

SOME NOTES

BY

MAJOR B. C. BATTYE, R.E.

ON

THE MINOR TACTICS

OF

TRENCH WARFARE

WITH

Special Reference to the Co-operation of Infantry
and Engineers

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INTRODUCTION.

One of the most deeply rooted traditions of the British Army is that battles are won more by the strong right arm of the British fighting man than by mechanism and genius. In emphasizing this, we have perhaps underestimated the value of mechanical invention and scientific organization. It is, however, the duty of the tactician to ensure that the British soldier shall at least meet his opponent in hand to hand conflict on approximately even terms, and having ensured this much, the British soldier armed with bayonet and fired with the traditions of his race and the grandeur and justice of our cause can be safely entrusted to do the rest. The more recent development of trench warfare has introduced so many new conditions and surrounded us with an environment so entirely novel and unexpected that ideas tend to become fogged and the most nebulous and contradictory opinions exist with regard to the minor tactics of the form of warfare. Many who by their training and experience are fitted to make valuable deductions from these experiences, can only by the very nature of their duty obtain them at second hand; while of those who do obtain this experience at first hand, many are unable to make any such deductions, while of those who could so few return to tell the tale that little or no progress is gained towards the general elucidation of these problems.

Several weeks enforced idleness accompanied by frequent discussions with other similarly placed regimental officers has provided ample opportunities for thinking over these problems. The following notes originally prepared for lecture purposes comprising a preliminary attempt to crystallize some of the ideas and lessons of the last six

months into a logical analysis of the whole subject are the fruit of these meditations. It is the writer's firm conviction that the time has now come for some such treatment of the subject and that a thorough appreciation by all officers of the various phases of trench operation and their relative importance is absolutely essential for the preparation and carrying out of reliable defence schemes, for the drawing up and execution of sound operation orders, and last but not least, if the right lessons are to be learned from failure, a correct understanding of the many still unsolved problems of trench warfare and the circumstances still attending them may be of great assistance in paving the way for a thoroughly systematic investigation and eventual solution.

J. J. FAYAT, C. B. M. G.

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The Minor Tactics of Trench Warfare

WITH SPECIAL REFERENCE TO
THE CO-OPERATION OF INFANTRY AND ENGINEERS

PART I.

Trench and Field Warfare compared.

1. MODERN WAR OF TWO TYPES.

Modern "civilized" warfare, so called, now falls into two categories, viz., Field warfare, which has hitherto formed the bulk of all military operations, and Trench warfare which has hitherto been confined to siege operations but which now forms the major part of all military operations. In our Field Service Regulations the chapter describing the battle is composed largely of descriptions of the methods to be adopted in the preliminary advance culminating in the building up of a strong firing line prior to the assault. To the assault itself only a few lines are devoted mainly composed of bands playing and bugles and shouting. Recent experience goes to show that instead of a single paragraph, volumes might be devoted to the study of this phase of the battle which now usually extends over many weeks in place of the few seconds previously allotted.

This dragging out of the assault into protracted trench operations lasting over many weeks constitutes modern trench warfare and is due to the necessity of making frontal attacks against carefully entrenched positions, owing to the absence of any flanks which may be turned, which is in turn due to the enormous size of modern armies enabling them to hold the whole length of a frontier from end to end.

It is most probable that as soon as the enemy's forces have been sufficiently reduced in numbers to render it impossible for them to hold such frontages and in the absence of any shorter frontages for them to fall back on, or what is more likely, the development by them of new methods of defending their lines depending less upon men than upon the more highly developed use of carefully protected machine guns, combined with the employment of masses of artillery, we shall see the resumption of field operations on a grand scale such as those of August last.

2. FIELD WARFARE.

The distinctive characteristics of field operations as compared with trench fighting are as follows:—

- (a) Flanks are turned by manoeuvre.
- (b) The majority of responsibility falls upon the staff.
- (c) Field works when carried out are generally constructed by working above ground and more or less free from fire.

3. TRENCH WARFARE.

The distinctive features of trench fighting, on the other hand, are as follows:—

(a) Frontal attack by force resulting in much greater ferocity and more hand to hand fighting, the ultimate object of these frontal attacks being the production of those flanks which did not previously exist.

(b) The majority of responsibility and initiative falls on the regimental officer.

(c) Field works have to be constructed by working below ground under the close range fire of the enemy leading to the adoption of hoes in the place of shovels, also under the cover of darkness.

