ball of a hedgehog that ever baffled a pack of terriers. They should ensure that the hostile scouts

SOME RECENT TENDENCIES IN FIELD ENGINEERING.

By Capt. E. E. B. Holt Wilson, d.s.o., R.E.

(Lecture delivered at the School of Military Engineering, Chatham, on 16th March, 1911).

Typical Tactics for Resistance.

On active service there arrives a moment when theories and text-books fade into the background, and the young field engineer finds himself face to face with the execution, and not the mensuration, of field defence works. The value of good organization and training, sound strategy, capable commanders, efficient troops, and the lessons of military history, have already found definite expression in the instructions given to him by his immediate superior, and the field engineer is in point of hard fact now required to deliver the finished article, ready for use, and situated on ground unlike any of the favourable examples he has previously encountered in print.

It is chiefly in matters of detail, especially in the correct variation of the normal to suit the tactical occasion, that the officer of field engineers is able to show that he intends his side to beat the enemy, not merely to baffle him.

The particular tendencies of field engineering which it is proposed to examine now are those of the technical design of certain of these details of fieldworks, more especially as disclosed in the recent publications of foreign countries.

All armies have normal types for fieldworks. They are based upon the tactics considered most likely to lead to victory over the most probable opponents; and in Continental manuals of engineering the types are planned almost entirely for use in the particular variation of the offensive-defensive which it is expected will be employed against highly trained civilized troops—the situation, for instance, of our Territorial Force employed for home defence.

We have become so accustomed to acknowledge that the correct tactical application of fieldworks is everything and the details nothing, that we are in danger of leaving it at that, and of trusting entirely to such flashes of Napoleonic genius in matters of detail on the part of all ranks, as we already demand from the higher commanders upon the momentous question of when to launch their general reserve beyond recall. We must remember however that tactics themselves

do not report that the enemy are entrenched at such and such points but that "the country is infested with the enemy."

The underlying principle is that every man and gun should be continuously employed so as to immobilize the largest possible number of the enemy, keep them out of mischief elsewhere, get their teeth into them, and at the same time make it impossible for them either to withdraw, or even to maintain their ground, without a steady drain upon their reserves.

The depth of such a zone of resistance should be sufficient to provide inducements for the enemy to develop an irregular and broken frontage, deficient in lateral cohesion, tending to present local flanks vulnerable to local attack by local mobile reserves, and difficult of support by artillery. In brief, to catch flies in detail by enticing them to walk across a wide strip of sticky paper instead of rebuffing them with a wire gauze screen, without catching them.

In order to produce the necessary distortion of the attack; to afford foothold for these garrisons in times of extreme stress; and to act as pivots of manœuvre within the zone of resistance, the consensus of foreign opinion points to the selection and fortification—probably in the form of miniature field fortresses with definite garrisons finding their own local reserves for offensive action—of a certain number of small areas which are likely to become or to contain points of possible future tactical value to the enemy. We cannot as a rule label them "tactical points" by virtue of any topographical consideration alone, for "tactical point" is not a geographical expression, but one compounded of time *and* place—which may be defined crudely as "the piece of ground the enemy would like *next*." Fighting a zone of resistance on chance ground in the open field bears to a strategically chosen and deliberately fortified fortress area much the same relationship that a point-to-point race across unflagged country bears to flat racing between the rails, and it requires a constant succession of bold and rapid decisions and ceaseless activity with the spade. Granted that, for our present purposes the zone of resistance will include the provision of some self-contained entrenched groups, strongholds, or redoubts, we will examine their probable disposition and design.

The first and principal lesson taught us as field engineers by the Russians in Manchuria is the failure in defence of a linear disposition of fire trenches closely supported by rear lines of trenches or redoubts which are not fully engaged until a portion of the original front line has fallen. The centre of gravity of the defence has moved forward from its old position on the lines of strong closed supporting works in rear right up to the very foremost trenches, and has taken the strong works with it. "Foremost" is not here used in a linear sense, but in the sense of having the pick of the early firing points, a step-by-step abandonment of which is not contemplated.

Such a stronghold or group then must fulfil two distinct purposes:

to be the headquarters of an offensive hornet's nest by day, and the prickly hedgehog during fog, darkness, reduced garrison, or the heavy rush ; and all the time it must take a steady toll of the enemy without letting him attain his object, namely to open secure communications through the zone of resistance. Any attempt to rely upon one general disposition of troops to deal with both sets of conditions, especially that suited for hedgehog tactics alone, has usually led to failure. For dealing with the enemy by day we must have, in addition to artillery, numerous alternative, invisible shooting pits and small but deep trenches, to hold from 4 to 50 rifles each, well disposed to get the pick of the shooting, with plenty of small bolt-holes and shelters, and all in covered communication with each other and with supports and local reserves.

For passive resistance during the close seasons of darkness we must arrange that the enemy, before he can overrun the group, *must* pass over our section of near foreground which has been marked out in a series of well-fenced death-alleys, every foot of which can be brought under a deadly enfilade fire from firing points which are manned for this purpose alone and if possible entirely screened from the direct fire of the enemy. Such firing points are often designated as "stabbing" trenches or "stabbing" batteries.

The measures outlined above form however but the second of the important activities of the garrisons of a zone of resistance. They have been selected as being more closely associated with the heavy work of the field engineer than are the primary services of protection by reconnaissance, which provide the forewarning without which forearming is futile.

An advanced screen or false front forms a connecting link between the measures of protection by reconnaissance and of protection by active resistance. Its preparation may often call for greater skill in treatment by the engineer than the main zone of resistance itself. Great importance is attached in most continental armies to the use of an entrenched false front not only as a means of obtaining indications of the enemy's intentions and dispositions, but as a means of gauging his powers and methods of attack, and of inspecting his armoury generally, in sufficient time to arrange a suitable treatment for him in the main zone of resistance. If his artillery is to be brought under review, guns must form part of the advanced screen also.

But although the engineer, thinking perhaps of the unreadiness of his freshly planted "concealments" and unfinished communications in the main zone, may be tempted to put such good work into a false front that, with modern weapons, this front may unexpectedly hold its own with ease as a barrier screen for a considerable period, such success may not always further the intentions of the commander to get his teeth into the enemy and worry him in the main arena. Such

an unintentionally severe check to his advance may end in so sudden a change of his plans that not only will the Intelligence Department of the defenders be hard put to it to overtake his new movement, but their engineers may scarcely have time to dig and roof the next series of fighting pits, still less to complete the gardening of the peaceful landscape with its steel wire undergrowth.

If such a screen is formed in front of an entrenched zone of limited frontage it appears to be advisable to keep its main positions well out to either flank. This may cause a greater and more premature dispersion of the enemy in deployment than the original frontage of the main zone would have done, and will increase his circuit for the turning movement which is awaited in all positions of limited frontage; while the withdrawal of the screens will leave them still playing the part of echelon supports to resist the envelopment of the main zone round which they pivot, and at the same time decoying the enemy into well "treacled" ground.

Redoubts.

It should now be easy to realize why the very word "redoubt" has almost acquired a guilty sound of defeat in the soldier's ear. In its hitherto accepted form and meaning it has been associated almost exclusively with the form of resistance which may be described as the "rolled-up hedgehog and hope for the best" policy—the last resort of the half-beaten soldier. The principal defects of the small fort or redoubt which stood alone, excluding the tactical aspects of its employment, were one or more of the following:—relatively short and formal frontage of continuous fire parapet, still shorter flanks, often traced from arbitrary or even geometrical considerations to deliver a "defensive" flanking fire regardless alike of probabilities and of the demands of adjacent works for particular lines of supporting cross-fire. It as a rule occupied one small topographical feature, and that imperfectly, and often added to this vice that crowning crime of visibility from afar which has been said to form one of the chief safeguards of some of our defended ports against oversea invasion—because the cry of "Look at their forts" might send a battalion of the enemy with such a rush over to one side of the vessel carrying it that it would capsize in deep water. The small formal redoubt can perhaps be seen in its most pernicious form in some of our earlier designs for that ill-mated partnership—a battery for heavy guns and a flank and gorge parapet of formal trace for so-called "musketry defence," the whole surrounded by an unflanked obstacle of oval trace, just as it came out of the standard-plan cupboard. Surely the zenith of tactical confusion in the application of fortification to war!

The Russians realized much of the foregoing in Manchuria when it was too late to change their tactics in passive resistance; for to-day a

change of method in the application of field fortification is no longer merely a change of trace or profile, but affects the fundamental training of the troops who are to employ this weapon. The Russians tried, in their field entrenchments, to put their formal redoubts right by adding wing or whisker trenches to increase the frontal fire, but were too late in realizing that the closed works themselves should have been right up in the front fighting line, and of tactical, not formal, trace.

It was not until the close fighting had set in at Port Arthur itself that they endeavoured in costly haste to relegate their monumental permanent forts to their only possible *rôle* as "keeps" to a series of modern entrenched groups, and ploughed the rocky foreground with numberless fire trenches in the attempt to meet the advances of the enemy on even, if not superior, terms. But the ardour of the enemy's attack and the rocky soil were against them, and their groups never developed sufficient strength to perform their task effectively, either in mutual fire support, intercommunication with the main arteries, or in dispersion and multiplication of targets to dilute the enemy's heavy fire.

What can be done in the way of resistance, even by an indifferently entrenched but well-fought group-stronghold, is strikingly exemplified by the case of the twin redoubt group on the 210-203 Mètre Ridge. Here a garrison of 1,500 Russians, renewed until they had suffered 3,000 casualties, inflicted a loss of upwards of 14,000 men upon their still braver attackers before the group fell.

There are three typical positions for the employment of invisible redoubts in a group stronghold in the first line, of the type under consideration. Not being limited as a rule to one topographical bump on the ground, the extent of frontage taken up by such a group can often be lengthened and can be given the pick of the firing points for frontal fire until favourable ground is found to develop a really effective flanking fire across the adjacent groups. All flanks are a source of anxiety and here is one typical position for the use of redoubts—redoubts with their main lines of fire devoted to the control of the intervals, and their own flanks and gorge traced for home use in the passive defence of their group in times of stress. The second typical position for a redoubt within a group is such as to stiffen a salient, if any, in the main front of the group—but here there is a divergence of opinion—the Germans put a redoubt in the forefront, but the French prefer the third typical position namely behind the skyline as seen by the hostile artillery.

The merits of the second and third positions are questions which we have not time to discuss at present and are after all dependent upon local circumstances. Which redoubt should be selected for early strong treatment to form the key or keep of the group depends more upon the enemy's tactical facilities in attack than upon local

topography, though the importance of developing the full *offensive* powers of all works from the first has already been alluded to.

The general treatment of the intervals between such groups appears to be the provision of a chain of selected firing points well echeloned back in a concave festoon in plan, entrenched and concealed, but only lightly picketed with troops; ready to receive fresh troops if called upon to check a serious attempt to punch a hole through an interval; as a screen in front of lateral communications and of batteries posted in support of the groups, and for controlling ground dead to the fire of the groups.

We will now examine a few types of fieldworks which may help to illustrate some of these recent tendencies in further detail.

A Sketch of a Field Stronghold or Group, planned for Field Defences and Mobile Artillery (*Fig.* 1, *Plate* I.).—There are 12 alternative concealed pits for direct fire guns, of which four are for emergency use in the defence of the salient. Ten alternative emplacements for field howitzers, of which two (marked H 6) are set back to develop fire upon dead ground in the S.W., on the 500 yards rifle zone, and four (H 2 and H 5) for the special assistance of adjacent strongholds. Redoubts at the flanks. A second tier of direct fire as a salient keep. A wire obstacle enfiladed by machine guns and rifle fire. Echelon support is derived from other mobile guns and howitzers, and an additional obstacle for artillery enfilade is provided on the salient spur to the west. Liberal communications are provided throughout the group, and numerous small shelters in the firing line, redoubts, and reverse slope communications, each to hold about 5 to 10 men. Two field emplacements are provided outside for mobile electric lights, with the usual artillery and infantry fire control and observing stations. A guard fence is shown to assist in the control of the intervals at night, and to defer a near approach to the main obstacle. The group occupies about 150 acres of ground, an area about equal to that of the "Feste Kaiserin," one of the satellite strongholds of the Fortress of Metz.

**A Permanent Stronghold or Group* (*Austrian*) (*Fig.* 2, *Plate* I.).—The backbone consists of three pairs of armoured Q.F. guns for direct fire, and four long range direct fire armoured guns on the highest point. The fire position for infantry is in the form of a curtain trench between the Q.F. guns, which are at the salients. At the gorge are two masonry shell-proof shelters which provide reverse musketry fire, and gorge stabbing batteries for flanking the intervals. The obstacle, which is in an open carefully graded ditch, is enfiladed from sunken flanking galleries, and by the gorge shelters.

A Simple Group, or Extended Redoubt, Field Entrenchment (*Austrian*) (*Fig.* 3, *Plate* I.).—This is an example of a redoubt taken to

* From *Permanent Fortification for the Imperial Military Training Establishments, etc.*, by M. R. von Brunner, Major, Austrian Engineer Staff, 1909.

pieces and distributed to the best advantage for fire effect. There is continuous communication but not continuous fire trench. Six shell-proof shelters in masonry would classify it as a "provisional" work. A "keep" is formed at the central forward salient, marked 6. The wire obstacle is more or less well flanked.

German Field Redoubt for One War Company (*220 men*) (*Fig.* 4, *Plate* I.).—Plain oval trace, 50 mètres front to rear. Unflanked obstacle, and outlying sentry pits. Forty-four shelters for five men each provide shelter for all the garrison. The latrine and dressing station are on the forward slope, at 5 and 3, and the headquarter telephone shelter on the reverse slope at 4.

An Example of Fire Trenches refusing a Flank in Echelon (*Fig.* 5, *Plate* I.).—Echelon support is considered better than "turning back" the flanks whenever possible, as it increases the circuit of the necessary outflanking movement. The unit trenches are similar in principle to the example in the *Manual of Field Engineering*, 1911, *Plate* XVI., and portions of the support trenches, under cover from the front, are prepared to act as stabbing trenches for flank fire only. One machine gun is shown flanking the forward slopes of an outlying spur, and one in a stabbing emplacement, to sweep the crest and reverse of the spur. A temporary end is formed with a closed work and stabbing battery, and is supported conventionally by mobile reserves of three arms, and covered by heavy artillery still further back, and not shown on the sketch.

[*Six other examples were also demonstrated*].

PROTECTIVE PROFILES.

Profiles of fire trenches are not illustrated in textbooks as a prescription for effective shooting, but as a normal and economical provision for protection, concealment, and communication under certain average conditions of time, labour, soil, site, and field of fire which are seldom all found in conjunction; and it is extremely unsound to lay down a given profile to be adhered to, even throughout the length of one small trench. To lay down or report in a paper scheme that a whole position would be entrenched, and shelters made to a given profile, (not unknown in the past) would show a disregard for death and local peculiarities which might be magnificent, but certainly not war. A fundamental rule in defence must always be that *each* rifleman is entrenched to the best advantage to give a good account for every cartridge he fires: and whilst inside his lair must not get killed except by accident. Beyond that it is of little interest to know how many cubic feet of earth he disturbs for the purpose; though it is often of great interest to know that it will average so many hours *per rifle* to arrive at the required result. Even this can only be a wild guess before at least a portion of the given sites

have been actually dealt with under the war conditions prevailing at the moment. The differences of time from the normal caused by war factors are more often in days and weeks than in smaller units of time. A sound rule in such estimates of time is to add 24 hours (to the calculated answer) for the "King's enemies," earthquakes, rain, etc. Remember also that "easy soil" means more excavation, more revetment, more return-filling, and generally *more time* to arrive at a given profile or degree of protection than in ground firm but not rocky.

It may not be without interest to glance at some typical normal profiles of firé trenches from foreign armies.

Normal Profiles for Fire Trenches (*Fig.* 6, *Plate* II.) *as used by France, Russia, Germany, Japan, and Great Britain.*—Fire standing is normal for all. The arbitrary effect of local units of measurement is evident in the figures selected for describing a suitable average height over which to fire standing on level ground. Russians fire over 4′.8″ (2 arshin); France and Germany, 4′.7$\frac{1}{8}$″ (1·40 mètres); Great Britain, 4′.6″ (4$\frac{1}{2}$′); Japan, 4′.3$\frac{1}{5}$″ (1·30 mètres).

The height (1·30 mètres) for normal "fire standing" adopted by the Japanese is that considered suitable for a man 1·54 mètres in height (5′.0·63″). Taking this proportion (five-sixths of the man's height) we find that 4′.6″ corresponds to a height of 5′.5″ nearly, and that a Guardsman of 6′.0″ should fire over 5′.0″ on level ground.

Four types of profile are illustrated, and the average cross sectional area in square feet is given above each type. The average time to *excavate only* two paces of the average profile of each type, at British normal rates of work, is as follows:—*Type 1, without parapet,* 3$\frac{1}{2}$ hours; *type 2, with parapet,* 1$\frac{1}{2}$ hours; *type 3, deepened,* 5 hours; *type 4, kneeling,* 50 minutes. The designers however claim a higher speed in their textbooks.

Points of interest are that Russia and Japan have adopted a *normal* parapet command of 1′.9″ and 1′.8″, as the result of a stern experience of average values, and have cut the width of their revetted firing step down to 1′.2″ and 1′.4″ to get the utmost value from the cover of the interior slope. Many other points of comparison could be drawn and discussed. On the whole our types appear to be on the wide side of the average (and would be wider still in soft ground) and unduly exposed to plunging fire on account of the great width of elbow rest adopted and the low height (4′.6″) fired over compared to the other European armies of equal, and in some cases lower, average stature.

The Russians and French leave the question of elbow rest for local adjustment by the rifleman. The former however provide a cartridge berm, of the width of the hand, at ground level, and invariably shoot over fire cover with the *left hand on the butt* of the rifle: thereby deriving the last ounce of cover and steadiness from the parapet.

In "*type 3*," with a passage trench in rear of the firer, the British normal type shows the greatest total vertical depth of cover (6′.6″);

which is attained by the drop of 2′.0″ from the firing step; as compared with France and Japan 1′.4″, Germany 1′.8″, and Russia 1′.9″. The Russian type also shows a parados as a normal provision, partly in order to reduce the area of parapet to be concealed in front, and partly for reasons indicated presently.

One of the duties of a normal profile is to suggest ideals, and the representation of a vertical interior slope by France and Great Britain serves as a reminder of the importance of reducing to a minimum the horizontal distance between the foot of the interior slope and the firing crest above it.

ENTRENCHING UNDER FIRE AND IN THE ATTACK.

All manuals deal cautiously with this subject for fear of training their infantry to entrench every attack to a standstill.

The French say "a trench dug during the attack must never become the grave of the offensive spirit."

It is rather a pity that the subject is somewhat shirked, as we all know very well that it will probably only be by means of the spade that any modern troops will be able to make good their advance upon troops already entrenched, or even behind better natural cover. The subject is however almost entirely a tactical one and in technical details falls under an introduction to the subject of siege works.

The Russians have shown a distinct tendency recently in favour of the use of sandbags in the attack as a preferable alternative to grubbing with the entrenching implement. A suitable bag is said to measure about 20″ × 14″, with 40 lbs. of gravel. Coloured grey-green it is said that a man is invisible behind it at 1,100 yards in the open, and that even at 400 yards the target is extremely difficult to pick up. It is also claimed that as it can provide bullet-proof cover the men much prefer the labour of dragging it along 30 or 40 yards at a time to the unsatisfactory process of frequently grubbing in the ground only to provide a very visible and non-bullet-proof screen,—for bullet-proof cover is as a rule out of the question in this class of work. There is also considered to be less danger of the attack entrenching itself to a standstill.

A German comment on this principle claims that the occasions for favourable use would be exceptional, and that it would diminish the men's activity and cripple the offensive spirit—remarks which would be equally applicable to the provision of any entrenching implement at all for use in the attack, and which appear to point more to an optimistic estimate of the bravery of the soldier than to the recent experience of the stern realities of war which underlie the Russian experiments.

[*Examples of the methods adopted by various armies to entrench under fire were also demonstrated*].

Protection in the Firing Line from Enfilade and Reverse Fire.

The full importance of effective traversing from oblique, enfilade, and reverse fire is not as a rule properly appreciated except when under fire. One has only to study the development of details as a war progresses to notice the general tendency towards placing every rifleman under a lid and in a safe tub of his own, for shooting from; and in a still safer bolt-hole near by for protection when he is being "over shot at." Whether it is that in peace we do not realize the full range of modern weapons—for the German rifle kills at 4,400 yards (2½ miles), or that we are over-sensitive in admitting the fact that little mistakes such as "shorts" from supporting artillery, or a terrific outburst of rifle fire from over-excited supports are constant occurrences in war, and must be insured against. The fact remains that when trigger-snatching begins in earnest streams of metal will and do arrive from absolutely untraceable sources.