(d) Trench warfare consists entirely of the attack and defence of fortified positions, resulting in—

(i) Short ranges in which the long range features of the modern rifle and machine gun are no longer a necessity, suggesting the adoption of an entirely new type of weapon, capable of combining the flat trajectory of the rifle with the highly curved trajectory of the trench mortar or hand grenade. A combination of the rifle and bayonet as now used with a single pattern of grenade capable of being either thrown by hand or fired from the rifle, would appear to be the ideal compromise.

(ii) Deliberate methods resulting in slow progress, advance by ssp and parallel, the expenditure of much more time, and consequent feasibility of adopting much greater elaboration in detail, and the use of much more highly scientifically developed appliances, requiring time and deliberation in their employment.

4. EVOLUTION OF TRENCH WARFARE FROM FIELD OPERATIONS.

(i) This generally takes place in approximately four phases as follows:—

(a) The attack of an entrenched position has been held up at distances varying from 200 yards to 500 yards and the firing line have been compelled to dig themselves in, in rifle pits.

(b) These rifle pits are connected up into a continuous trench line and at the same time the firing line advanced and dug in as far as possible under cover of darkness.

(c) This position is then counter attacked by the enemy and probably part of the line lost and again re-established by a counter-counter attack during the second or third day.

(d) This line having resisted counter attack is then consolidated and held over a period extending from days to weeks prior to a general assault.

The above is what appears to have happened in Gallipoli.

(ii) During the first and second phases, while the assaulting line is being established and dug in, groups of men will have been established in advanced positions offering natural cover from fire, which must be connected up to the main line without delay, while other men will have established themselves in advanced trenches with their flanks in the air, resulting in gaps in the line.

These gaps must be closed up and the flanks made secure by digging additional trenches at the earliest possible opportunity. A case of this kind occurred after the battle of Neuve Chapelle where one regiment occupied a trench with its left flank in the air and 150 yards in front of the rest of the line. The attempt of the enemy to get behind this trench at night was only anticipated just in time by the construction of a combined communication and flanking fire trench connecting up the two. The enemy actually attacked the digging party while at work, but were driven off.

This may result in the establishment of a general front line of the most grotesque shape which may have to be altered and adjusted later, usually by digging new lines of trenches at night.

PART II.

Holding an Entrenched Position.

1. INTER-DEPENDENCE OF CONSOLIDATION AND DEFENCE.

To enable a position to be held for any period, consolidation is absolutely essential and as this cannot be carried out effectively unless the position is effectively defended, a superiority of fire maintained and the enemy's organized annoyance overcome, while on the other hand no effective defence can be maintained unless the position has been consolidated, the two are inter-dependent and must go together. The first duty of all regimental officers is to commence the consolidation of a position the moment it is occupied, and to go on consolidating unceasingly and without resting until relieved by another unit. This unit must then carry on the good work day and night without ceasing until the position has been rendered absolutely impregnable by the construction of advance saps, supporting lines and every artifice known to the engineer, particular care being taken to continue the same policy as that adopted by the last unit.

2. CONSOLIDATION FOR DEFENCE.

The nature of the work to be done naturally depends upon the nature of attack which is expected and it is therefore advisable to consider each in turn, in the following order, which is that in which they will usually occur:—

- A. Counter attack.
- B. Shell fire.
- C. Assault.
- D. Daily wear and tear.
- E. Deliberate attack and bombing.

B.—COUNTER ATTACK.

For protection against counter attack three things must be kept in view.

- (i) Protection from enemy rifle and shrapnel fire which can usually only be obtained by connecting up the rifle pits already dug into a continuous trench of the usual type 3 feet by 3 feet with traverses and 18-inch parapet for fire standing.

Nothing more than this can as a rule be obtained in the short time available between the holding up of the attack and the delivery of the counter attack. Overhead cover, shelters, and such like should not be attempted at this stage and any spare time available should be spent in establishing:—

- (ii) A line of obstacles of any description out of materials available sufficient to hold up the assaulting troops, under close range fire. This is of the utmost importance and for this purpose portable frames previously prepared by the R. E. ready wired for placing out are invaluable: also furniture placed upside down and the legs wired together, and other similar methods.

- (iii) Finally, provision must be made to facilitate rapid exit from the trench for delivering the counter charge, should the assaulting troops succeed in passing the obstacle.

A.—SHELL FIRE.

For protection against shell fire it is necessary to construct cover against two types of fire:—

- (a) Shrapnel.
- (b) High explosive.

- (a) For protection against shrapnel, splinter-proof shelters must be constructed and up to the present this has been done on two different systems as follows:—

- (i) What may be called the collective type of shelter constructed immediately behind the front line to hold from 6 to 12 men.
- (ii) The second or individual type consisting of small shelters constructed in the fire trench itself, each large enough to hold one man lying or two sitting.