From starting without any traverses to speak of the Russians finished up in most places with a recess for every rifleman, and heavier "passage traverses" from 8 to 15 yards apart according to the degree of obvious exposure. Back cover is provided always. This may be raised high enough to provide a background if necessary, but no traverse is ever allowed to show above the general level of the parapet, and, especially on a forward slope, every traverse is made to fall to the rear at a steeper slope than the line of sight from the enemy's gun positions.

We find also in the final Japanese lines north of Tiehling the men were recessed in twos and threes, and similar traverses were used.

A moral value of many small traverses is that they often save men the knowledge of what has happened in the next compartment. Density of fire line has ceased to affect the question seriously, since the Russians tell us that *trained* riflemen well entrenched from 5 to 8′ apart can deal with the worst situations by day or night, and it can usually be arranged to develop an emergency shoulder-to-shoulder line, if desired, to fire over any parados or head cover at night.

[*Five examples of typically traversed trenches were demonstrated*].

Protection from Plunging Fire.

About the value of good head and overhead cover as an ideal there are no two opinions, and Lieut.-Colonel von Swartz, of the Russian Engineers, writing while the lessons of Manchuria were still deeply bitten into his Sapper conscience, says :—

"The designs of the days of infantry parapets without head cover for the rifleman must now be put away among the curiosities of

ancient history." The Japanese, Russians, and Germans all agree that overhead shelter from splinters and bullets *must* be provided somehow *actually in the firing line.*

It may be taken as an axiom that a rifleman detected firing from behind *visible* cover is at an actual disadvantage as compared with an undetected opponent who is making intelligent use of natural ground cover; and the former may as well, if he has the time and material, roof himself in straight away.

But before any form of head cover is undertaken as a *precaution in advance* the following question has to be answered in the affirmative:—"Shall we have the time and the means to render our *head-cover* indistinguishable from our background at the distance at which it may have to face the enemy's artillery?" If the answer is no, or even doubtful, it would be wiser to dismiss the idea as tending to weakness rather than strength, and to put the labour into small and numerous shelters *inside the fire trenches*, to deepen cover generally, and to make sure of good communications and concealment.

Once we have definitely been found out and ranged by both gun and rifle, and concealment has failed us, in the absence of alternative concealed cover, our next move is to multiply targets incessantly, and to strengthen our cover regardless of concealment, including if possible the addition of *overhead cover*, and so to dilute the enemy's fire by offering such a bewildering choice of suspicious objects that the smile is once more on our side. Or we may follow this policy from the first, as most other armies do, if we cannot trust to concealment. On the other hand there appears to be no excuse for omitting well-concealed overhead cover in strategic defences deliberately prepared from 24 hours and upwards in advance.

We can now examine some examples of cover in fire trenches.

A Type of Box Loophole suitable for Use with or without a British Service Loophole Plate in Deliberately Concealed Works. To give 60° *arc of Traverse* (*Fig.* 7, *Plate* II.).—The result of experiments to get a ready-made loophole which can be turned out in numbers, and will probably provide a better shoot than the article hastily built up by the untrained soldier. The plate is not fastened to the box, but slips in between the box and the revetment tray. The screen preserves an unbroken exterior slope to the head cover and avoids the black shadowed tunnel which usually vitiates all attempts at concealment.

Overhead Cover, with Curved Iron Sheets, suitable for a Redoubt (*Fig.* 8, *Plate* II.).—The parados is joined up to the head cover, and acts as a reserve parapet in the event of damage to the light blindage, and as a second tier of fire at night.

An Example of Overhead Cover in Reinforced Concrete (*Fig.* 9, *Plate* II.).—Consists of a 6′ × 6′ gallery with 4′ roofed in. Steel loophole plates to open forwards and up. [*Details of the loopholes were also shown*]. An upper platform provides for overall fire. The

hollow under this platform provides full length sleeping space. A "shock absorber" of loose boulders is given in front of the interior slope revetment. The soft parados behind is arranged to act as a reserve parapet. The cost of construction is about £9 per rifle. Time, about 10 working days with European facilities. An extension of this design by thickening the floor to 3′ will provide good underground shelter.

Parapet Shelters, German (*Fig.* 10, *Plate* III.).—Shows two shelters, for five men each, between traverses 10 mètres apart. 3′ 3″ head room; 22″ sitting space each man. Wooden flaps are provided extra to guard against splinters and rain. No interruption to the firing line. No traverses showing above the parapet, and an easy curve round their ends. Parapet shelters of this nature figured prominently in the defences of Kimberley.*

Parapet Shelters, Russian (*Fig.* 11, *Plate* III.).—

1. Direct support from firing step.
2. Shelter at the lower level, and stronger.

Interruption of banquette is not necessary. Men can climb over the earth step, if left, as in the German type (*Fig.* 10).

Larger Shelters, German (*Fig.* 12, *Plate* III.).—For 20 men each. The chief feature of interest is the use of curved steel sheets, of special make, 1 mètre wide, as an article of store and bolted together at the crown, in pairs. Suitable for permanent centreing to concrete also. Very rapidly used as compared with timber, and more portable.

Sketches for a Dressing Station for Wounded (*Fig.* 13, *Plate* III.). —Requirements of dressing station are 2′ clear space all round a table 6′.6″ × 2′.6″. A shelf and a seat.

Shelters for supports should enable men to sleep lying down. Seats, if provided, must not encroach on the minimum floor space or they will probably be demolished after the first night. Each shelter should be numbered, and in direct communication with firing points similarly numbered. The roof is often provided with a "burster layer" of boulders, or better, inclined rails to induce ricochet. The size of shelters is nearly always controlled by the materials available for roofing, and cannot be standardized, but the rule is "*many and small.*" As regards actual resistance to shell fire the Japanese consider 4′ of earth, with a burster layer of boulders, a fair protection against single field gun shells, and 6′ or 7′ against single light field howitzer shells. The Russian figures run from 4′.8″ to 7′, and the German from 3′.3″ to 13′, while against heavier howitzers (6″ and upwards) a thickness of 16 to 20′ of earth or 9′ of concrete may be necessary.

[*Twenty further examples of cover were demonstrated*].

* *R.E. Professional Papers*, 1900.

COMMUNICATION EARTHWORKS.

A better realization of the paramount importance of mobility in defence, the occupation of wide frontages, and the increased accuracy of artillery fire, have sent up the mileage of communication trenches to a length which may well appal the engineer. Not only safe paths for foot traffic, but sunken ways for pack transport, and sunken roads for wheeled artillery were provided on a prodigious scale by both sides in Manchuria.

Although such communications cannot all be developed at once the safest routes can and must be selected and marked out immediately, so that they can be followed by night or day. Cover from view is the keynote. No one will waste shot upon communications if they do not know when they are in use; but on forward slopes, such as between supports and firing line, communications must either be absolutely concealed or omitted altogether if the firing points are not to be betrayed.

For foot traffic the Russians say "keep the width down to the minimum, about 2′ 4″ at the bottom, and make passing places of double width every dozen paces, with occasional recess refuges if there is much traffic. Throw all the earth on the exposed side, and only divide it if doubtful. Go on gradually deepening up to 7′ as long as the trenches are in use."

In Japan and America experiments in the rapid preparation of long lengths of trench for easy excavation have recently been made by detonating light charges of explosive along the trace.

In America charges of 8 oz. of dynamite dropped into holes jumped about 2′ apart and 2′ deep were fired simultaneously over a considerable length by the shock of detonation of a single charge towards the centre. These loosened the ground to a depth of some 4′.

In Japan a continuous charge of 11 oz. per foot run laid on the surface of the ground rendered shovelling easy for some 3′ below ground.

The immense importance of good covered communications has hitherto been somewhat overshadowed by the supposed paramount importance of early preparation of the fire positions themselves. In peace practices it is quite the exception to find that the necessary communications within an entrenched zone have even been marked out by the time the fire positions are completed; whereas the process should be exactly reversed. The fire trenches are a matter of hours, and paradox though it may be, the later they are sited and made the more use they are likely to be, whereas communications take weeks to develop sufficiently to ensure that the defenders may compensate for their lack of numbers by their powers of rapid concentration for the production of a superiority of fire at any given point.

Take a visionary example. A stronghold intersected by tube-

tunnel railways could be provided by this one means with bombproof shelter, countermine galleries, stairs to the surface close in rear of every good rifle fire position, sidings to run out the truck-mounted guns to every good artillery position, lifts at every point suitable for electric searchlights, and safe signal services, all at a cost less than that of a chain of massive forts and fixed armoured batteries. Yet without a single rifle pit it might well be considered likely to prove a harder nut to crack *in the hands of good troops* than any fortress recorded in military history.

[*Four illustrations of communications were demonstrated*].

Obstacles.

Obstacles, like other fieldworks, are good servants to the rifleman only when they enable him to increase his bag. The German axiom, that the most effective obstacle is the fire of the defender, is only another way of saying that no one is going to try to pass a good obstacle by daylight as long as every foot of it is under effective fire; for the Germans make immensely strong birdcage wire obstacles themselves.

To ensure the repulse of a heavy night attack not only is a good obstacle essential, especially on short range European battlefields, but it must be, as far as possible, under easy *enfilade* fire from points definitely prepared and screened from direct fire. Radial fire is weaker than ever in the dark, and as a mere passive obstruction, not controlled by fire, an obstacle soon melts away. The tendency now is to realize that the night obstacle problem must be divorced from the daylight fire problem, and that it is usually unsound to make the trace of obstacles slavishly conform to the dispositions for general fire effect. In dealing with obstacles and close fighting we are in many points carried back in a moment to the conditions prevailing in the days of Vauban. This is not new, for General Brialmont exemplified it many years ago in his triangular ditch round a fort of oval fire trace. We have now passed beyond the stage of the oval fort in the shooting department and the obstacle question becomes more and more a detached problem. Although it takes many hours to complete an effective obstacle, a very short time will suffice to get a few strands of wire up throughout the trace, and this should be the first move. The finished obstacle also need not be of equal density throughout, but should increase in passive strength in proportion to the difficulty of effective fire control, which may be due either to distance or to bad ground. It is usually quicker to "landscape garden" the obstacle itself than to dispose and conceal the earth thrown from a glacis trench in which to sink it. In war we *may* have to use silver-bright barbed wire picked up locally, but it would

be unpardonable to issue it from store until it had been through the green or khaki paint. The Germans issue special instructions for the daubing with clay of all freshly cut wooden surfaces on the posts of wire obstacles, and advocate concealment by transplanted vegetation.

Most obstacles made in peace time convey the impression that the enemy may try to jump them in marching order. Crawling is the pace and attitude of war, and density of wiring near the ground, and a few cartloads of broken glass, are disappointing to crawlers.

No more suitable article of store for use in the rapid construction of obstacles has appeared in recent years than the expanded metal gabion. A continuous central core of such gabions threaded on two or three uncuttable wire ropes and densely wired at all heights to other gabions spaced out instead of posts, the whole stiffened with a few steel fencing posts as holdfasts, and well strewn with broken bottles lightly earthed over, should afford plenty of promotion for the enemy's sappers.

[*Three illustrations of modern obstacles were demonstrated*].

OBSERVATION AND FIRE CONTROL IN ENTRENCHMENTS.

There is no necessity to emphasize the important part now played in defence by protected look-out and fire control posts. Several examples of infantry observation posts have already appeared in the plans of works shown, and it will have been noted that they are sited quite independently of the firing portions of the works. The generally agreed principles for their disposition are that there should be enough look-out posts to keep the whole field of fire and every possible line of approach under close observation by day. If possible not more than about 45° of arc should be allotted to one observer. The German normal type shows about 40°, the Russian 75°, which appears to be rather too much.

Since the observers *must* remain on duty under artillery fire, storm and tempest, protection and concealment are of paramount importance. They are therefore best well away from visible entrenchments, but must be in communication with the fire control posts both by signal and by covered walk, and if in advance, must be well screened from reverse fire. By night a different set of look-out posts would usually be required if the defences included obstacles, and the men in such posts should be close to any alarm guns or flare lights provided, and able to operate them at will independently from any involuntary operation of them by the enemy.

An officers' fire control post would usually include a look-out pit, with a splinter-proof shelter near by for the telephone, signallers, and orderlies awaiting messages. This look-out pit requires a wide arc

of view and should include all ground under fire by the men under the officer's command. An ordinary fire loophole is quite unsuitable. A horizontal slit, in steel plate if possible, about 2″ high, 12″ wide and 5′ above the observing step, is usually convenient. A seat should be provided 2′ 1″ below, and an elbow shelf (12″ wide) 1′ 1″ below the sill of the look-out slit for convenience in the use of binoculars.

In the O.C.'s post a megaphone aimed at one or two of the adjacent subordinate fire control posts should be kept fixed and ready for use at night in addition to a loose megaphone on a peg. Rockets and light signals for communicating at night with more distant posts, or with artillery, may be stored in the O.C.'s shelter. The map (ruled in the same squares as that with the artillery) should be oriented, in a good light, but protected from weather. Enlarged sketches of foreground can ignore the relative sizes of the conventional signs and should have the important range features boldly indicated and lettered to read easily *when the reader is facing the feature*, not, as sometimes seen, written upside down from a mechanical sense of homage to "α Ursæ Minoris." In addition to the lists of ranges chalked on the sides of traverses, etc., every range so marked should be actually verified by rifle fire—a precaution often overlooked—and every man should constantly be made to repeat from memory the ranges to his targets, even when a certain number of them are already marked on the ground with their actual range by a number of visible objects corresponding to the number of hundreds of yards in the distance.

[*Illustrations of the use of hyposcopes and fire-control posts were demonstrated*].

Cover for Machine and Field Guns.

Machine Guns.—All the principal armies now fight their machine guns from low tripod or sledge mountings—the latter being favoured by Germany and Russia.

Our "Maxim" and the French "Puteaux" fire over a height of from 14½ to 30″. The German sledge mounting fires from a ramp varying from 4″ to 2′ 4″ below the fire crest (*Fig.* 15, *Plate* IV.), and the Russian variety (*Fig.* 16, *Plate* IV.) fires off a level shelf some 3′ wide and 7″ below the fire crest. The advantages of the shallow sledge mounting working on an inclined ramp which permits of instant withdrawal are obvious.

Cover for the detachments and a protected look-out must be very near and very safe, since the weapon is essentially of the "now or never" variety and the detachments have to keep alert under cover for hours or even days ready for a few seconds' shooting at the warning of the look-out man (*Fig.* 15, *Plate* IV.).

Stabbing Batteries of Machine or Field Guns (*Fig.* 14, *Plate* IV.) for close range flank fire in the open field are greatly favoured by the Russians, and find a place in all recent designs for permanent works. In the latter they are usually found in an armoured gorge casemate caponier, and in fieldworks behind some natural salient screen in front of the general fire line. Their sudden leap into prominence is no doubt partly due to the success at Port Arthur of the famous "Open Caponier No. 3" (Hachi-maki-Yama), now known as "G," where a couple of field guns and a couple of machine guns thus mounted gave such trouble to the Japanese that they were compelled, for the first time in the history of war, to use 500-lb. shell from 11″ howitzers against simple earthworks.

Cover for Field Guns.—The chief tendencies in recent types of artificial cover for guns are in the direction of concealment, better flank traversing from oblique fire, and blinded cover for detachments and ammunition. The formal battery is as extinct as the formal fire trench, and a good hidden shoot with the maximum of protection are the ruling factors. A favourite opening move with the Japanese field artillery seems to have been the standing up of half-a-dozen large sacks filled with earth, (as gabions) to act as revetment to detachment shelter parapets on either side of the gun. In spite of its minor disadvantages the sunken gun pit, without visible parapet, is the normal emplacement, and separate screens to defilade flash and hide the gun shields are commonly provided. Both Russians and Japanese agree as to the importance of providing separate emplacements for night and day use, and spare emplacements in the rifle lines to enable guns to join in the shooting at assaulting mobs. The latter require gun shelters and easy ramps not unlike the types of 30 years ago.

German Field Gun Emplacements (*Fig.* 17, *Plate* IV.).

Battery without parapet to fire over ground level, sunk 2′.8″ at gun emplacements and 5′.7″ at shelters. Similar to the gun pits used by us for 4·7″ guns at Modder River Camp in 1899.

Russian Field Gun and Howitzer Emplacements (*Fig.* 18, *Plate* IV.).—The types of Russian field gun and howitzer emplacements are principally of interest from the practical simplicity of their trace and the extent to which blinded cover is illustrated. The illustration of cover for an ammunition limber or wagon (*Fig.* 18(1)) close to the gun is of special interest since so many armies have left this point to the long list of brilliant improvisations expected at short notice on the battlefield.

SUMMARY.

Time will not permit of any examination of the many recent developments of interest in connection with other branches of field engineering, such as searchlights and other field illuminations, land mines and explosives, field tramways, telephones, alarm signals, tools

and materials, bridging, and numerous subjects of equal interest, and it only remains briefly to sum up our own situation with regard to field engineering to-day.

If in the course of the examination of a few recent types of works there may have been an apparent tendency to dwell unduly upon the material means of defence or attack, it must not be thought that the paramount human element, or the spirit of the man who is "out to win," have been overlooked or ignored.

We know well that the best instances of good defences in history owed but little to the skill of the engineer as compared with the valour of the man behind the gun, yet it is still the duty of the engineer to apply his skill in seeking for strength, and still further refinements of strength, and to place them at the disposal of the man who does the shooting—to use or not to use—as he may think best for the occasion. The strength of field engineering, like the paint on the artist's canvas, produces nothing of value unless it is applied in the right place, in the right quantity, at the right time, and of the proper form and colour. Otherwise it remains, as the Malay idiom expresses it, "of no more use than a shield in a pawnshop."

Whatever critics may say to the contrary the defences constructed by the Russian engineers around Port Arthur were immensely strong; far stronger than their own constructors thought them to be; but they were not in harmony with the spirit of men who are determined to conquer, not merely to baffle their enemy. The science of field engineering applied in the true spirit appears to aim at supplying the means for that economy of force which enables the skilled jiu-jitsu wrestler to divert the ill-balanced strength of the impetuous giant in such a way as to hasten his downfall.

The field engineer must however be careful that it is the enemy, and not his own side, that he arranges to mystify, mislead, and surprise; and all his schemes should have that stamp of effective simplicity which will provide the maximum of opportunity for the *average* soldier, led with *average* skill, to inflict the maximum of loss upon the enemy. The good fighting man, now, as always, can make the best of his opportunities from moment to moment, though the best of soldiers cannot to-day ignore the spade and win through with rifle alone. It must always be remembered that it is the duty of the engineer to provide the soldier of the line with the assistance he *wants*: not something which the engineer thinks he *ought* to want, and is lucky to get. It is not enough for the engineer to set the stage and have his own lines by heart, he must rehearse the play from the very beginning with the gunner and rifleman present on the stage in full costume, or he may find at the first public performance, like the Austrian engineers at Königgrätz, that he has forgotten to inform the rest of the caste where the performance is supposed to take place, and where the properties are kept.

In this country we are perhaps fortunate in escaping the fatal magnetic attraction of cramped and obsolete types of land forts, which so often throughout military history have administered the slow poison of defeat to those who put their trust in them. But for this very reason it is all the more necessary for us to be fully prepared with matured plans for the rapid and intelligent anticipation of events, and for the use of provisional defences applied so skilfully that, however quickly the decisive point for using the leverage of one of our striking forces may be moved, that lever (the striking force) may always find a strong and tactically opportune fulcrum against which to bear at the decisive moment.

It is abundantly clear that, as fighting goes to-day, it is possible to extemporize effective fieldworks both from the smallest beginnings and in a comparatively short time; and that such works, if used so as to develop to the full the power of the modern firearm, possess enough of the passive strength of permanent fortress works for resistance, while they are of far greater value for making good in the wake of the offensive, owing to their being strategically sounder and tactically more opportune. But such works can be carried out *only by engineers trained for this purpose.*

The master-thought in all education in the use of the spade should not be that men well entrenched can *resist* the attack of several times their number, but that men who are trained and equipped to use the spade so as to increase the power of their other weapons should be able to surround and destroy or capture a larger force which has not this advantage.

Part of the Armoured Train.

A Corner of the Bivouac.

The Oudh and Rohilkhand Railway Volunteers

THE OUDH AND ROHILKHAND RAILWAY VOLUNTEERS.

By THEIR COMMANDANT.

ANOTHER year has rolled over the Oudh and Rohilkhand Railway Volunteer Rifles since the first notice in regard to them was published in the *R.E. Journal;* and although their conversion into Royal Engineer Volunteers (Railways) is still only "under consideration," it is now at least officially before the Government of India, and another short account of the year's work of a body of men, who hope one day to be linked with the bond of the Volunteer to the Corps, will, it is hoped, not be without interest.

The year, like most in the history of a Volunteer regiment, has had its encouragements and its disappointments; among the former being the loan of a Maxim gun for instructional purposes by the Lucknow Brigade, a long-deferred visit from the Inspector-General of Volunteers, and many kindnesses and much hospitality from the brigades and Regular regiments that the corps has come into contact with, both at its headquarters and elsewhere. About the latter, its disappointments, we will hope least said soonest mended; even obsolete weapons will finally refuse to work some day, and it is to be hoped that when the said day comes the replacements may be less obsolete and that the corps will not be "billed!"

The machine gun was of course eagerly taken up, and there were very soon squads—with a leavening of old soldiers—reasonably well versed in Miss Maxim's little ways and able to keep her in a good humour through quite long periods of continuous work: while as soon as the Inspector-General's approaching visit was announced it was decided to push on with a project that was already on hand for a dummy armoured train, and, with the cordial co-operation of the other Volunteer corps in Lucknow, to give the General an example of what might be accomplished in the way of special railway training for Railway Volunteers.

Work was therefore started at once in the shops on the construction of what is described above as a "dummy" train, but what is more correctly the nucleus of a real one without either the armour, or, for the time being, the 12-pounder; while outside, the weekly parades were devoted to placing the 5-mile stretch of line between the Gumti River at Lucknow and the next station—Malhour—in a state of defence.

On one bank of the Gumti a much improved sleeper-and-sand-

sandwich blockhouse, of the type illustrated in the *R.E. Journal* of July, 1910, was built by the Loco. and Carriage Company in the course of eight hours work, while elsewhere along the line other defences were constructed, some of them as having been built in a single afternoon, being of particular interest in showing what could be done in a few hours in an emergency, with materials, previously filled sand-bags, etc., railed out from Lucknow.

The blockhouse when completed was tested at close quarters with ball at what looked like its weakest spots, but resisted penetration successfully.

The armoured train is modelled on South African experience, but has been built of old broad gauge 4-wheeler stock instead of the South African metre gauge bogies, and has a Maxim gun truck fore and aft patched up out of old covered goods wagons, with, for the present, a most excellent dummy 12-pounder, which has had the honour of deceiving at least two generals as to its nature even at fairly close quarters! A photo of part of the train standing in the carriage and wagon shops accompanies this article, and shows one of the Maxim gun trucks with its infantry escort truck and the 12-pounder, next to which comes the end of the officers' carriage which accommodated the inspecting officers at the inspection. Since the 4-wheeler wagon, particularly of our old types, does not admit of many rifles in addition to the Maxim gun barbette, the balance of the infantry garrison of the train is carried in escort trucks, linked to the Maxim trucks, and with an armoured way between them.

There is some advantage in this division of 4-wheeler stock for the purpose as compared with a bogie, for the latter is an acknowledged "beast" to re-rail under difficulties, and by freeing the coupling between the two wagons the escort truck can if necessary be separated, half the armoured way then acting as a door to close the opening in the end of each wagon, so as to enable it to be defended independently if necessary. The train has now been fitted with special couplings to enable any likely "cut" to be performed without exposing any of the crew.

What, I fear, looks like a flag in the photo, is really the searchlight emplacement, at present, I regret to say, empty.

It was only just possible to turn the train out by the date of the inspection so that little previous practice of any sort was practicable, but a lecture was given to the officers of the corps on the handling of the train, and tactical notes were distributed; and although the enemy no doubt scored a "derailment" in the subsequent sham fight, this comes all in the day's work of an armoured train, and some useful experience was no doubt gained in this kind of work.

Opportunity for realistic practice is the difficulty on an open line as everything has to be naturally restricted to suit the time table, with the result that operations have to be somewhat rushed.

On this occasion the train was manned by a railway 12-pounder gun crew, road repairing and re-railing working parties, a telephone section, and one Maxim gun section, while the Lucknow Volunteers found the second Maxim gun and most of the infantry garrison. It ran out to Malhour, dropping the garrisons of the posts *en route* before a passenger train, and hostilities commenced as soon as this latter train was "through." The most important points on the section were the Gumti bridge, Malhour station, and a bridge about 1½ miles from the Gumti, each of which was strongly defended. In addition to these, defensive posts were constructed at either end of a cutting about a mile from Malhour intended as a "harbour" for the train and there was one other intermediate post. Each of these posts were tapped to the ordinary telegraph wire by means of field telephones, and could thus intercommunicate between themselves, and, when necessary, the train with them by means of the train telephone and a bamboo and clip arrangement, enabling connection to be made in a couple of seconds with the wire used by the 'phones. The inspecting officers examined the defences of the cutting, and news then came by 'phone that a party of the enemy were interfering with the track between the Gumti and the intermediate bridge referred to above, so, as there was no news from elsewhere, the train pushed down the line in that direction. As a matter of fact the great bulk of the enemy (who consisted of the majority of the Lucknow Volunteer Rifles and the Lucknow Troop of the Oudh Horse) were lying up close to the cutting, and as soon as the train proceeded on its way they attacked in force and the garrison was ordered (or thought it was) by the local umpire to "quit." On reaching the next post, news was received over the wire of the plight of the west post of the cutting, and the train hurried back, and found a fight still raging in the vicinity of the post. As it was now almost dark and impossible to distinguish at any distance between friend and foe, it was decided to push into the midst of them, detach the leading Maxim truck, and withdraw the train with the 12-pounder to come into action after the enemy's position had been determined. In doing so the leading vehicles passed slowly in the dusk over what had been settled upon as the sign of wrecked track, and it being now very late the "Cease Fire" had to be sounded, and friends and such foes as could be found railed back to Lucknow.

In November a team of 12 men was sent to Meerut—the "Bisley" of Upper India—and came back with one cup, two first prizes and two medals in connection with the match Regulars *versus* Volunteers in which the latter were victorious, besides sundry smaller prizes; so it was quite satisfied with its achievements.

Almost immediately after the Christmas holidays, on January 6th a move was made into the annual camp, held this year some 9 miles from the Armoury on the further (left) bank of the Gumti River near

the camp of 1910. The corps for the first few days worked by itself, the task first undertaken being the entrenching of a position, each of the three companies in camp constructing a length of trench the first day, attacking it with blank the next to show up defects, and then, after remedying anything desired, equipping it with earthenware jars or "chatties" to act as targets for the following day's field firing. Part of each trench was loopholed and part purposely left without overhead cover to show the effects to the men, and the different companies further adopted different types of head cover.

On the third working day, each company was directed with ball against the trench of one of the other companies, in addition to which the Maxim gun was dragged out 2 miles from camp (on its parapet mounting) to take part in covering from our left flank the advance against the trench. The very high percentage obtained this day of 19 per cent. of hits to rounds fired was no doubt largely due to fire being permitted up to about 150 yards range; (from which distance the trenches were "rushed" with fixed bayonets,) but it also shows general good shooting amongst the great bulk of the men in the ranks.

Next morning we were reinforced by a troop of U.P. Horse, two guns R.H.A., and three companies Lucknow Volunteer Rifles, and ordered to seize a ferry on the Gumti on the right flank of the Lucknow Brigade which was operating against a flagged enemy some 2 miles from the right bank of the Gumti.

The movement was opposed by two squadrons of British cavalry, and began auspiciously for the detachment as its guns caught the cavalry crossing its front at about 1 mile range in close order apparently to seize our field firing trenches. The enemy then seized a village, and after some fighting there fell back slowly on to river where they eventually got hemmed in and the "Cease Fire" was sounded, all except the Oudh and Rohilkhands returning to their various camps and quarters.

The Railway Corps sent officers over the river to get into touch with the brigade and report the result of the day's work, and went itself into bivouac for the night in a guava grove, all ranks making very neat *tentes d'abris* out of two blankets laced together along one edge, and stretched over a string and two bamboo sticks, which formed part of the "mobilization" equipment. The third blanket was used to wrap around the three occupants.

The general appearance will be seen from the photograph showing a corner of the bivouac.

The orders received from the brigade were to cross the Gumti at daybreak and join the right flank of a position they had taken up covering Lucknow; and this was accordingly done, the men crossing in country boats, and the horses and mules swimming.

The junction with the brigade was effected without incident, and

the corps received a portion of the defensive line covering a ford over a tributary of the Gumti. The enemy were, however, unkind, and attacked the extreme left flank, and after this had become apparent, our right, including the Oudh and Rohilkhands, was ordered to move north and take part in an attack on the enemy's left, in the course of which it saw and took part in some very interesting work.

About 2 o'clock in the day the operations came to an end with a "draw," our force having rolled up the left flank of the flagged enemy, and the enemy having equally rolled up ours; and all the troops dispersed, the Regulars to Lucknow, and ourselves to our camp. When we got back that evening about 5 p.m. we had covered something over 16 miles all over rough and roadless country, and with only one "casualty" which wasn't bad going.

It had been intended to strike the camp next day, but there being some difficulty over transport and a very general desire to extend the camp, it was eventually decided to delay the return by one day, and instead of the march back the G.O.C. Lucknow carried out his inspection, the battalion forming outposts during the morning, and practising ceremonial in the afternoon. The next day the men returned to Lucknow, marching in in good style and many of them genuinely sorry that the camp, which including the marches in and out had lasted nine days, was over.

There is no doubt that a great deal of value is learnt by many during these outings, not only in the actual drills and manœuvres but also through the odds and ends of practical work that have to be carried through to effect these manœuvres. Getting the baggage out for the bivouac, for instance, was no easy job. The only mules we had the loan of were for water and tools, military transport failed, and country carts had to be commandeered: the route was roadless and intersected with nalahs and the baggage guard had frequently to dig roads for themselves, take the bullocks out from half the carts to double team the remainder, and so on. Again, the country was largely unknown and opportunity was taken for instructing in military sketching, engineering officers already well acquainted with deliberate railway surveying, etc.; their work being utilized in the subsequent marches and operations.

The rest of the season was devoted to the usual routine. An occasional "tactical" afternoon, and the rest a much-needed "rubbing up" in the handling of arms and movements in company drill; more especially with a view to bringing on the non-commissioned officers. This ended towards the end of March with an examination of two officers and a number of N.C.O.'s for their "Proficiency Certificates"; the Regular subaltern's "a" and "b."

The only exception to the above was at Bareilly where the O.C. Volunteers, who had been unable to come into the regimental camp, arranged to join the Bareilly Brigade on manœuvres with a section of

25 men—many of whom had already done the regimental camp. Owing to the hospitality of the Seaforth Highlanders, to whom they were attached, they had a most enjoyable three days, ending in a night march and attack at dawn on the details left in Bareilly.

During the year we have lost no less than four youngsters through enlistment. One of these has gone to the Seaforths and is doing well. One of the others to R.H.A.

Of the railway officers no less than six are in the ranks awaiting their turns for commissions, and all we lack are Sappers ready to utilize their professional qualifications in helping on the rest of the corps. During part of the camp a Military Works officer joined us as a guest, and though unfortunately he could not come till the digging was over, was able to help afterwards in the sketching work, etc.

The principal feature of the past year has been the great increase in the efficiency of both the company officers and the men as a result of the new musketry course. This is based on the Regular course, and, like it, divided into an instructional period and a "test," the former being under the company officers. As a result, for the first time on record the company officers have taken a keen personal interest in the musketry training of their companies, a work which hitherto has invariably (practically under the *Regulations*) been left to the paid staff. The cessation of the *rôle* of figure-head for the company officer, and the greater incentive to the ordinary bad and indifferent shots to do well when working under the eyes of their own officers, has been of a value to both officers and men that it would be difficult to reckon too highly.

THE BRITISH MILITARY MISSION IN EGYPT, 1798—1802.

THE following interesting documents were found amongst a number of papers which originally belonged to Lieut.-Colonel Sir C. Holloway, R.E. They refer to a little-known Military Mission which was despatched to Egypt under Brig.-General Koehler, R.A., and in which the Corps played a conspicuous part.

The mission was originally intended to assist the Turks in expelling General Buonaparte and the French Expedition from Egypt in 1798, but, as this task proved impossible, the British Expedition was despatched to Egypt in 1800 under Sir R. Abercrombie, and General Koehler was ordered to assist by every means in his power.

General Koehler died early in 1801 and Major Holloway, R.E., then assumed charge of the mission and commanded it until the end of the operations.

The documents reproduced consist of Lord Granville's original instructions to General Koehler, and a letter from him in October, 1800, telling of the intended despatch of Sir R. Abercrombie's expedition. Two letters from Capt. T. Lacey, R.E., giving a description of the Turkish advance and defeat near Cairo in March, 1800, and of a battle near Belbeis in May, 1801. There is also a copy of Major Holloway's summons to the French garrison at Cairo in April, 1801, and a letter from Capt. (afterwards Sir A.) Bryce giving details of the preparations made for the attack of Cairo. Finally Major Holloway's detailed report on the operations is added, the original MS. of which was found amongst some old records in the Institute, as also a report on the defences of the Dardanelles, submitted to General Koehler by Major Holloway, R.E., and Major Hope, R.A., in September, 1799.

(1).

*Instructions from Lord Granville to Brig.-General Koehler, R.A.**

DOWNING STREET,
November 11th, 1798.

To BRIGADIER GENERAL KOEHLER, etc., etc.

SIR,

His Majesty having resolved to send a certain Proportion of Military Stores, with a number of Artillery and Engineer Officers to

* The orthography, etc., is shown as in the original MSS.

the assistance of the Ottoman Porte, in order the better to enable that Government to prosecute the War in which the Grand Signior is engaged in common with His Majesty against France; and having been pleased to make choice of you to take the Conduct of this Expedition; I am now to convey to you such Instructions as may appear to be necessary for the regulation of your Conduct therein.

Immediately upon receipt of these Instructions, you will proceed by Land to Constantinople, with the greatest possible Expedition; taking with you as many of the Officers, placed under Your Command, as you may think proper, and leaving the remainder, together with all the Stores, to go in a Ship which the Lords of the Admiralty have received His Majesty's Commands to prepare for their transport to the place of their Destination.

Your knowledge of the Country to which you are going, and your Experience of the Manners and customs and Prejudices, political and religious, of the Government, and of the Inhabitants, will enable you to adopt and prescribe to the Officers under Your Command, the proper mode of presenting yourself, and of opening the objects of Your Mission to the Persons who may be appointed by the Grand Signior to communicate with you; as well as the proper Demeanour to be preserved during your Residence in the Country.

But upon these and all other points of a similar nature, you will refer in the first Instance to Mr. Smith His Majesty's Minister Plenipotentiary at the Porte, and will conform yourself to His Suggestions.

You will represent to the Turkish Government, the strong and lively Interest which His Majesty feels for the Success of the Arms of the Porte, and His Desire to contribute so far as in Him lies, to the vigour and efficiency of its Military Operations;—for which purpose you are commissioned to offer every Aid and Information in your Power, and are to act to the best of Your Ability, and to the Extent of the Military Means entrusted to your charge in any Quarter, and upon any Military Service which you shall judge to be conducive to the great objects which His Majesty has in view.

With regard to the nature of the Service which you may have to undertake, the peculiar circumstances of the case render it impossible to give you any precise Instructions.

The Defeat or Destruction of the French Army in Egypt, and also of their Transports and other Vessels in the Port of Alexandria, and elsewhere, will naturally engage Your first Attention. And you will be particularly solicitous to direct the efforts of the Porte in such a manner, as may destroy even the Possibility of General Buonaparte's using any part of his Force to the annoyance of the British Dominions in India. Subject to these Remarks, you will chearfully accept whatever Destination may be offered to you in which you can most effectually be employed against the Common Enemy; and you will

concert, as well with Mr. Smith, as with Sir Sidney Smith, or the Commander of His Majesty's Squadron in the Levant Seas, such Operations as it may be expedient to suggest to the Porte, for the Expulsion of the Enemy from the Grand Signiors Dominions, and generally for their Annoyance and Destruction there, or in the Coasts and Islands thereto adjoining.

You will communicate from time to time to me directly, and constantly to His Majesty's Minister at the Porte, an Account of the operations in which you may be engaged, and also of those of the Turkish Arms in whatever part of the Empire; and of the general Plan of Operations and success of the Campaign.

Of the Military Stores which you carry out with you, such as are of Ornament only, are in the first Instance to be presented to the Grand Signior, with whatever Formalities may be necessary on the occasion, as a present from His Majesty, and as a Proof and Pledge of His Friendship and Respect for that Monarch.

That part of them which are destined for active Service, you will endeavour to keep as much as possible under your own direction until you shall have succeeded in instructing the Turkish Officers in the method of using them with Effect; and you will follow your own Discretion, and the Judgement of His Majesty's Minister, as to the Propriety of ultimately making them over to the Turkish Government, or as to the Moment at which it may be expedient to do so.

The Board of Ordnance having appointed a Commissary to superintend the use of these Stores (but subject entirely to your Control as to the mode of using them) and to account for them to the Ordnance. You will of course give him a regular Discharge for such Articles as you may from time to time part with to the Porte or Its Officers.

I am with great Truth and Regard,
Sir,
Your most obedient humble Servant,
GRANVILLE.

(2).

DOWNING STREET,
10th October, 1800.

To GENERAL KOEHLER, etc., etc.

SIR,

The King having, on a consideration of the present state of Egypt, determined to send thither a considerable body of Troops under the command of Sir Ralph Abercrombie, I have received the King's commands to transmit to you, for your information, an Extract of the Instructions which have been given to that Officer for the regulation of his conduct in this important service. And I have to signify to you

His Majesty's pleasure that you afford Sir Ralph Abercrombie every possible assistance which can contribute to the success of the enterprize in which he is engaged. For this purpose it is His Majesty's pleasure that you regularly transmit the most accurate information of the state and operations of the Turkish Army in Syria to Sir Ralph Abercrombie, and that you should in all respects govern your future proceedings by such orders as that Officer may think it expedient to give you on his arrival in the Levant, or by any previous communication.

His Majesty's Ambassador at the Porte is instructed to correspond with you on this subject; and He will apprize you of the measures he may have taken or may wish you to take for procuring such a number of saddle and draft horses as may be wanted for the immediate use of the Army on its arrival in the Levant; and for such other objects as may contribute to Sir Ralph Abercrombie's success.

I have the honour to be with great truth and regard,

Sir,

Your most obedient humble Servant,

GRANVILLE.

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(3).

Letters from Capt. T. Lacey, R.E., to Major Holloway giving descriptions of the Turkish Advance upon Cairo in March, 1800, *and of the Battle of Belbeis in May,* 1801.

CAMP AT JAFFA,
21st July, 1800.

To MAJOR HOLLOWAY, etc.

Report in compliance with Orders of Major Holloway, Comdg. Royal British Engineer in the Dominions of the Grand Signior, of Military Occurrences to which I was an Eye-Witness, from the time of my presenting Dispatches that had been entrusted to me for the Grand Vizier, by His Excellency the British Ambassador at the Ottoman Porte, to the period of my arrival at Jaffa, after the total Rout and Defeat of the Turkish Army.

I presented my Dispatches to the Grand Vizier, at his Camp at Belbeis, the day after my arrival there; viz., the 9th March, 1800. From this period to the 12th of the same month we continued encamped at Belbeis, myself remaining under Mr. Morier's tent; but without being made acquainted with the interior arrangements or intended operations of the Army; and only employing myself to assist Mr. Morier in copying Dispatches and Advices, which, not being of a military nature, I do not here feel it necessary to disclose. On the 12th March, the Army moved towards Cairo; and from this event,

I shall proceed to copy from my Note-book such remarks as circumstances enabled me to collect, thinking this the best mode of conveying the information now required of me.

12*th March*. The Army leaves Belbeis and marches towards Cairo, the place for the new encampment having been proclaimed through the Camp two days before; when it was left to all to take up their new ground at such different intervals of time and in such order as they thought proper, and without waiting for the movement of the Grand Vizier. At three hours distance from Belbeis, we arrived at an Arab Village called Lavanhie. A flat loose sand lay all the way on my left hand, with the view bounded by a ridge of low sand Hills, the confines of the Desert of Suez. On my right hand nothing but cornfields of the highest culture, a vast appearance of abundance, and many Arab villages shaded by tall Date trees, raised on little mounds above the plain; built of sun dried bricks, and furnishing excellent positions and materials for Military purposes. The country everywhere is well adapted to the operations of cavalry. In the afternoon, arrived at our new camp, six hours distant from Belbeis, no order observed in fixing it, it looks like a fair. This place is called El Hank.

13*th March*. Expecting an attack from the French. The Grand Vizier, and all the Council in the greatest alarm, they send forward ten thousand men as an advanced guard, or army of observation; but have no system, and are even too ignorant to make the most obvious arrangements, they know nothing of disposition. I offered my services to the Grand Vizier, and proposed to find my way into Cairo under some false pretence, in order to view the country round about, to reconnoitre the works, and gain information from within, but this, after some consideration, was rejected.

14*th March*. Received a present of a shawl and other rich cloths from the Grand Vizier, in consequence perhaps of what passed yesterday. I was sent for to receive this in the tent of the Reis Effendi he asked me, why I had not visited him before. They have just sent to El Arish for their field train, they have not at present more than twenty pieces of small bad ordnance, and not even ammunition enough for them.

15*th*, 16*th*, 17*th*, 18*th March*. Turkish Ministers holding absurd conferences with the Enemy, by which the latter only endeavour to gain time, in order to collect their troops from Upper Egypt and the Delta.

19*th March*. Employed in writing letters to Major Holloway and my Lord Elgin.

20*th March*. In sight of Cairo and the Pyramids, a little skirmishing in front, and the French Army drawn up in a fine plain before us. Mr. Morier sends off a Tartar to Sir Sidney Smith, and I seize the same opportunity to send accounts to Genl. Koehler, on a leaf torn from

my pocket book. The Grand Vizier permits me to reconnoitre, and sends Officers of his own suite along with me. Very much in want of a Dragoman, my own having slunk away, to remain with the baggage. I placed myself near the right of the enemy's lines, and found their chief force compactly drawn up, to the amount of about seven thousand men, with plenty of cavalry and artillery, and seeming to be making dispositions on their left to cut off our advanced parties who were dispersed here and there, without connection or design, and of no use either to annoy the enemy, or to prevent their advancing. Our artillery moved forward at the same time that I did, and were placed in front of the enemy's lines, at the distance of about one thousand yards. As I had placed myself about half way between these guns and those of the enemy, I could perceive that our own did no execution at so great a range, while the enemy's guns, of much larger calibre, threw their shot quite home, and very soon dismantled two of ours. The enemy were drawn up in two lines, the one a little advanced before the other, and the right of the second line so far out flanking that of the first, that their Artillery from this quarter also had effect upon us. Having finished my observations I returned to urge the Grand Vizier, immediately to form his infantry, and to send forward some artillery to an advantageous situation, at the extremity of a grove of date trees, near the enemy's right. I brought him also one of the enemy's balls, thrown from their pieces de huit to convince him that our small ordnance should be placed much nearer the enemy, and in the spot I had just chosen for them. But the Grand Vizier thought he had done enough for that day, and after enquiring only after the enemy's numbers, seemed determined to return to his Camp at El Hank, supposing no doubt that the enemy would permit us to do so unmolested. Soon after however, the enemy moved forward; deploying, and extending their front and with battalions advancing round our right in a position either to cut us off, or to drive us immediately to the Desert, where the enemy had five or six hundred of their bravest troops mounted on camels, quite sufficient to have destroyed the few of us, only who then remained with the Grand Vizier. Those of the enemy who were coming upon our rear, had been mistaken for our own troops; when I found it necessary to undeceive the Grand Vizier, and to urge him, either to rally and repel the enemy, or instantly to save himself by flight, there was no choice left him so we fell back in the greatest disorder and precipitation towards Salahieh; the enemy pursuing us as far as Belbeis.

21st March. Arrived at Salahieh. Recommend them strongly to maintain this post, at all events, and to keep open a communication with Damiat and by retire thither in case of disaster. Met with nothing but insult and contempt.

22nd March. Wrote to Gen. Koehler all that had passed, and sent

my letter by Mr. Morier, who was then about to depart to join Sir Sidney Smith by way of Damiat.

23rd March. The Turks in Cairo defend themselves bravely, some resistance also, made by them at Corin. They bring in a few heads, with the uniform of a French General.

24th March. The Grand Vizier directed all those, who had good horses and good arms to follow him. I consequently mounted myself and my servant upon a sick horse, all that remained for me and put myself in the Grand Vizier's suite. I had previously offered large sums of money for a couple of horses or camels and had also made a strong requisition for them to the Grand Vizier, but all in vain and I had the mortification to see Mr. Franchini's Men's conveniences attended to, while I, in the utmost necessity was left either to be massacred by their own disorderly troops, or else to fall a prey to the enemy. At the instant of our joining the Grand Vizier, a general pillage ensued, the troops fought among each other, and only permitted me to escape with the greatest difficulty. I lost all my baggage, with letters, notes, instructions, etc. Soon after we entered the Desert, my horse being without shoes, and having lost a great part of one of his hoofs, fell suddenly lame, and would not proceed further. The Grand Vizier and his Officers had many led horses and trains of camels slightly laden, but offered me no assistance, though it was evident I must perish without it, and had it not been for the humanity of a Mamalouk attached to Ali Pacha, this would certainly have been the case; he placed my servant upon one of the Pacha's Dromedaries, and gave us water and bread from time to time, by which alone we were enabled to cross the Desert.

25th March. Arrived at Catieh.

26th Do. At El Arish.

28th Do. At Gaza. The Army again encamped to the amount of ten or fifteen thousand Men, having left many to be destroyed by the Enemy or to perish in the Desert.

29th March. Sick, and very ill treated.

30th, 31st Do., and *1st and 2nd April.* Do.

3rd April. Required to translate letters received from Lt.-Col. Murray by the Grand Vizier, and to return an answer, the Dragoman of the Porte treating me all the while with the greatest scorn and indignity.

4th April. Sick.

5th Do. The Army marches to Jaffa, myself not in a condition to continue with them.

6th April. Sick.

7th Do. Resolved to follow the Army, though still very weak, and sent to the Pacha to request a guide to conduct me to Jaffa, but this was refused me. The treatment I experienced determined me to set off without one. Arrived at an Arab Village with a Turkish garrison, where they would hardly permit me to enter.

8th April. Obliged to set off in the middle of the night, to be taken before the Pacha of Jerusalem as a spy. Was permitted to continue my route, but having been taken out of my way, lost myself, and was obliged to hire guides from village to village, where the Bedouins were then plundering and the Turks at war with them.

9th April. Having been well treated by the inhabitants, I proceeded towards Jaffa, and arrived in the evening, in so bad a state, that I was obliged to be taken off my horse and conveyed to bed immediately.

THOS. LACY,
Lt., Rl. Engrs., and Captn.

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(4).

CAMP AT BELBEIS,
17th May, 1801.

To MAJOR HOLLOWAY, Comdg. British Forces, Camp Grand Vizier.

SIR,

I have the honour of reporting to you, that on the morning of the 16th about 7 o'clock, I quitted the Camp at Belbeis, accompanying Mahomed Pasha, who with the troops under his command, moved forward to support the advanced corps under Tahir Pasha. After proceeding nearly three leagues, on the side of the Desert, we joined these corps about half past eight, at which instant they were engaged with the enemy and had been so for some time previous. The enemy were posted near a village and wood of date trees on the skirts of the Desert halfway distant between Belbeis and El-Hank, while Tahir Pacha with his Albanian infantry occupied a village near them, maintaining a brisk cannonading and constant skirmishing. When this had continued near an hour, the troops under Mahomed Pacha, who had halted during this time, advanced with three light field pieces, and the enemy quitted their position. The Corps of Dehlis and Mamalouks had posted themselves upon hills in the Desert on our left. The enemy then moved towards these hills the first body of them, which formed their right wing, gaining the heights, where, formed in hollow square, they protected the rest of their army as they filed from the wood and the village. While this was effecting the Grand Vizier arrived with a fresh body which joined Tahir Pacha, whose troops, with great alacrity and bravery, had previously possesed themselves of the position the enemy had quitted. The enemy were now in the Desert continually shifting their ground, and pressed on both flanks. Tahir Pacha on their left and the cavalry on their right. In this situation of things they quitted the heights and retired further within the Desert, their left being annoyed by the guns of Tahir Pacha. From this period the enemy made no further use of their artillery, but retired, on their left, along the desert with great rapidity, and sometimes in disorder. Their infantry laboured thro' the sands

evidently with great difficulty, the Turks hovering on all sides, and continually harassing them, and Tahir Pacha's troops keeping the cultivated country, extended themselves far beyond the head of the enemy's column. In this state the enemy were pursued beyond El Hank, and for a distance of eight miles they must have been in constant apprehension of being cut off, and entirely routed. The enemy amounted to nearly five thousand, composed of infantry, cavalry, and Hedjins (?) and with about twenty pieces of Ordnance, guns and howitzers. I left El Hank an hour before sun-down, when the pursuit had been given up, and the troops under Tahir Pacha were retiring to their quarters.

Sir,

I have the honour to be

Your Most Obedient, Humble Servant,

THOS. LACY,

Captn., Royal Engineers.

(5)

Copy of Major Holloway's Summons to the French Garrison in Cairo.

AU CAMP IMPERIAL OTTOMAN DE SON ALTESSE LE SUPRÈME VIZIR-EL-ARISH,

3^me^ *d'Avril*, 1801.

Les derniers Succès des Armes Britanniques et Ottomanes dans le voisinage d'Alexandrie ne peuvent pas vous etre inconnus; ni l'Approche d'une grande et puissante Armée sous Son Altesse Le Suprème Vizir: par lesquels toute possibilité de Secours vous est coupée.

Son Altesse Le Suprème Vizir par des Motifs d'humanité et par un desir d'epargner le Sang des Braves Troupes, m'a donné des Pouvoirs d'offrir à la Garnison de la Citadelle de Caire les termes suivans.

La Garnison doit se rendre prisonnière de Guerre dans l'espace de 24 heures àprés la reception de cette Sommation.

Les Canons, Mortiers, Munitions de Guerre et de Bouche, Fusils et toute espece de Munition et Proprieté publique dans la Citadelle doivent etre remis dans leur etat actuel, au Commissaires qui seront nommés pour les recevoir.

Les Vies des Français qui composent la Garnison seront sauvées, leurs personnes respectées et un transport à la France leur sera fourni.

CHARLES HOLLOWAY,
Du Corps Royal de Genie et Major
Commandant les Troupes de Sa Majesté
Britannique avec l'Armée Imperiale Ottomane.

À l'Officier Commandant les Troupes de la Republique Française, qui composent la Garnison de la Citadelle de Caire.

(6).

Letter from Capt. Bryce giving details of the stores, etc., prepared for the attack on Cairo.

CAMP NEAR TERRANI,
29th May, 1801.

SIR,

I have received by Lieut. Col. Kempt the Commander in Chief's Orders to make preparations for the attack of Cairo which has been determined on in concert with the Vizier. And am informed at the same time that you intend to take the Command of the Corps of Engineers on this occasion.

I will not pretend to conceal my dissapointment on being thus a 2nd time unexpectedly superseded on the eve of a Seige, after having been so long in command of the detachment under very uncomfortable circumstances, and after having left England with the Boards warrant to command. More especially as your diplomatic duty appears to be more distinguished and preferable to the other. I hope however that I need not assure you that these circumstances shall not prevent my exerting myself as much as possible in forwarding the necessary Stores, and making such arrangements as seem to me best calculated to forward the service in which you are engaged.

It is much to be regretted that circumstances (with which you probably are acquainted) prevented anything on this head being settled before we left Rhamanie. The Stores would during this time have been collected and measures taken for their being forwarded. At present a small proportion are with the Army here, some at Rosetta, some on board the Transports at Aboukir, the remainder at the Camp near Alexandria. So that owing to the great difficulty of getting over the bar of the Nile, The small depth of water on Lake Maadie (by which the Stores from Alexandria must come) and the difficulty of procuring enow of Germs I apprehend much inevitable delay. I shall set out for Rosetta to-morrow that I may be enabled to give the necessary directions on the Spot. In the mean time I enclose a list of what I propose forwarding to you. In making out this proportion I have adverted to the propriety of reserving a certain Quantity of Stores for the Siege of Alexandria as well as the probability of your being supplied with some part of certain Articles by the Viziers Army. And the great difficulty of procuring sufficient tonnage to forward them. If therefore it should appear to you inadequate, let me know as soon as possible and at the same time arrange with the Qr. Mr. General the additional Germs necessary for their conveyance, or if you observe anything in

the list not absolutely necessary the sooner I am informed of it the better. I have been exceedingly anxious to avoid as much as possible in our operations a greater expenditure of Intrenching Tools, as they are not to be replaced in this country. I hope however for a supply from Malta where Major McKerras left a considerable quantity which I have written for. Very little of my original Stock of pine timber remains having used a great deal for a variety of purposes and having been unavoidably obliged to furnish the other departments of the Army, as well as the Navy, but 4 Ordnance Ships lately arrived have brought 17,000 feet of 3 inch pine plank and 8,000 feet running of Timber 12 × 10, this last is much too heavy but having no other I must send it with two or three Pit Saws, of which I have but four. Lieuts. Birch, Graham, Kennet, Arnold and Lieut. Harrison Asst. Engineer will proceed with the Army to join you, and Capt. Ford and Lieut. Squire from the Army before Alexandria (where I shall have remaining Lieuts. Hayes, Handfield and Dundas). I am sorry that our detachment of Artificers and Labourers is so small being in all 32 of which 8 are Labourers. Those with the Army here will proceed to join you, I understand that you have with you a small detachment, I believe the Army will furnish you with about 100. The list of Stores I have with me here was made out at Marmorin Bay and therefore incorrect as a considerable quantity has been expended since, but I will forward you a corrected list from Rosetta that you may know what is to be had from this Quarter. I must beg you however not to lose sight in your calculations of the time and difficulty in getting Stores from Alexandria to Rosetta.

I have just sustained a great loss here by the death of my best Clerk of Stores, I will however endeavour to send one on to you with two Conductors who are but indifferent. I also send 4 civil Coopers, two of them very good men and fit to be employed in charge of Stores. I have got a great quantity of Staves in bundles for forming Casks, I propose if you think fit and I can find conveyance to send you 300 or 400 bundles and some more Coopers to set them up. I have to request you will excuse this hasty sketch which conveys you as much information as occurs to me at present. I shall be happy to hear from you soon and very happy to do everything in my power to contribute to the success of the undertaking in which you are engaged.

I have the honor to be,
Sir,
Your most Obedient Humble Servant,
ALEXANDER BRYCE, *Capt., Royal Engrs.*

To MAJOR HOLLOWAY, Royal Engineers, etc., etc., etc.

29th May, 1801.

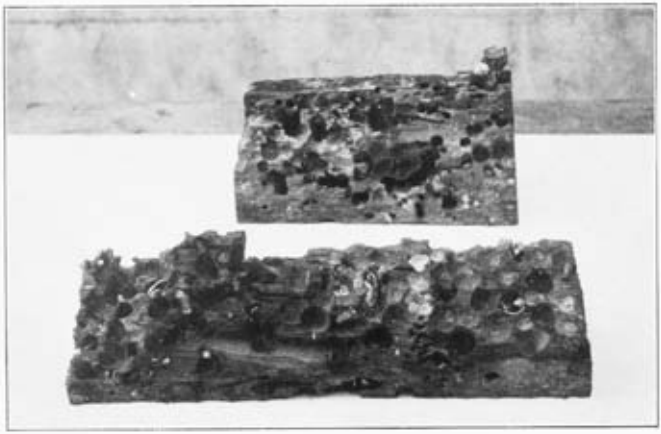
List of Stores proposed to be forwarded to the Army acting on the Nile.

Axes, felling	... ...	100	Manes wood 40
„ broad	... ...	40	„ pin 10
„ pick	... ...	1,000	Mallets fascine 100
Augers	... ...	10	Mattocks 200
Adzes	... ...	10	Nails, 40'd 8,000
Bills, hand	... ...	300	„ 20'd 8,000
Barrows, wheel	... ...	50	„ 10'd 4,000
„ hand	... ...	50	Pickets fascine ... ... —
Bags sand, bushel	...	40,000	Planes Jack 4
„ „ ½ bushel	...	40,000	„ Trying 4
Baskets ballast	... ...	400	„ Smoothing ... 4
Coals, casks	... ...	4	Rammers earth 40
Candles, lbs.	... ...	56	Rope, coils 4
Forge carts complete	...	2	Rules 2 feet 6
Crows iron	... ...	12	Squares iron 10
Choakers fascine	... ...	30	Spikes 7 inch 10,000
Chisels, sets	... ...	2	Shovels 14,000
Grindstones and Troughs		4	Spades 700
Gimblets, sorts, dozens	...	3	Spare helves, Spades and Shovels 600
„ spike „	...	2	Spare helves, Mattocks and pickaxes 300
Hammers hand	... ...	10	Saws with files, Cross cut 10
Handspikes	... ...	40	„ „ Hand ... 30
Hatchets hand	... ...	300	„ „ Pit ... 2
Harness Men's, sets	...	6	Stones rag 10
Iron of sorts, Cwt.	...	4	Plank 3 inch pine, feet ... 8,000
Jacks screw	... ...	3	„ 2 and 3 inch oak ... 1,500
Knives, drawing	... ...	6	A proportion of such scantling as can be had.
Ladders scaling, joints	...	60	
Levels Masons	... ...	4	
Lanthorns of sorts	...	20	
Line Hambro, skeins	...	10	

(*To be continued*).

DESTRUCTION OF A TIMBER JETTY BY THE SEA-WORM

View of the underside of the Jetty, showing the condition in which the uprights appeared when the walings had been removed.



Tunnels made by the "Teredo.

The Sea-Worm

THE DESTRUCTION OF A TIMBER JETTY BY THE SEA-WORM, AND ITS RECONSTRUCTION IN BILLIAN.

By Capt. G. H. Addison, R.E.

Introduction.

In 1904 and 1905 extensive reclamation works were being carried out by the Admiralty on the north shore of Victoria, Hong Kong, in connection with which two timber jetties, 550′ long, were constructed. These were handed over to the War Department, and, with the exception of some 100′ at the east end, are now in use by the A.S.C. and the A.O.D.

In 1909 it was found that considerable decay was going on in the timbers below high-water level. The rapidity with which this increased during the hot weather was remarkable, and, in view of the heavy loads to which the jetties are subjected, it soon became clear that partial repairs would not meet the case. The eastern portion used by the A.O.D., being a year older than the western or A.S.C. portion, was naturally in the worst condition, and in the spring of 1910 it was decided to dismantle and completely rebuild it, leaving intact only the hollow cast-iron piles upon which the structure is carried.

Alternative Methods of Reconstruction.

Three materials for reconstruction suggested themselves, viz. :— (i.), Timber; (ii.), Ferro-concrete; (iii.), Rolled steel sections. Leaving (i.) for the moment and considering (ii.). Although opinion may still be divided as to the chemical action of sea-water on Portland cement concrete and this form of construction cannot yet be said to have withstood the test of time, there is plenty of inferential testimony that reinforced concrete is about the soundest system for new work of this nature. Immense difficulty is, however, experienced in getting such work done locally, and, with unskilled coolie labour, the amount of supervision and length of time necessary would both have been excessive. The scantlings of the various members could not have been safely reduced, so that the cost would have been considerably

higher than timber. As regards (iii.) the main objection lay in the fact that the original piles have naturally not been driven quite truly in line, the length of the various members thus varying in every bay. This would probably have necessitated marking off, cutting and drilling the ironwork on the spot; work to which Chinese methods and tools are ill-suited, and in which much delay and difficulty would be caused by tides. Moreover, seeing that these jetties are a replica of the Admiralty berthing jetties at Portsmouth, and of very massive construction, it would also appear a work of unnecessary supererogation to embark without excellent cause on entirely new design and calculations. Method (i.) then had much to recommend it, always provided that either means could be found to protect the timber from the ravages of the sea-worm, or that a timber could be found which in itself would be unassailable.

MEANS OF PROTECTING TIMBER.

Many processes both mechanical and chemical have been tried for the preservation of timber. The former, which usually consist in covering the timber with some form of metallic sheeting, were put out of court by the large expense involved. Of the latter by far the best is creosoting, but, so far as the writer knows, the requisite plant does not exist in Hong Kong. The timbers in the existing jetty were tarred, but, as has been stated by many writers, tar alone is not of much use. Colson* points out that the crude naphthas or oils lighter than water are useless as antiseptics and immediately evaporate, whilst the solidity of the pitch renders it incapable of absorption. Coal-tar in distillation is broken up into three groups of products, viz.:—oils lighter than water, oils heavier than water, and pitch. Of these the heavy oils constitute the creosote of the timber yard.

Various patent paints are sold for the protection both of timber and iron under water, in most of which coal-tar and resin play a prominent part. John Rahtzen's introduction of shellac dissolved in alcohol seems to have made a great advance in this connection, and of several paints tested during this work Rahtzen's gave the best results. The writer has it on good authority that some temporary piles of ordinary pitch pine treated with Rahtzen's "anti-fouling" paint were found practically untouched by the worm after five years' immersion in Malta Harbour, unprotected timber during the same period being completely eaten away. None the less any external treatment of this kind can only be regarded as a temporary measure, and would require constant observation and periodical renewal.

* *Notes on Docks and Dock Construction*, by C. Colson, M.I.C.E.

Varieties of Timber Used in Sea Work.

Greenheart and Teak.—Turning now to the subject of the timber itself. Up to a comparatively recent date greenheart, from British Guiana, and teak were considered, if not impenetrable, at least indestructible. In tropical and semi-tropical latitudes, however, this has been found to be by no means the case. Among many others, cases have occurred at Malta and at Port Elizabeth where greenheart jetties have been so badly attacked as to require rebuilding after comparatively few years.

Australian Timbers.—Several Australian timbers, viz. :—Cypress Pine, Turpentine, Eucalyptus, and Jarrah, and New Zealand Totara have been found immune in some places, whilst in others they have suffered severely. In *Cassier's Magazine*, August, 1910, a case is quoted in Auckland Harbour where 12″ × 12″ piles of the best Australian timbers were eaten right through in seven years. Some temporary piles of white pine were destroyed in three months in the same place. The worm, as is well known, will often not attack timber when there is a softer and more palatable variety in the neighbourhood, and this may account for spurious reputations obtained from time to time.

Bamboo, etc.—It is interesting to note that palms, bamboos and similar timbers are seldom attacked by the teredo, which prefers a more compact wood. Along the Praya in Hong Kong may be seen numbers of flimsy bamboo piers, which appear to withstand both the worm and the weather in an amazing manner.

Timbers that are Proof against the Sea-Worm.

Aranga.—There remain two little known trees, both of which provide timber that would appear to be actually unassailable. These are Aranga (Homalium) from the Philippines, and Billian or Iron-wood (Eusideroxylon Zwageri) from North Borneo. The Hong Kong and Kowloon Wharf and Godown Company, Ltd., have aranga piles driven 25 years ago, which are absolutely sound to-day. The better Philippine woods are, however, becoming scarce, and are strictly preserved by the Americans for their own use. Aranga is consequently impossible to obtain.

Billian.—Billian is one of the most important timbers of North Borneo. A considerable amount is imported into China *viâ* Hong Kong, and it may thus be obtained without much trouble. The above-mentioned dock company's trial billian piles were destroyed some years ago in a typhoon, but they consider it to be the equal of aranga. Colson refers to it as unassailable, and Baterden* says "So far as the

* *Timber*, by J. R. Baterden, A.M.I.C.E., in the Westminster series.

author knows there is no wood which is not liable to attack by the sea-worm, with the possible exception of billian from North Borneo, and that has not been much used, but appears immune." Billian is a very hard heavy timber of a light reddish-brown colour. Its weight is given by Baterden as 70 lbs. per cubic foot, but tests made during the work under review gave uniform results of 78 lbs. It is rather liable to star shake, and has a considerable tendency to split when driven or sawn; in consequence of which the price of sawn timber is out of all proportion higher than that of rough hewn. The market price varies considerably, but, if obtained direct from the importers, it can usually be had at about $1.50 per cubic foot, rough hewn, or $2.50 sawn one side. For sawn all four sides as much as $7 or $8 may be paid (the dollar varied between 1s. 9d. and 1s. 10d. when these prices were quoted). The Chinese contractors' prices are a good deal higher. It cannot be obtained in greater lengths than 40′ to 45′, or in section about 14″ × 14″ (Baterden says 10″ × 10″, but 14″ × 14″ was supplied for this job, although a good deal had to be accepted that did not comply with specification; wanes of several inches being rather the rule than the exception). The hardness of the wood is remarkable, and the wear and tear to tools used on it is very great.

DESCRIPTION AND EFFECT OF THE SEA-WORMS.

During the dismantling of the jetty there were opportunities to observe the working of the various destructive agents, and the results noted, though probably differing little from many records of a similar kind, may be of sufficient interest to be briefly described here. The damage was almost entirely caused by the Teredo Navalis and the Chelura Terebrans, the latter being by far the more destructive of the two.

Teredo Navalis.—The teredo resembles an ordinary worm with a hard shelly head attached. This head is in two parts, which work on a sort of hinge, and its front edges are very sharp—somewhat like the edge of a fine fret saw. By this means it bores its way into the wood. The hole by which it enters often appears very small from the outside, but once inside the timber the worm gradually grows both in length and girth. The average dimensions, as given by various authors, differ very considerably, but specimens have been measured up to 6′ in length and $\frac{3}{4}$″ diameter. Once having entered they never work out again, and their size would seem to naturally depend on the bulk of the timber inhabited and the length of residence therein. In the present case the average dimensions were $1\frac{1}{2}$″ by $\frac{3}{8}$″, the largest measured being only 2″ by $\frac{3}{8}$″. One worm never enters the hole made by another, but always works round, leaving a thin wall. This is frequently torn away by a small crab that preys upon the worm, and so increases the damage to the

timber. The most serious effects wrought by the teredo were in the lower horizontal walings, which were completely honeycombed to a depth of $1\frac{1}{4}''$ to $1\frac{1}{2}''$ on every side. The uprights were also attacked, though not so seriously. In this case the damage extended from the top of the pile caps (the timber inside the caps was completely immune) to an average height of 2′ 8″. This, as may be seen from the drawing, is about 4′ above L.W., or 3′ 6″ below H.W.; that is to say, approximately mean tide level. The highest marks found in any upright were 5′ 6″ above low water.

Chelura Terebrans.—The chelura is like a minute shrimp, generally $\frac{1}{4}''$ to $\frac{3}{8}''$ in length, and has two long claws, or feelers, with which it attacks the wood. Thousands of these animals will be found in one piece of timber, and their borings are so close together that the slightest action of the waves washes away the surface of the wood. Their invariable point of attack appeared to be a joint, or where pieces were in contact. In the view of the underside of the jetty, it will be noticed that the uprights are eaten right through at a very uniform point. This was the point at which the walings, struts, and uprights were in contact. Similar effects were to be seen on the fender piles. These were untouched below ground level; thence to about 3′ above low water they were dotted with tunnels of the teredo similar to those in the walings, while the chelura had attacked and completely eaten them away throughout the length of contact with the walings.

Limnoria Terebrans.—The limnoria terebrans, though often mentioned as being even more destructive than the chelura, was not found in the present case. It is smaller than the latter and quite different in appearance, though it produces very similar results. It prefers a soft wood, and differs from the chelura in being equally active in cold as in warm latitudes.

Details of Reconstruction Work.

No particular interest attached to the actual work of reconstruction, which was carried out without difficulty. In view of the high price of sawn billian, $7'' \times 3\frac{1}{2}''$ steel channels were substituted for the $14'' \times 7''$ walings, and a few minor alterations in design were made as a matter of convenience, chiefly in connection with the fender piles. Much of the decking was found to be full of dry rot and had to be renewed. This was probably due to the fact that the deck boards were laid so close together as to be touching in many places. In relaying a minimum interval of $\frac{3}{4}''$ was left between boards. Regular attention given to keeping the gaps between boards clean and open will be found to considerably lengthen the life of such decking. Almost all the ironwork was found fit for re-use. The plates and straps below mean tide level had lost on an average ·0035 of their

weight, but were otherwise in good condition. The steel walings were coated with a mixture of cement and tar; the remainder of the ironwork, and all timbers below H.W.L. were painted with Rahtzen's No. 2 anti-corrosive paint.

It was difficult to determine at all reliably of what timber the original jetty was built. Almost all the timber used for general purposes in Hong Kong comes from Borneo or the Straits, and goes by the general name of "hardwood." Those most generally met with at present are kapor or camphor wood (Dryobalonops Aromatica) from Borneo, and botchow from Singapore. The former, which is typical of these "hardwoods" is described by Laslett* as a moderately hard and tough wood, most useful when used in greatest bulk. He rightly says that it is not likely to be esteemed by engineers or builders. These, or very similar woods, were probably used in the original construction of the jetty. To what extent billian will realize expectation the future alone can show.

* *Timber and Timber Trees*, by Thomas Laslett.

TRANSCRIPT.

ROYAL ENGINEERS IN CO-OPERATION WITH OTHER ARMS.

By Brig.-General F. C. Heath, c.b., *Inspector of Royal Engineers.*

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I have been asked by General Lawson to talk to you to-day on the employment of Royal Engineers with other arms and kindred subjects. This I am glad to do, because, whatever we may have been accused of in the past, I feel sure you will bear me witness that we are now as keen as any to come out of our shell of exclusiveness and work in with other arms.

The *rôle* of the Royal Engineers is to "help on the show," and this, of course, they cannot do unless they know and thoroughly appreciate what other arms want, but besides this those other arms must realize the nature of the assistance that can be given, lest there be danger of their not asking for what they can get or of making impossible demands; so you see, we must know one another and more than this, the knowledge must be so intimate that help is given, or assistance asked, as a process of intuition. We cannot afford to wait until the time of active service to learn these things, as then everything must go as if by clockwork.

My subject is a dry one I fear, but I trust it may help us to think out these matters.

I daresay most of you remember the days when a field company did not form part of the peace organization of a division, indeed, it is only some few years since all that was changed. In former days it usually happened that a field company was thrown at a G.O.C.'s head just as he was starting for a field day, with the obvious result that he and his staff uttered a bit of bad language and wondered how they were meant to use those d——d sappers.

But now that has all changed, and every division has, you know, as part of it a little battalion of Royal Engineers, consisting of two field companies and one divisional telegraph company, commanded by a lieut.-colonel. The field companies never change stations; the lieut.-colonel usually commands them for four years, and the other officers are with them for not less than three years. They are entirely under the General of Division and his staff for training, so you see it is now their fault if these engineers are not trained to suit their requirements.

I am thankful to say that this new organization has worked a very great change, we are now being taught something, and the uses to which we can be put are being thought out and considered.

Now, if I can, I should like to enlarge on this matter and explain to those who have not thought out the subject some of the many ways in which we should be able to help for the common good.

To do this we will follow out an imaginary campaign. The war begins with a concentration at an oversea port or elsewhere, such as took place at Alexandria, for instance, after the bombardment of 1882. In this particular instance, the civil population had fled and there was no local skilled labour to be had. Now, on paper, a concentration at a well-found port seems simple, and, perhaps looking at it from outside, it is so, but it is an extraordinary fact, human nature perhaps, that no one ever seems satisfied with what he has got. The landing stages are not convenient for landing some particular kind of stores and must be altered; special landing stages are wanted for troops, so that stores and troops should not get mixed up; the departmental staff find excellent sheds to accommodate their stores, but the doors and openings are all wrong, railway sidings have to be brought up to them; water must be laid on to the enclosure selected by the veterinary officer for his remounts; the medical officer and headquarter clerks vie with one another in their urgent demands for shelving, the one for his bottles and the other for his stationery. Believe me, the unfortunate R.E. get inundated with requisitions of all sorts; some of the greatest importance, other only of importance because of the high quarters from which they originate; an active A.D.C. is sometimes a terror in these matters.

Now, in the early stages, just at the rush of things the only R.E. landed are probably the field companies and the only source from which tradesmen would be forthcoming to tackle these innumerable jobs. I want to tell you all this, because I have heard it stated that skilled tradesmen are not required in a field company, that a less expensive individual would suffice. Well, I may be prejudiced, but when I look up my journals and realize what calls were made on our tradesmen whenever a force was halted, either at the landing stage, on the line of march, or on the occupation of an enemy's town, such as Cairo, I am appalled with the thought of how blue the atmosphere would have been had tradesmen not existed. Even in the occupation of a friendly town it is wonderful how little accommodating the town seems to be, and how particular G.O.C.'s and C.O.'s become. But it is so natural that all these requisitions should be met, that no one waits to enquire what they entail to the R.E., and then they consist of such a multitude of small, though essential, services of which no record is kept, that no wonder when official histories are written no mention is made of them. I do not mean that we want this recognition, but what I wish to point out is the fact that when we are told that we do not want tradesmen, we find it difficult to prove the necessity to those who have not had the experience of what is expected of us in these matters.

Well then, from what I have told you, I hope you will admit we want tradesmen and that you will agree that a nominal 150 in a company is none too many.

Now married men amongst you who are not in occupation of Government quarters and have to pay for their own repairs will no doubt remember their economical spirit getting a shock when it is a case of repair, a simple

burst pipe for instance, the plumber with at least two assistants turning up for the job. Well, I am not prepared to say that both assistants are absolutely necessary, but certainly one is, and you bless your stars in thinking that after all he or they are only labourers and therefore cheap. So you will readily understand that it is not economical to use any of these 150 skilled tradesmen as assistants, for assistant's work unskilled labour is the cheapest, and the more there is of this within reason, the more skilled work you will get out of your 150 sappers.

Perhaps some of you have guessed what I am leading up to; it is, of course, the necessity for working parties. So when you are halted at the base, on the line of march, or elsewhere, where there is work to be done, let us have what labour you can spare ungrudgingly, because what work is done, is done for you, not for ourselves. In foreign conscript armies, you know there are pioneer battalions, these I have always understood to be a self-contained units, *i.e.*, a units consisting of the necessary skilled tradesmen plus necessary unskilled labour. Until we have our own labour tacked on to our field companies like this, I feel we shall be obliged to borrow. In Egypt and South Africa we were allowed to hire natives, and in this way formed little pioneer battalions for ourselves, but that was exceptional.

Up to now I have been assuming that the army is more or less at rest, when the field companies would not, perhaps, be so closely associated with their divisions, but would, perhaps, be concentrated for, what I call, war works services, such services as I have mentioned above and those under the following six headings, which will probably appear in our new training manual, viz.:—

(1). The improvement of the piers, wharfs, derricks, pier and wharf accommodation, exits from the docks, etc.

(2). The provision of suitable entraining accommodation.

(3). The improvement and making of roads in the docks and town, and the marking of the routes to camps and depôts.

(4). The provision of water supply and sanitary services for billets and camps.

(5). The conversion of such buildings as may be required into hospitals, stores, sick lines for animals.

(6). The erection and maintainance of suitable telegraphic or telephonic communication.

Plenty of work you see for the engineer companies and their tradesmen.

But the army is now to move; each division must draw in its engineers and move off complete, the engineer work at the base being left to the line of communication troops. The march begins, in the early stages out of reach of the enemy, when the principal duty for the field engineer will be that common to everyone else, viz.:—to do the marches with the minimum of fatigue to men and horses, and it will much assist in this if, at the end of the day's march, the force can go straight into a fully prepared billeting area or other accommodation.

In small ways there is a good deal to be done before a billeting area, camping, or bivouac ground can be said to be prepared. Water supply arrangements have to be looked into; the municipal authorities can often

help a good deal in this matter if given time and treated with tact and consideration; then there are always gaps to be made through hedges and walls, gateways to be enlarged, swampy places to be improved, etc.; so you see if you want to find everything comfortable for you when you march in, I would advise you to keep in touch with the C.R.E. and get him to make an early reconnaissance with your staff officer, and, above all, get your field companies on the ground and at work as early as possible; if the enemy is not in close proximity, it might often help to send on a field company well in advance of the column, so as to be on the spot several hours before the troops arrive with the engineer officers, employed on reconnaissance, well in front of these again, so that they may meet the company with a detailed scheme and lose no time in getting the R.E. to work. I want here to impress upon you all the *supreme* importance of engineer reconnaissance; if you think a little, you will see how much depends on this. Before you can commence work, you must first know what you have got to do. You have to get the necessary tools and materials on the spot, think out the best way to do the work, the number of men required to do it, etc., and all this takes time, and unless the problem is cut and dried by the time the workmen arrive, there will be waste of time and much cussing and swearing, marching and countermarching before the particular tradesmen with the particular tools and materials they require meet one another at the desired spot. If you want us to do good work, you must help us to look ahead; the more we can do this, the more efficient you will find us. You must give us the very earliest intimation. This seems common-sense, but yet, strange to say, there are occasions when this has not been given, and we have been expected to get work done as if we had a magician's wand at our disposal.

Engineer reconnaissance takes many forms. In my opinion, and I hope it will be clearly laid down in our new training manual, engineer officers should always accompany the general staff reconnaissance of a position or of a river or pass, or one made preparatory to a march or for the purpose of selecting billets, camps, etc. The duty of the engineer officer will be to study the best method in which engineers may be employed, so as to enable the commander of the engineers to advise on technical matters. It is important that reports, giving the details of engineering work required, should be sent from the cavalry to the army in rear, from the advanced guard to the main body, and from the army to the lines of communication. It is only by the early receipt of such information that the engineers with each portion of the force will be able to carry out the necessary work efficiently and promptly.

I remember not so very long ago at a staff ride, or divisional manœuvre, it being a question of the passage of a river, staff officers were sent out to reconnoitre suitable places to cross. When these came in, the engineer officer was informed that he was to make bridges at the places specified. He had then to make his own technical reconnaissance, and, at least at one place, found the technical difficulties so great that the general staff officer had to go out again and find another place. I merely mention this to show how much time is really saved by the staff taking an engineer officer with them on this sort of reconnaissance.

Then there are reconnaissances in attack and defence. I will again quote them from what I hope may appear in our training manual shortly to be issued :—

"Prior to, and during, an attack, the attention of the engineers should be specially directed towards such points as will facilitate the advance of the other arms. Reconnaissances will, therefore, be carried out with a view to ascertaining what obstacles will be met with, and how they can be crossed or destroyed, what improvements in communications and approaches are necessary, the work required to strengthen covering positions, and the best arrangement of telegraphic or other means of communication."

So you see there is a good deal in this matter of reconnaissance for the engineer officer, and I trust that those responsible for training will see to it that we do not neglect this important work.

On manœuvres, etc., it is one of my duties to watch the work of the engineers. When I meet a field company, my usual remark is "Well what are you doing?" and I am sorry to say that the usual answer is "Oh, the usual thing, nothing; we have got no orders." I am afraid that I then get angry and want to know why there are five engineer officers on the roadside doing nothing. I want to know why the officers are not ahead looking out to see whether they cannot do some useful work. If there is nothing better for them to do, they could with advantage visit farms, sheds, etc., and see whether there is barbed wire and what tools can be got in case these are wanted later. And here I may remind you that an engineer company carries only some 108 pickaxes and each infantry battalion only some 155 pickaxes, rather more shovels in each case; no materials, such as barbed wire or timber, are carried. So you see if entrenching is to be seriously taken in hand, it will be necessary to collect more picks and shovels from elsewhere, not to mention wire for entanglements and timber for overhead cover, and for these the engineer officer or others must search.

Well, we are now beginning to approach the enemy; you know it, because you find marching not so simple, the enemy is trying to delay you with obstructions, broken bridges, etc If your cavalry is in front of you, and the engineer officers with the field troops accompanying it have done their duty, they will have sent back precise details of the nature of the obstructions, broken bridges, etc., which would enable the C.R.E. to make his plans and get to work as soon as *you* get him to the spot. His men have to march remember, and if they are far behind in the column you will have difficulty in getting them to the front and, when you have done so the men will have had a forced march, so to speak, and you will not get such good work out of them than as if they had been with the advanced guard. Incidentally, I might mention that some French authorities make a great point of relieving the sapper of as much weight as possible when on the march so that he may be fresh to undertake work when required. My own view is that during the march the greater part, if not all, of your engineers should be with the advanced guard, but, in every case, please take your C.R.E. into your confidence before your operation orders are got out and make him responsible for the distribution of his units. He should know best what men and tools are required for the job

in hand. R.E. field companies are small units and take up but little road space, particularly if the pontoons are relegated to the 2nd line transport, where they would usually be unless there is a prospect of having to bridge a river; if there is work for the engineers, it will be in front and usually, until the engineers have done their work, the column will not be able to advance. It is so easy to get your engineers off the road and out of the way if they are at the front and not wanted there, but it is quite another thing to get them quickly to the front from the rear.

We will now imagine that you have got your sappers to the broken bridge and are fuming to see it repaired. On manœuvres these things are simple, a piece of wood is put over the supposed gap and after a specified time the bridge is judged by the umpires to be repaired. This is a bad lesson. Bridges are not so easily repaired, for remember the spirit may be willing but the material absent; nice mast-like fir trees do not always grow on the spot. I suppose generally it would come to ripping up a floor of some neighbouring houses, which might be a little way off. And this is a point I want to make. Earlier in this lecture I asked you to help us with labour, and now I want you to realize that we shall often require transport also. Material will have to be brought in from a distance, planks and joists for bridge repairing, barbed wire, tools, etc., when putting a position in a state of defence, so do not grudge transport if we ask for it and you can spare it, it will be used in your interest.

You know, of course, that every field company has pontoons with it capable of bridging a 25-yard span to carry ordinary wheeled traffic, but it is not every river that is suitable for this class of bridge, there must be depth of water to float the pontoon for instance, and then it is not always advisable to tie up your pontoons so to speak, I mean use a pontoon bridge in preference to repairing a broken bridge, because the loss of your pontoons may be serious to you if there is a river to cross later when in touch with the enemy.

I am not certain that the tactical value of pontoons is always appreciated. Two years ago you know the manœuvres hung on the passage of the Thames. I had hoped to see pontoon bridges freely used and troops crossing at unforeseen places as a surprise to the enemy (a 25-yard bridge could have been thrown in some 15 to 20 minutes anywhere), instead of this, it seemed to me that commanding officers preferred to wait until the ordinary masonry bridge had been repaired, forgetting that its position was accurately known to the enemy, who in real warfare would have kept the defile well under artillery fire. Pontoons are horsed with six horses in war, so can go across country.

We are now in touch with the enemy, and the dispositions for attack are made, but not until after reconnaissance. On manœuvres this consists of counting red flags or observing lines of men on the slope of a hill supposed to be hidden away in invisible trenches. Now, of course, Gentlemen, you realize that the real thing is very different. I would just like to quote to you what they think of this abroad. Colonel Polyanski, in the February, 1909, number of the *Injenerni Jurnal*, says:—

"Reconnaissance or scouting in the attack is, properly speaking, a duty which belongs to cavalry, but such are the conditions of modern war, that

it has become impossible for the cavalry to deal with all questions which have to be answered before the plan of attack can be decided upon. The modern arrangements for the fortification of a position are so complicated and reconnaissance is rendered so difficult by means of masking and the use of dummy works, that none but engineer specialists can understand from long distances the intention and character of the various fieldworks with which the enemy may have added to the strength of his position.

"That special engineer reconnaissance is necessary, first became evident during the Russo-Japanese War. In the month of September, 1904, when attack operations were in contemplation, it was decided to form engineer reconnaissance detachments, and these were recruited from among the officers of the engineer and sapper units."

This is a matter which hitherto has not been much studied. I must confess that I see difficulties under peace conditions, but I should like you to realize the necessity and try and train your engineers accordingly.

The reconnaissance having been made, the orders for attack are got out. At recent manœuvres it has been the practice to attach a field company to each of the leading brigades, but we must be careful not to adopt this as a hard and fast rule. Engineers must be distributed in accordance with their probable requirements, and I venture to think that in all cases the C.R.E. should be made responsible for that distribution after being made fully acquainted with the conditions, and that, even after distribution, the C.R.E. should still keep in touch with his command and, should circumstances change, advise a redistribution. For instance, the G.O.C. might suddenly decide during an action to have a position prepared to fall back upon, or a series of bridges might be required on a flank, in fact, anything might suddenly arise to make it necessary to withdraw the field companies from the brigades, so brigadiers should remember that at any moment they may be deprived of their engineers. Perhaps some might say "Well, I do not think that will matter much, for I do not see what use they can be to me in the attack." Unfortunately, manœuvres are not quite the real thing, or I venture to think those brigadiers would soon change their tune. Even on manœuvres I have seen a brigadier purple in the face because, through some mistake in orders, his field company had been left with the 2nd line transport; the brigadier had got into a village and would have given his eyes for engineers to make loopholes for him, blow down a few inconvenient walls, construct a few barricades, etc., but he had left them behind and got turned out of his village; and I was pleased, for it was a good lesson.

Gentlemen, even if you do not know what to do with your engineers, for goodness sake have them well to the front; you never know when you may want the gun-cotton and crowbars.

I know that in the stress of manœuvres, when everything goes about ten times as fast as it would in war, the unfortunate brigadier is kept at the end of his telephone and has little time to think of the accessories which do not count on manœuvres. I do not know whether you will think me right, but I tell our people it is their own fault if they do not get employed. It should be their business to help the brigadier, and they can best do this by keeping in touch with events. In my opinion, the major commanding

the field company temporarily allotted to a brigade should be with the brigadier, and, of his four officers, at least two should be out to the front looking out opportunities for being useful; the artillery are hung up at a boggy place, a few planks and baulks would make all the difference; guns cannot get to an otherwise favourable position in a wood for want of a road being cut into it; the flank of the artillery position is much exposed, a suitable building exists there which, if put in a state of defence, would make for safety; the colonel of No. 1 Battalion sees his men hard pressed, he wants suitable rallying points formed, or a bridge blown up to stop the pursuit of the enemy, or a partially destroyed bridge repaired, to enable him to get up his ammunition and machine guns; obstacles removed; captured positions made strong, etc.; in fact, there are innumerable jobs, big and small, where the engineers can be of use. I hope that in our training manual about to be issued, the duties of the R.E. in the attack will be laid down as follows:—

(i.). Assisting the various arms to cross rivers, streams, difficult country, etc.
(ii.). Strengthening ground won, and special points, to help the resistance against a counter-attack, or to serve as pivots of manœuvre.
(iii.). The close reconnaissance of an occupied position.
(iv.). Removing or destroying obstacles prior to the final assault.
(v.). Improving and marking communications.
(vi.). The erection of observatories.
(vii.). Water supply.
(viii.). Fighting when required.

But again let me remind you that unless these things are practiced in peace, they will not be carried out intuitively in war. We want to be so much in touch with you, that you should get all these aids to your advance without your having to ask for them, so to speak.

Perhaps I might here be allowed to make a few remarks as to brigade training. I am sorry to say that I am not myself intimately acquainted with the routine of brigade training, but I imagine that you practice the attack and defence, and that in most cases some R.E. are put at the disposal of the brigadier. Since on manœuvres a field company is almost always attached to each leading brigade, we may assume that the practice will be carried out in war. Brigadiers should remember this and realize that the field company may often be a part of his command. He will then see the advantage of training it and his infantry brigade as one homogeneous whole. We have practically given up moving our field companies from station to station; so far as I understand the policy, the 5th and 11th (Field) Companies will always belong to the 2nd Division, so you see this homogeneous training I dream of can be made a reality, because the officers, non-commissioned officers and men of the R.E. are the same that will be with the brigade on the battlefield, and it is obvious what a pull the brigadier will have by knowing engineer officers personally and so training them to his ways that they will act intuitively on the battlefield. For brigade training, unless bridges or defences are to be actually

constructed, it is, in my opinion unnecessary to take out the rank and file, since these can be better employed keeping up the knowledge of their trades in workshops than in marching about doing nothing; but all officers, non-commissioned officers, and tool carts, accompanied by a few sappers, should go out and, in the attack and defence or retreat, the brigadiers should make it their business to think how the R.E. can serve them and issue orders accordingly, just as they would in actual warfare. The R.E. can then make all their dispositions, get the necessary tools on the spot, arrange for collecting material, appeal for working parties, in fact, do everything except the actual work, and the actual work is an easy matter when a good preliminary plan has been made and tools, material, and *personnel* collected.

I feel certain that in real warfare, during the attack for instance, a brigadier will have calculated in his mind the chances of a temporary set-back due to counter-attack, etc., and, therefore, the need of rallying points. But this is only one of the innumerable ways in which he can get assistance, and the more he thinks out the problem and uses his imagination from an active service point of view, I am certain he will more and more realize the extreme importance of practicing these matters in peace. Even when he has no use for the men, he should remember that there are six more or less intelligent officers with each field company, each with a horse, and all dying to be his slaves in reconnaissance work, orderly work, or what not.

I shall deal with the defence later, but I have often thought that, when it is a question of a marked enemy, you have an excellent way of instilling into your engineers your ideas as to how to defend a position, and in this way would gain confidence in their work should the time ever come when you have to trust them to take up and strengthen a position for you in your rear for you to fall back on or otherwise. I suggest to divisional generals that they might give us a chance, now and then, to show our prowess in strengthening a position, by allowing us to work out the marked part, and we might even add a little "cunning" and means to deceive, which would add interest. At company training, when fieldworks are being done, I suggest that an officer from the field companies should meet the infantry company officers, and that they discuss the question of the siting of trenches, and their arrangement for mutual support, the siting of obstacles, etc., etc.

Well, so much for the attack.

The defence should, of course, be to the glory of the engineer. But I am not certain that we have yet arrived at the proper way to use him. Perhaps we do not sufficiently discriminate between a deliberately entrenched position, and position which a force takes up in the course of a battle and where the men dig themselves in, more or less, where they happen to be, and more to get cover whilst resting or organizing for a further advance, than with a view of standing their ground on the position, wearing out the attackers and then going for them and finishing them off in a good counter-attack.

In the former there can be but little science; in the latter there should be a very great deal.

In watching manœuvres, I have observed that it is often the practice to

break up a field company into sections (you know a field company consists of four sections, each of some 33 men, 1 tool cart, 1 forage cart, and 1 pack) and distribute these all along the line. Now, personally, I do not think this an altogether sound arrangement. For manœuvre purposes it may be convenient, because you will not have the Inspector of R.E. telling the Inspector-General that the R.E. are not employed, but it is a slovenly, scaled-pattern way of doing things, which does not appeal to me. My view is that, if the field companies are allotted to brigades in the front line, the brigadier should take his O.C. Field Company to look over the position, and then decide what is the important work to do. There will be communications to be made in rear, to enable reserves to be gradually brought up, rallying points strengthened, bridges in the front constructed to admit of the further advance, clearances and roads to admit of the artillery getting to good positions, topping distant trees, etc., etc. So I consider that field companies should be held together until it is decided what work there is for them, and not broken up and distributed all along the position on the chance of there being something for them to do.

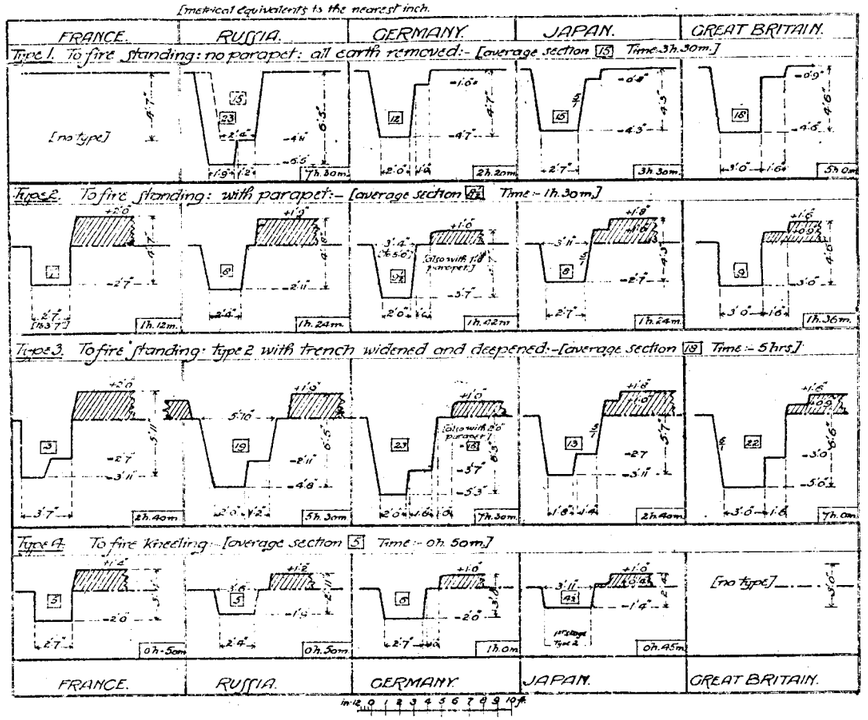
The course of events may make it desirable to fight an offensive-defensive battle on the position, by which I mean, as I said before, to allow the enemy to wear himself out against the position, and then go for him with all you are worth, to swallow him up in a great counter-attack. For this I venture to think a more scientific arrangement can be made than that of merely improving the trenches formed by the troops, when they dug themselves in with a view to further advance. More care must now be taken to co-ordinate work and add those accessories so essential to a properly defined position. Judging from what I have seen, I am sure that much more care should be taken in co-ordinating work than has usually been the case. I have seen one battalion commander take the top of the crest, whilst his neighbour took the bottom of the slopes. I have seen trenches from neighbouring sections arranged so as to fire into one another, but I have not often seen one section commander arrange his trenches so as to support his neighbour. For proper co-ordination you want a well-thought-out plan, and I believe it will be well worth your while to cause a roughly contoured map of the position to be made, showing approximately the arrangement of your trenches, etc. Given a 1" map, it is astonishing how quickly they can be enlarged to a bigger scale, and with, say, four officers good at sketching, and a mile of front to do between them, viz., 440 yards each, a sufficiently accurate map on a large scale would soon be ready, sufficiently accurate for arranging a co-ordinated scheme of defence.

You see I have in my mind a position so scientifically defended that a minimum number of men are required for the defence, allowing of a maximum for the knock-down blow, the counter-stroke, and this cannot be done in a haphazard, happy-go-lucky way. But I am perhaps wandering from my subject, for it is the employment of the R.E. that we are discussing. Well, in this deliberate defence, as in all others, I think you should take your senior engineer officer into your confidence, and after explaining the position to him, allow him to make his proposals to you for this apportionment of work between the R.E. and the infantry.

PLATE II.

FIG. 6.— Normal Profiles for Fire Trenches.

[metrical equivalents to the nearest inch.



[Approximate Sectional areas given in square feet, and the time taken by one man to excavate 2 paces at British normal rate of work.]

FIG. 8.— Type of Fire Trench with Overhead Cover.

steel loophole plates, shelter recesses, and fighting parados suitable for a field redoubt or pivot group.

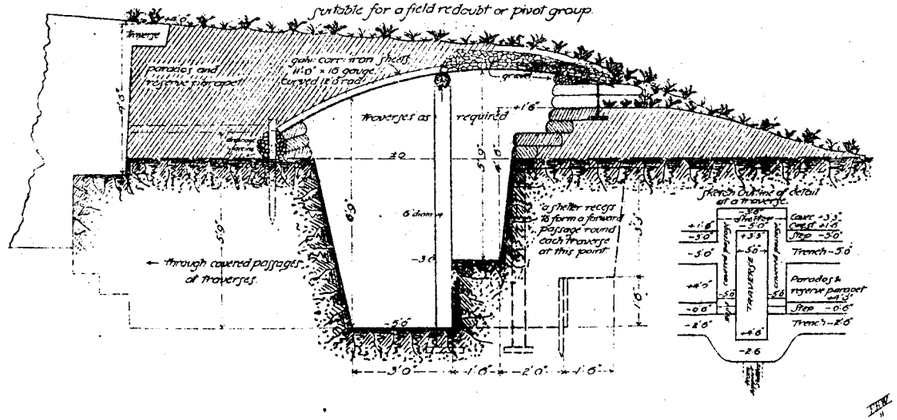


FIG. 7.— Box Loophole.

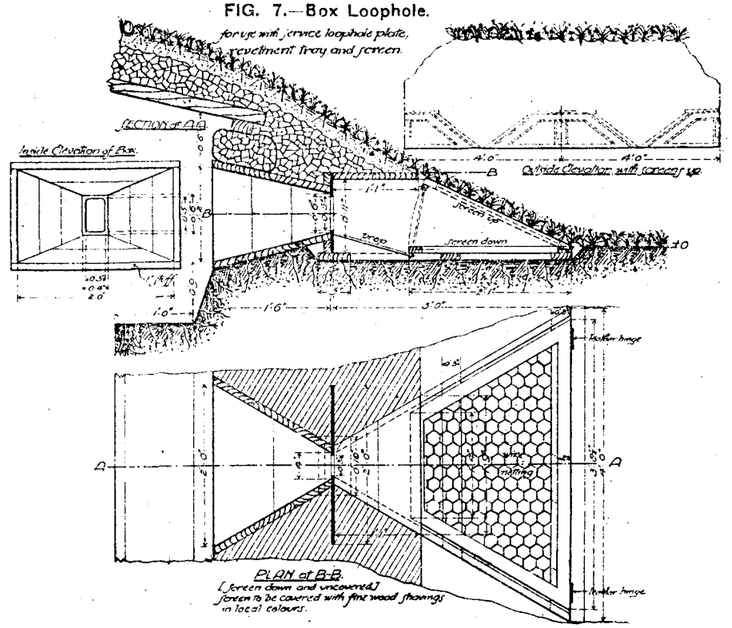


FIG. 9 — Provisional Defences.

Type of Fire Trench and Shelter in reinforced concrete.
[density of firing line: one rifle per two feet run, including all traverses.]

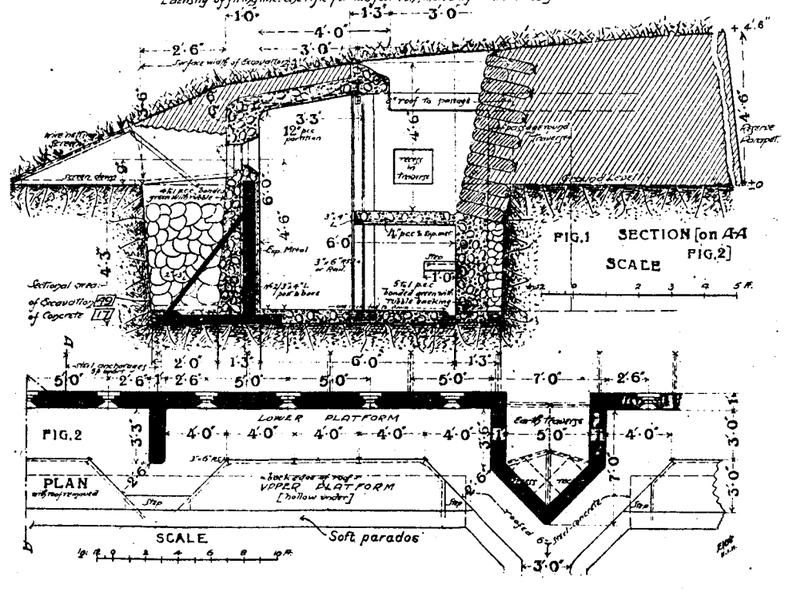


FIG. 10.—Fire Trench with Splinter-Proof Shelters under the Parapet (German).

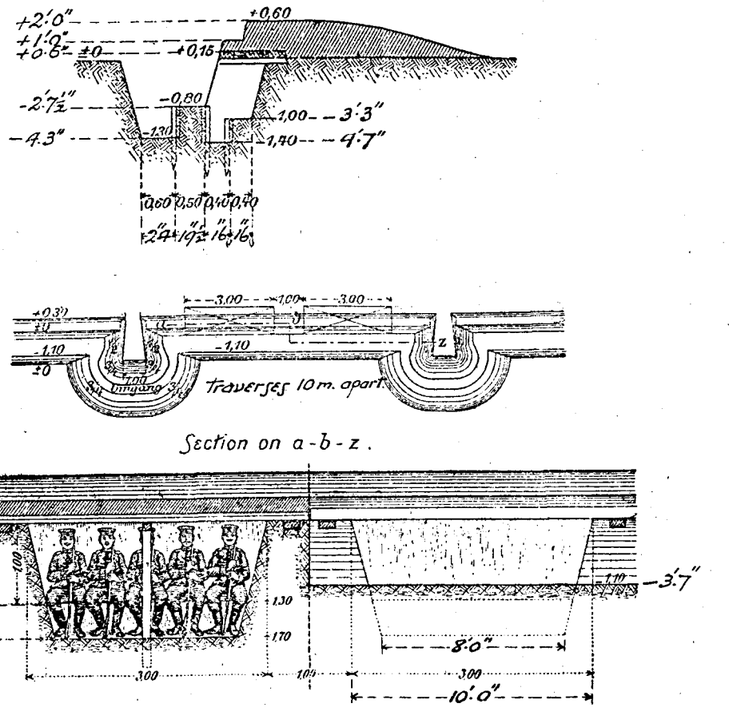


FIG. 11.—Splinter-Proof Shelters under Parapet (Russian).

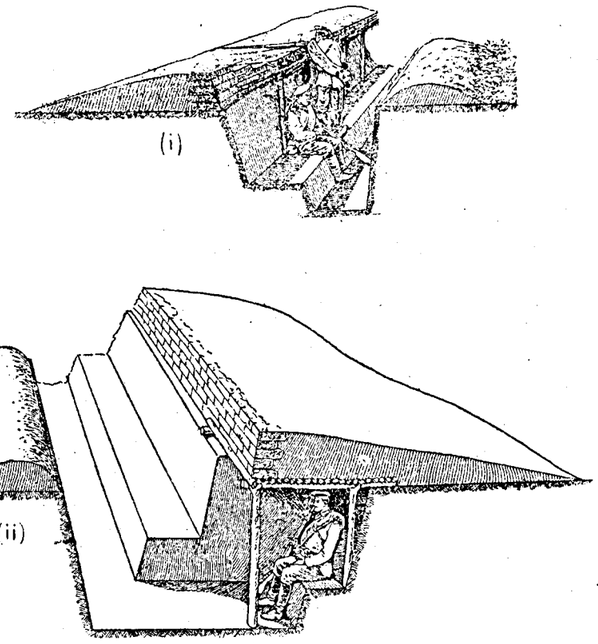
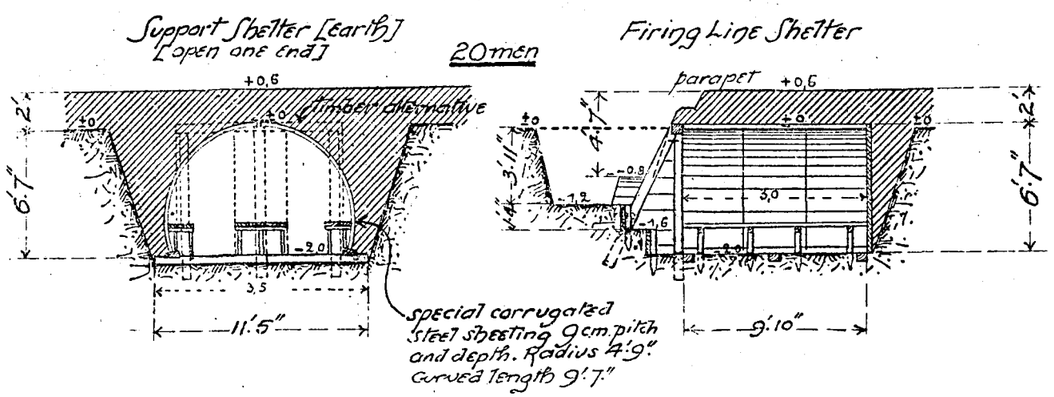


FIG. 12.—Types of Shelters (German).



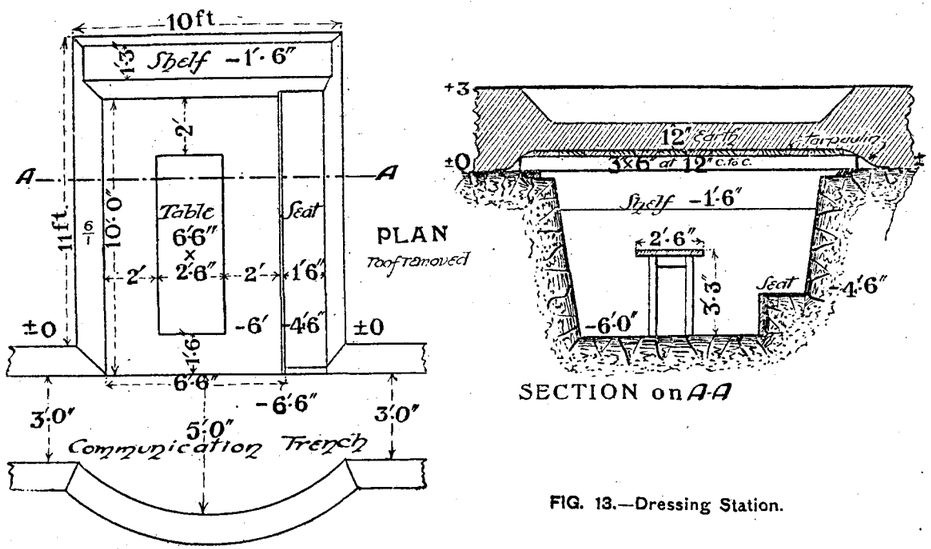
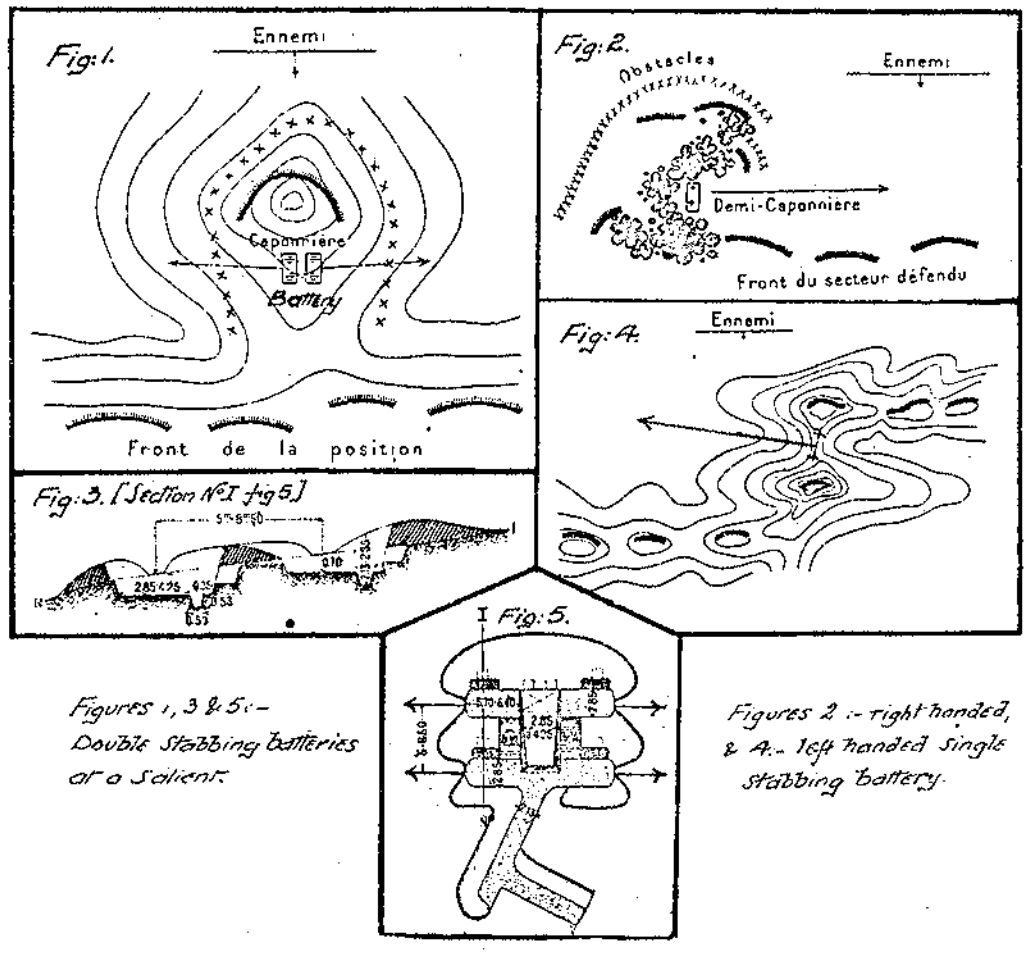


FIG. 13.—Dressing Station.

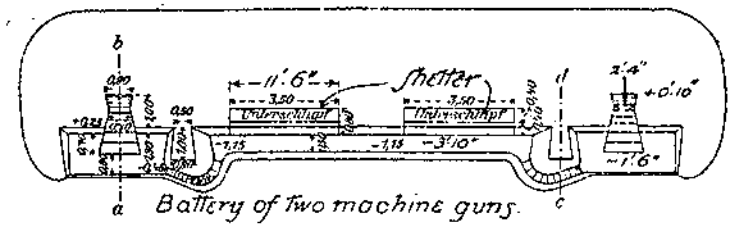
FIG. 14.—Stabbing Batteries (Russia).



Figures 1, 3 & 5:— Double Stabbing batteries at a Salient.

Figures 2 & 4:— Right handed, & left handed single Stabbing battery.

FIG. 15.—Types of Machine Gun Emplacements (Germany)



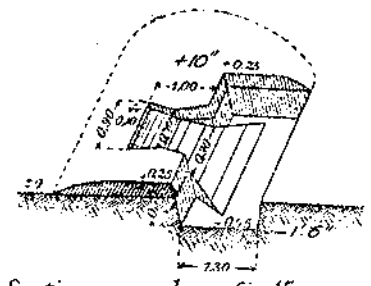


FIG. 16.—Machine Gun Emplacements (Russia).

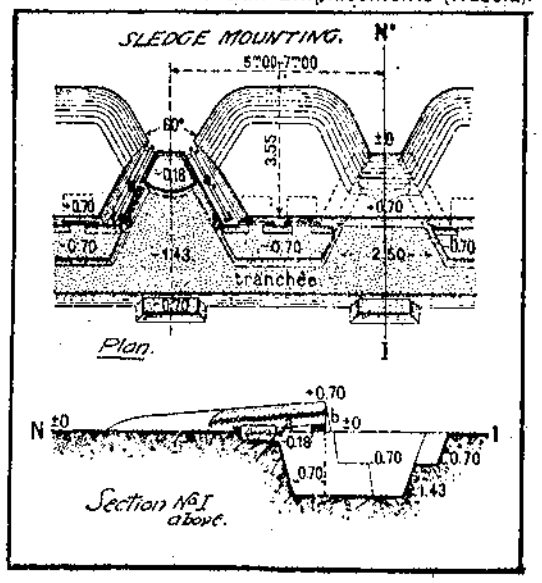


FIG. 17.—Q.F. Guns in Battery without Parapet (Germany).

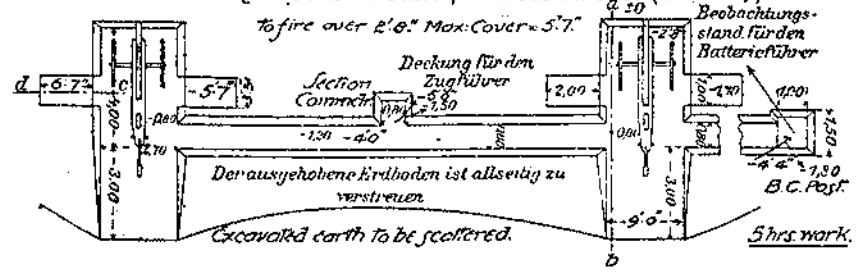
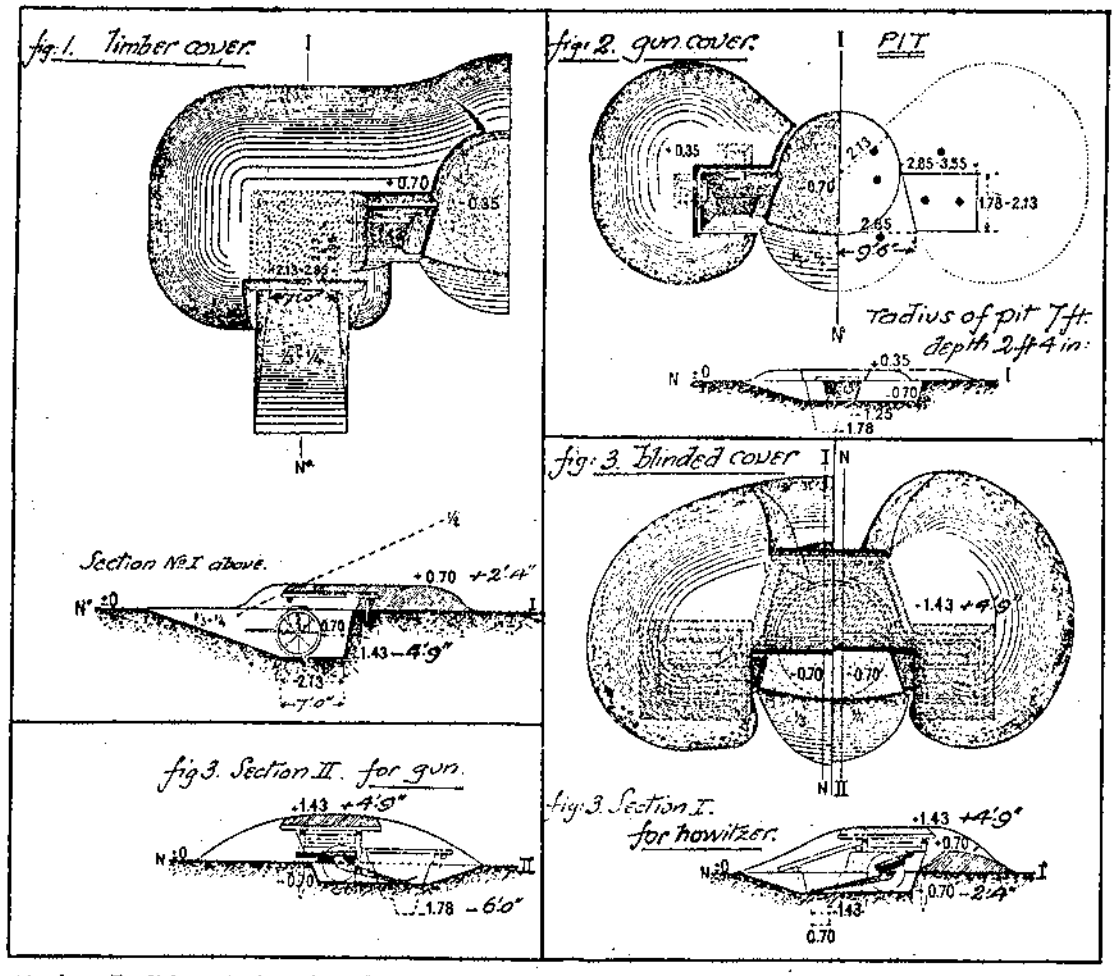


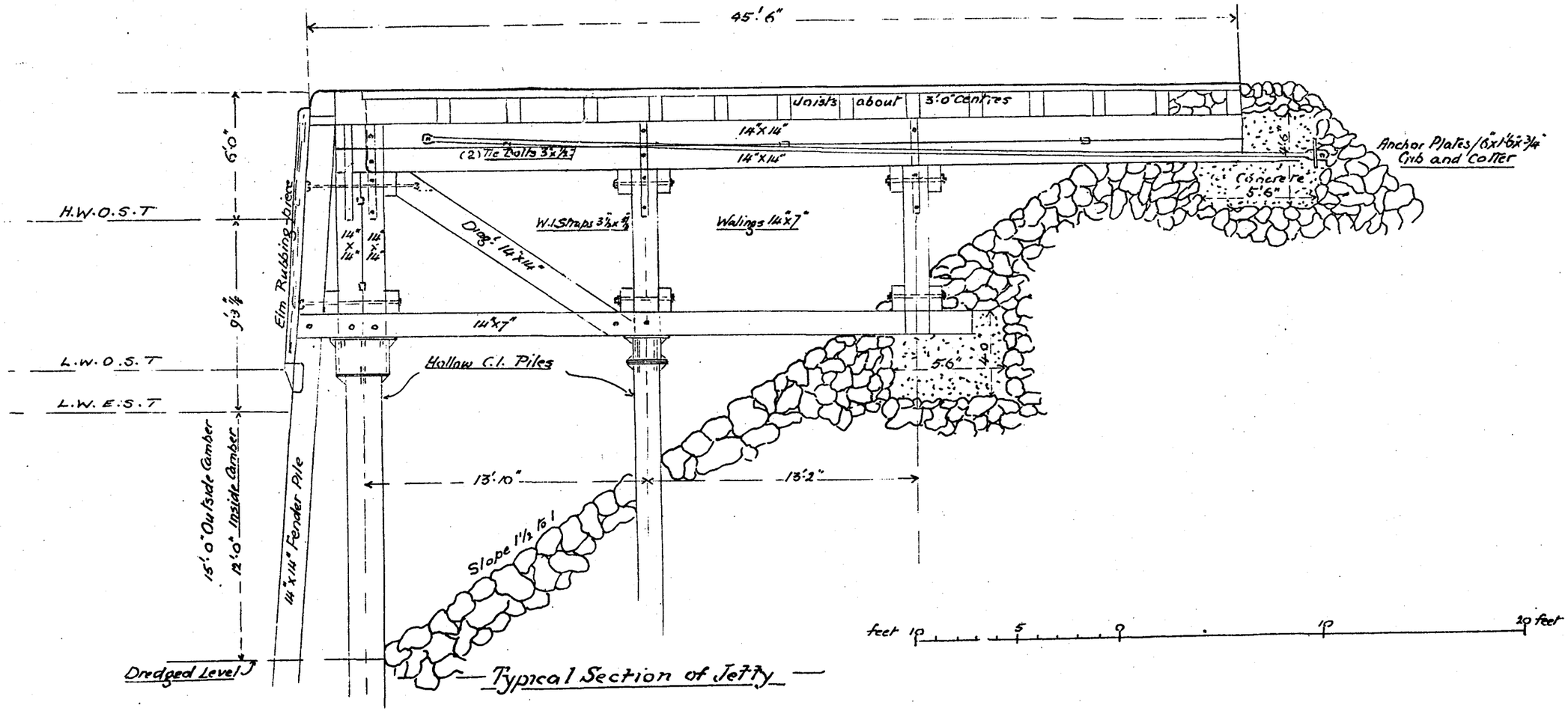
FIG. 18.—Types of Field Artillery Cover (Russia).



NOTE.—Dimensions are in centimètres, except where English equivalents have been added.
For conversion of centimètres to the nearest inch multiply by 4 and cut off the last figure.

DESTRUCTION OF A TIMBER JETTY BY SEA-WORM.

HONG KONG. W.D. RECLAMATION A.S.C. & A.O.C. JETTIES.



Typical Section of Jetty

Now as regards the employment of your R.E. when strengthening a position, there is nothing laid down, and rightly so, because we are prepared to undertake anything, or should be, but, generally speaking, I should say that the officer commanding the section would decide where his fire trenches are to be, and so co-ordinate them as to mutually support one another and neighbouring sections; he would leave their construction entirely to the infantry, who, of course, should be equally competent to dig trenches, and better qualified for siting them. Only let me remind you that a battalion commander may site his trenches well from his own selfish point of view, but these very same trenches may, on the other hand, be exceedingly badly sited from the general point of view. I mean he must co-ordinate. Of course we may have many, many views on the siting of trenches. I remember coming across a trench, not so very long ago, beautifully sited for fire over ground from 800 to 1,200 yards from the trench, but a hopeless position for bringing fire to bear on the ground within 300 yards of the trench. The officer who constructed it said that regulations insisted on a good field of fire, and as it was a question of siting so as to bring fire over all ground within 400 yards of the trench, with a bad field of fire beyond this, or siting so as to get a good field of fire beyond the 400 yards, and much dead ground within this zone, he preferred the latter. Now I may be wrong, but I believe that that trench should have been sited so as to bring every bit of ground within 300 yards of the trench under fire, leaving the ground beyond to be got at by cross-fire from neighbouring trenches if possible. It is sometimes forgotten that when you are occupying a crest exposed to the enemy's artillery fire, your heads may be kept under by it until the attackers are within 200 yards of you, so that the very extended field of fire is not always so important as would first appear to be the case. To my mind the important thing is that every bit of ground from the trench as far as possible outwards should be under fire from the trench or flanking trenches; that even at the sacrifice of field of fire the trench should be hidden from the enemy's artillery fire, that command, as a rule, takes too high a place in the scale of importance, that it must be borne in mind that where trenches are placed low down on a slope, it is difficult for the enemy's artillery to support the infantry attacks; with the trenches at the top of the slope this support can be given up to the last moment. With trenches low down, almost at the bottom of the slope, it is easy to hide them, and double line of fire, combined with dummy trenches, becomes possible. The argument against the low-down trench is the difficulty of support, but there is no difficulty in constructing trenches for the supports on either side of the firing trenches. We have got into the habit of digging our trenches for support well behind the firing trench. I cannot understand the reason. They should be close up to the firing trench, and so save communicating trenches.

Then there is the question of retreat; but we do not fight to retreat. Besides, there are nearly always little subsidiary valleys running in at right angles to the main features which can be easily screened to admit of retirements. Of course, there is the other alternative of making your trenches well back from the crest, holding the crest with a few men to

bring fire on lines of approach and mislead the enemy by means of dummy trenches, and flanking the advanced slope with artillery fire, which can often be arranged in a fairly low position. The above, of course, are only my opinions, and they are certainly against practice, for we seem always to get in well-exposed positions half-way down a slope, or on the crest. The fact is, there is this instinct, which it is so difficult to get away from of being able to see everything from our trenches. Foreign authorities lay stress on the importance of short trenches, not more than 40 yards long, as these can be more easily arranged for mutual support and invisibility than long lines of trenches. For protecting the flanks, they prefer trenches in echelon.

So much for siting trenches. Well, Gentlemen, this is your job, and not that of the R.E., except when forced to do it, as when they are sent to entrench a position on their own, which it will, by the way, often fall to their lot to do, with the assistance of working parties, civilians, Territorials, Special Reservists, and others. No, the infantry should dig their trenches, and I think you will be well advised to employ your engineers on the accessories in laying traps for the attacker, putting cunning and science into the defence, etc. The section commander should, in my opinion, explain to his O.C. R.E. the general scheme of defence, and ask him to suggest the accessories. There are clearings to be made, dummy trenches, and artificial screens to be constructed, entanglements and obstacles cunningly arranged so as to force the attack to come over ground to suit you, dead ground filled in, trees topped which would otherwise block artillery fire, bridges in front of the position destroyed, walls loopholed, communications in the rear constructed, head cover and casemates, in fact, there are a hundred and one things to be thought of beyond the mere entrenchments, and often these are more important than the trenches themselves. Unfortunately, manœuvres do not admit of the use of these accessories being developed, and I fear that in consequence we are not giving them the attention we should do. It would be interesting if some day at divisional training a marked position were specially prepared to admit of these accessories being employed with all the cunning and deceit that the art of the engineers could devise. You would have to employ special devices to show entanglements, clearing obstacles, dummy trenches, etc., but this would not be difficult.

I expect the attack of such a position would give some fun.

I remember not so long ago a flagged position had been carelessly marked (at least this was the excuse). Two of the red flags had got out of place well to the front of the main line. It was a foggy day. Those few flags completely misled the attack, and it was a long time before the real position was grasped.

I feel we have yet much to learn in this matter of deceiving the enemy.

Now, Gentlemen, before concluding, I should just like to read you a few notes on some foreign ideas on taking up and strengthening a position. It is interesting to know what line others appear to be taking, it provides food for thought.

Well, some of the foreign authorities propose to hold the main line of a position by means of fortified localities or *points d'appui*, occupying

those tactical points which the attackers must seize before being able to make further advance.

These *points d'appui* are to be at supporting distance each from the other and arranged, if possible, so as to flank one another.

They are either fortified natural localities, such as woods or villages, or are artificially constructed.

Each is given a definite garrison, which provides its advanced posts, supports, and reserves. The duty of this garrison is to hold on to the ground to the last. The duty of the reserve is to turn out the enemy should he affect an entry into the locality, or deliver offensive returns, and go for his flank should he penetrate the interval between the *point d'appui*, or support a neighbouring *point d'appui* should it be hard pressed. In fact, the reserve of each *point d'appui* is, as I understand it, a mobile force for action inside and between *points d'appui* in what is called the "return offensive," but not for action beyond them. The remainder of the garrison allotted to the *point d'appui* is an immobile force strictly on the defensive. The rest of the force provides the grand reserve, which is the mobile manœuvre force from the great counter-attack by which alone a victory can be obtained.

A few entrenchments are sometimes of advantage, constructed in the intervals between *points d'appui* to help the reserves of the garrison of the *point d'appui*, or local mobile force in its duty, but these should not be occupied except when the offensive return is being made. The *rôle* of the artillery, presumably inferior to the attackers, is chiefly to bring cross fire in front of the *point d'appui* and support the counter-attack. It is said that this arrangement admits of the fewest possible numbers of the defenders being immobilized by occupying trenches, because they appear to consider that troops manning entrenchments are practically immobilized as regards offensive action, and leaves the greater number free for mobile action, and that these can be kept under cover and resting until the moment arrives for that mobile action. It is also said that by this arrangement the attacker is gradually worn out, that he has to expose his hand and that of the commander, by keeping in communication with the various *points d'appui*, can, as it were, feel the pulse of the attack, and so know where and when to launch his counter-attack, by which alone decisive results can be obtained.

Naturally, these *points d'appui*, whether natural or artificial, must be made very strong, with ample cover for supports close up to, and connected with, the fire trenches. A keep should be provided—something solid and storm proof—to enable some portion of the defenders to hold on till help can be sent, even were the trenches rushed in a night attack, for instance.

Some authorities point out that it is the business of the commander of the *point d'appui* to try and get the attackers to go for him, and not to deter him from doing so by long distance fire, etc., because the mere fact of a serious attack being made means that a force of four or five times that of the garrison is being employed, and so a greater number of the enemy is being immobilized than in the defence; whereas, if the commander, by showing his strength, prematurely frightens off the attacker,

it means only that the enemy's forces, which would otherwise have been committed and so immobilized, will go to swell the attackers elsewhere.

The attacking artillery, firing on a *point d'appui* at long range, cannot be said to be immobilized, because it has the power of diverting its fire to neighbouring *points d'appui*; it can only be said to be immobilized when it is not in its power to do this, that is to say, when it has been obliged by circumstance to come in so close so that all change of objective becomes impossible, or that the infantry that it is supporting requires its undivided attention.

The attacking infantry can only bring pressure on a *point d'appui* by being sufficiently close to it, but this attacking infantry cannot necessarily be said to be immobilized, because up to a certain point it is at liberty to break off the attack.

So you see a *point d'appui* is liable to a distant artillery attack, and may have to resist an infantry attack without the pleasure of knowing that the attackers are really committed and, therefore, immobilized as regards actions on other parts of the battlefield, and the commander is not to be congratulated when, by his energetic action, he has warded off an attack.

A *point d'appui*, then, to fulfil its mission, must be ready to receive shot and shell and bullets without replying, and must, therefore, be well organized for defence.

Some authorities believe in taking up the main line of defence some distance behind the main advance crest, that is to say, on a secondary crest, or even on the reverse slope, if not steep. They point out that if on the main crest, which is fully exposed to the enemy's artillery fire, your infantry are subjected for a long time to the nerve-shattering effect of an artillery bombardment, and are forced to keep their heads down until the attackers are within 200 yards of the position, when supports cannot reach them without elaborate arrangements in the way of covered communications, whereas if the front crest is occupied by a few well-placed detachments, in trenches, with dummy trenches in between, the power of the rapid smokeless fire of the modern rifle will allow of the enemy being deceived, and he will probably deploy for attack and carry the crest. Once this done, you have them at a disadvantage, because you can sweep these crests and the intervening ground with your artillery, when he cannot use his artillery, and the conditions for counter-attack become very favourable.

Well, Gentlemen, these are some foreign ideas; there are many more. There will always be many opinions on this difficult subject. There can be no hard and fast rule for taking up and strengthening a position, but, undoubtedly, you will enormously handicap your adversary if you can manage to take up a position which is not an obvious one to him and not defended in an obvious way to him. If you can do this, you may deceive, confuse, and delay him, and sometimes so manage as to prevent him making effective use of one of his arms, such as his artillery, and at the same time retain full scope for your own, and so bring about all the conditions for a successful counter-attack.

REVIEW.

GEOLOGY FOR ENGINEERS.

By Lieut.-Colonel R. F. Sorsbie, R.E.—(Griffin & Co.).

The relation of geology to every branch of civil engineering, almost without exception, is so obvious as to require no explanation, yet, so wide and varied are the other sciences which must be studied in connection with the equipment of the modern engineer that this fascinating and important branch of learning is either neglected or at most confined to a few lectures, usually far above the head of the ordinary student. There is, however, a certain amount of excuse for this neglect in that the study usually involves the reading of a large number of textbooks containing matter which, though of great scientific value, is of little relevant importance to the practical engineer. It also involves outdoor examination of rocks and their characteristic positions which cannot be carried out except under expert guidance. Lieut.-Colonel Sorsbie has in this book given the cream of a large number of scientific treatises in so far as they relate to the profession of the civil engineer, and has supplemented this information with many valuable hints as to what to observe in the field, and how to make observations.

In carrying out this task, which from the very nature of the case has involved much labour and careful selection of relevant matter, he has worked on a definite plan. He has divided his work into five distinct parts.

Part I. treats of Dynamical and Structural Geology, giving emphasis to the various agencies which have effected changes on the earth's surface, *e.g.* the work of wind and of rain, of underground water, and rivers, of glacial action, of ocean waves, and of living organisms. Then follow changes within the earth, internal forces, volcanoes, crust movements, earthquakes. Subsequently three sections deal with the structural characters of rocks of various classifications, igneous, aqueous and metamorphic. The whole of this part is a valuable foundation for the more detailed parts which follow.

Part II. deals with the study of Minerals, touching first on the subject of mineral chemistry, mineral forms, and the physical character of minerals. Then follows a chapter on rock-forming minerals, their classification and a fairly exhaustive list of various sorts. The study of rocks naturally follows giving indications as to their mode of origin, their composition, structure and physical characters, and finally a chapter describing the

more important rocks in such a way that they may be distinguished by the observer. The order of description follows the structural classification in Part I.

Part III. deals with Historical Geology, classifying the rocks of the earth's crust in order of their formation, and pointing out the successive groups of living creatures that have made their appearance at various epochs. The tables which form part of this section of the work refer not only to the sedimentary strata in Great Britain, but to the chief groups in North America, in Australia, and New Zealand. There are numerous illustrations of the fossils to be found in the various strata, In the description of the geologic systems there are references to nearly every part of the world, showing the main characters of the earth's crust in each place.

These three parts of the book occupy half the volume—a modest 188 pages full of close compact writing. The only criticism which we have to offer in this portion is that the writer might have alluded to the value of the various geological and mineralogical museums to be found in most places in supplementing the printed page. Without some actual examples of the various minerals and fossils, it is difficult to grasp clearly the distinction between the many and varied rocks described.

The remainder of the book is devoted to geological observation, in the field and in the laboratory, and to the applications of geology to practical engineering. In this portion of the book the author addresses himself to those who are acquainted with the ordinary phraseology of engineering, it is not necessary, for instance, to explain what is meant by a contour, or how to use a clinometer. The hints on fieldwork are sound and practical. Some of the purely technical definitions, however, *e.g.* those referring to "strike" and "dip," are a little wanting in clearness, a few illustrations here would have assisted in elucidating matters. There is a slight error in page 198 where "sin A" should read "cosec A." While making these criticisms it is fully admitted that they only refer to minor details, the main instructions are most ample, and well arranged. The indoor work in the laboratory would obviously be out of the reach of most practical engineers, probably time would be saved, and inaccuracy avoided if the specimens collected were sent for analysis to a chemist or Government analyst.

Part V. occupies one-third of the book and is rightly devoted to considering the bearing of geology on various branches of engineering, water supply, building materials (stones, bricks and clays, limes and cements), roads and canals, the action of rivers, coast erosion, and the uses of minerals. This is a very valuable section. What numbers of humiliating failures have occurred, what vast sums of money have been wasted, owing to the want of precautions based on sound geological knowledge and its practical application. Any engineer who has had to carry out works of any magnitude is well aware of this, and the necessity of such knowledge is accentuated when such works have to be executed in countries out of the range of civilization. The author has evidently borne this fact in mind, for his observations deal with fundamental principles and range over wide areas.

Lieut.-Colonel Sorsbie is to be congratulated on having placed within the reach of all a book of very moderate size, full of definite and accurate scientific teaching. The library that the practical engineer carries with him, necessarily limited to a few trusted guides, is the richer for the addition of this book. It is not indeed a royal road to learning, nor can it dispense with the laborious and determined study of the subject out of doors. But it serves its purpose if it guides towards that study, and, as far as we can judge, its guidance is reliable.

Officers of Royal Engineers, who have to undertake works in all parts of the British Empire under every variety of condition and climate, will find this book a very sound guide in many of the problems which they have to solve. This is especially the case with those who have to construct mountain roads, or to work out water supply schemes, two of the commonest tasks that devolve on military engineers, and in both of which cases success largely depends on accurate knowledge of geology.

G. K. Scott-Moncrieff.

NOTICE OF MAGAZINE.

RIVISTA DI ARTIGLIERIA E GENIO.

March, 1911.

MODERN PERMANENT FORTIFICATION AND LESSONS TO BE DERIVED FROM THE SIEGE OF PORT ARTHUR.—In a valuable work lately published by Colonel Jacofleff, military engineer and professor at the Nicolas Academy, important facts are brought to light with regard to the methods of siege warfare. Extracts from this work are taken from the supplement of the *Internationale Revue über die gesamten Armeen und Flotten* for November, 1910.

The author sets out with a consideration of the strife that commences at the moment when the besieger enters on the zone of infantry fire or about 500 to 600 metres from the work. From this point it is necessary for the attack to proceed by means of the sap, and successive positions of the infantry, until the assaulting position is established at about 200 metres from the work.

Before Port Arthur however the Japanese were able to approach nearer, for instance before Fort II., the sixth position of their infantry was found at 40 paces from the brow of the glacis, but this was only possible because the ground permitted of it and the works were deficient in any essential means of defence.

Jacofleff divides the near attack into three phases, commencing from the instant at which the assailants occupied the last infantry position, *i.e.*:—

1st. The attack on the glacis.

2nd. The attack on the ditch.

3rd. The attack on the ramparts and interior of the work.

Attack on the Glacis.—According to the theory of Vauban, this attack which constitutes one of the most difficult for the besiegers should be commenced openly, and recourse should only be made to underground operations when absolutely necessary. Its phases were calculated by weeks, and in fact they lasted all the time that a regular attack was carried on for the assault of a fortress.

Arab-Tabia in 1854, Strasburg and Belfort in 1870, the redoubts of Griwitza in 1877, the unfortunate assault of Perche before Belfort, and the attack of Geoktepe in 1882, are eloquent examples in the face of which a rapid attack according to the theory of Brunner, Sauer and Scheibert cannot be entertained. The Japanese, who found this theory convenient and opportune at Port Arthur, knew how much it would cost them and found it their duty to decide upon a regular attack which had

been at first excluded: however before the final decision they tried a new assault and were able to capture the glacis. This success might constitute an argument in favour of a rapid attack; but the question assumes another aspect when one considers the losses attendant and also (1) Under what circumstances the assault may succeed, and (2) By what technical and tactical means the attack on the glacis may be prolonged.

With regard to the first point it is necessary to note :—

(*a*). In front of the intermediate work No. 3 the Japanese on the 20th September had commenced the work of the sap, starting from the first redoubt, and it was not until a month later that they were able to capture a trench which the Russians had excavated at 400 paces in front of the counterscarp. The Japanese utilized this trench against the enemy and setting out from this on the 20th October carried on the work in advance. The Russians had planned a system of mines but were unable to carry this out owing to a want of the necessary tools and material; the fougasses organized as mines of observation were rendered unserviceable from losses produced by the enemy's fire which had broken the conductors and exploded the cartridges; so that there only remained the barbed wire, incomplete and insufficient even for a fieldwork, and which presented no difficulty to the destructive work of the Japanese pioneers. The artillery fire was also insufficient to sweep the ground around the intermediate works. The throwing of bombs by mechanical apparatus was imperfect, and could only be used to a limited extent against the Japanese approaches.

The defenders were reduced as a last resource to making sorties to resist the enemy's attacks. But these sorties were rare, and only diminished the capabilities of an active defence; the garrison was weak and unfitted for undertakings of this kind; the observations of the ground at night could not be properly maintained. These failures, it is said, resulted in placing the Japanese in possession of the glacis.

(*b*). In front of Fort No. III. there was a large dead angle which it had not been possible to avoid during the construction of the defensive works, but the defects of which it was sought to remedy by the construction of an advanced trench, provided with numerous blindages. The Japanese arrived on the 26th October at 20 paces from this trench and took it by assault after having silenced the defenders with a formidable artillery fire. They united it with their last infantry positions by means of trenches of communication and from thence they turned their approaches against the fort. The pioneers arrived at the foot of the counterscarp wall, and commenced to excavate rifle pits without encountering any opposition.

(*c*). In front of Fort II. there was a dead angle at the foot of the glacis which the Russians had given up defending, contenting themselves with constructing an obstacle of barbed wire which was under the fire of the fortress and flanked by the neighbouring works. At this dead angle, in the middle of October, the Japanese organized undisturbed their last infantry position, and excavated a mining gallery under the glacis. But this work was discovered from a work in the vicinity, and the Russians then tried to obstruct the work by sorties and countermines.

Owing to the Russians having exploded a charge of too great strength, a funnel was produced which laid open a portion of the counterscarp wall.

The besiegers at once profited by this accident and occupied the funnel and commenced the crowning of the glacis.

Returning then to the first point of the question, it may be concluded that the short period that the defence lasted before the crowning of the glacis, was due to defects in the construction of three permanent works of importance, and to an insufficient supply of artillery ammunition and pioneers' tools, and also to technical and tactical errors on the part of the defenders.

The most efficacious means of preventing the enemy from occupying the glacis would be a system of well-organized countermines. The galleries should be of sufficient length and so arranged that the enemy cannot reach the flanking defences. At Port Arthur the mines were excavated by men who had not been properly instructed and who worked with tools ill adapted for their purpose, so that their efforts were like the last convulsive spasms of a dying man.

It is most important for the defenders to utilize their obstacles, and every means possible for prolonging the defence.

If the besiegers construct galleries in advance, the defenders should endeavour by every means in their power to impede the execution of the underground works, by artillery fire, throwing of explosives, sorties, etc.

At Port Arthur the defenders are said to have used Whitehead torpedoes containing 31.5 k.g. of guncotton thrown by means of marine torpedo tubes, and charges of 6 k.g. of guncotton belonging to the guns of 47 m.m. thrown by means of a pole. But such primitive methods are bound to fail, and it may be found necessary to construct special apparatus for throwing explosives at short distances (from 30 to 250 m.).

For observation services a covered way with recovering places for sentries and blockhouses for the relieving guards are necessary, and it is indispensable that these observation posts should be in communication with the commandant by means of the telephone. During the night there should be a service of electric searchlights of large aperture installed on the flanking batteries, and also movable searchlights and torches in the covered ways.

But notwithstanding all these measures the enemy's intentions and work can only be ascertained by means of sorties made with small detachments, judiciously led, accompanied by pioneers, miners, artificers who should throw themselves against the advanced infantry position. And, as it may be suggested that this is almost a forlorn hope, these sorties should be used parsimoniously and after mature reflection on their duties and the moment and method of their execution, taking care to keep the secret up to the last moment and using signals which should not attract the attention of either side.

It is impossible to predict the time that the underground warfare will continue, or who will gain the victory. At the commencement the advantage should be on the side of the defenders, if they have been previously prepared in peace times by serious and complete exercises.

E. T. THACKERAY.

King Edward VII's Hospital for Officers.

Patron—HIS MAJESTY THE KING.
President—HIS ROYAL HIGHNESS THE DUKE OF CONNAUGHT.
Trustees—SISTER AGNES, LORD FARQUHAR, SIR WALPOLE GREENWELL, Bart., ERNEST DE LA RUE, Esq., S. ERNEST PALMER, Esq.

REPORT.

DURING 1910 241 Officers received treatment. 174 Operations were performed.
OFFICERS ADMITTED :—Royal Navy and Royal Marines, 33; Royal Indian Marine, 3; Royal Artillery, 24; Royal Engineers, 20; Cavalry, 9; Foot Guards, 1; Infantry, 74; A.S.C., 1; R.A.M.C., 2; A.V.C., 4; A.P.D., 2. INDIAN ARMY—Indian Army 7, Cavalry 11, Infantry 46, I.M.S. 1—65.
Staff, Unemployed, etc., 3.

TOTAL—241.

Dr. Balance Sheet, 31st December, 1910. Cr.

	£ s. d.	£ s. d.		£ s. d.
To RECEIVED IN ADVANCE IN RESPECT OF ANNUAL CONTRIBUTIONS		202 12 0	By INVESTMENTS	40,699 5 8
,, BALANCE—Viz., Excess of Donations over Initial Outlay and Current Expenditure to 31st December, 1909	43,099 12 0		,, CASH AT BANKERS	3,578 3 4
,, Excess of Current Income over Expenditure ...	975 5 0			
		44,074 17 0		
		£44,277 9 0		£44,277 9 0

Dr. Income and Expenditure Account, Year ending 31st December, 1910. Cr.

	£ s. d.	£ s. d.		£ s. d.	£ s. d.
To RENT, RATES, TAXES, WATER AND INSURANCE		708 1 2	By SUBSCRIPTIONS APPLICABLE TO THE YEAR, viz.:—		
,, REPAIRS AND ALTERATIONS TO HOSPITAL ...		512 17 1	His late Majesty King Edward VII.... ...	100 0 0	
,, GENERAL MAINTENANCE EXPENSES—			H.M. King George V....	100 0 0	
Salaries and Wages ...	1,398 0 3		Sir Walpole Greenwell, Bart.	100 0 0	
Washing	272 10 5		Sir E. Cassel, Bart. ...	100 0 0	
Provisions and Household Stores	2,040 18 3		S. Neumann, Esq. ...	100 0 0	
Wines and Spirits ...	67 16 3		J. Larnach, Esq. ...	100 0 0	
Fuel and Light	246 12 0		W. Burns, Esq.	50 0 0	
Clothing, House Repairs, Telephone, and other incidental expenses ...	391 0 4		Lord Burnham	100 0 0	
		4,416 17 6	S. E. Palmer, Esq. ...	100 0 0	
,, SURGICAL DRESSINGS, MEDICINES, PATHOLOGICAL REPORTS, MASSAGE, AND SUNDRY FEES		950 1 7	Sir H. Praed, Bart. ...	10 10 0	
,, BALANCE CARRIED TO BALANCE SHEET		975 5 0	Miss Keyser	100 0 0	
			Sister Agnes	100 0 0	
			Lord Rothschild... ...	100 0 0	
			Alfred Rothschild, Esq.	100 0 0	
			Leopold Rothschild, Esq.	100 0 0	
			C. E. Keyser, Esq. ...	100 0 0	
			Mrs. Livingstone Bruce	20 0 0	
			Margaret Lady Waterlow	10 0 0	
			Mrs. Bischoffsheim ...	50 0 0	
			Lord Strathcona... ...	105 0 0	
			Sir Edward Sassoon, Bart.	50 0 0	
			Arthur Sassoon, Esq., M.V.O.	50 0 0	
			Viscount Iveagh... ...	100 0 0	
			Sir E. Hambro, Bart. ...	100 0 0	
			Baroness Eckardstein	100 0 0	
			Lord Michelham... ...	100 0 0	
			E. Gordon, Esq.... ...	2 2 0	
			C. Gordon, Esq.... ...	2 2 0	
			Mrs. G. Goddard ...	1 1 0	
			S. Gordon, Esq.... ...	2 2 0	
			Mrs. A. M. Corry ...	20 0 0	
					2,172 17 0
			,, DIVIDENDS ON INVESTMENTS		1,870 19 8
			,, SUBSCRIPTIONS AND DONATIONS PER OFFICERS OF THE NAVY AND ARMY AND RETIRED OFFICERS		3,519 5 8
		£7,563 2 4			£7,563 2 4

We have examined the above Statements of Accounts with the books and vouchers of the Hospital, and find the same to be correct.

18th February, 1911. PRICE WATERHOUSE & CO

INSERT PLANS 116

FROM BOOK 116