There are serious objections to the first system due to the difficulty of getting men out rapidly when fast asleep to meet a sudden assault at night, and for this reason, many officers prefer the second system.

There is probably ample scope for both systems adopted simultaneously; if this is to be done the small shelters should be constructed first and the larger ones added behind later if opportunity permits.

With regard to the actual construction of these different types of shelter, practice differs according to locality and material available, vide "Field Entrenchments" Chapter V, p. 94. (Imperial Army series, John Murray & Co., price 1s, a most excellent handbook).

For the smaller type of shelters, in dry weather the men will invariably cut out recesses or "funk" holes under the front parapet

and it is very difficult to check this practice. The most practical course to adopt is to accept these recesses as inevitable, and to supply and fit in frames for shoring them up obtained from the R. E. or perhaps better still to dig away the parapet there, roof over with a corrugated iron sheet or timber, and rebuild the parapet again on top, *vide*, "Field Entrenchments," pp. 99 and 105.

When constructing shelters two or three points must be carefully attended to, the rest is common sense:—

(i) Roofing timber should always be three to four times as strong as appears necessary, if they are to last.

(ii) The sides supporting the roof must be revetted with sand bags in the type illustrated on page 105.

(iii) Ground plates, *vide* p. 101, must be provided, or the sides will collapse.

Parados give protection against short bursts of our own shrapnel.

(b) With regard to protection against high explosive shell, it is of course impossible to devise any means for protection against direct hits and the only course hitherto adopted is to:—

(i) Locate the effects of bursts by constructing parados and traverses 4 to 5 yards apart and, if the nature of the soil permits, cutting recesses, though this interferes with the construction of shelters under the front parapet.

(ii) Reducing the size of the target by keeping the trenches as narrow as possible.

(iii) By general concealment rendering observation more difficult, though the advantages of this method are far less than in field warfare, owing to the close range from which observation of fire is carried out.

(iii) Future developments may result in the withdrawal of most of the men from the front trench in order to avoid losses from shell fire, the defence of the trench itself being entrusted more to well protected machine guns, backed by Artillery; the men being posted in a supporting position 100 yards or so to the rear, ready to counter attack at any given instant.

This disposes of the known methods of protection for men. Protection must also however be given to message communications. Recent experience goes to show that the telephone system completely collapses under intensive shell fire and it is impossible to describe the utter chaos which results from the complete breakdown of all message communications during a heavy bombardment. This suggests the enormous importance of establishing a second and alternative system of visual signalling, to fall back upon when the telephone system has broken down, and is a point which has not yet received the attention it deserves.

C.—ASSAULT.

Before describing the methods to be adopted for protection against assault it is advisable to consider the policy to be adopted in carrying out trench improvement generally. There has been a tendency through this campaign to try and impose new methods and types of protection on troops holding the firing line based on experience gained in the construction of fortifications either under peace conditions or at a considerable distance from the enemy.

Such attempts have usually proved futile and in dealing with men fighting for their lives it is impossible to do more than direct, guide, and control the natural instincts possessed by the average soldier.

The policy to be adopted should be similar to that employed by the engineers when training a large river liable to flood, i.e., it is impossible suddenly to divert from its natural course, and the most we can hope for is to train it in the general direction we want, by a small push here and a little push there, and so by gradual influence gain the push here a little push there, and so by gradual influence gain the desired effect. For instance, every British soldier if left to himself will dig himself down 12 feet deep or when the soil will not permit will build up his breastwork 12 feet high, thereby ensuring ample protection from shell fire, but rendering the trench absolutely impossible to defend against assault. The regimental officer on the lookout for this can entirely counteract the disadvantages of this tendency by making the men leave a narrow ledge which can afterwards be well revetted into a fire step, while still permitting of a deep passage in rear. To attempt to stop and prevent the deepening of the trench at all would be impractical; it cannot be done, since it runs counter to the soldiers' natural instincts. The same applies to the undercutting of "funk" holes already referred to.

An assault delivered on the front fire trench has on most occasions till quite recently been supported by preliminary gun fire alone, that is the assaulting columns actually charge unsupported by any fire.

Under these circumstances it stands to reason that for making the actual assault no cover is required, and a trench becomes more of a disadvantage than otherwise.

For resisting assaults under these circumstances the following points must therefore be kept in view—

(i) First and most important of all, obstacles must be provided and the front must be well wired in.

(ii) Facility must be provided for enabling the whole garrison to fire over the top of the parapet unimpeded by headcover. For this purpose a complete fire step well revetted throughout its whole length is absolutely essential.

(iii) For facilitating supervision and control a passage behind the fire-step giving complete protection from fire while standing upright should be provided, this will develop naturally owing to the instinct of the soldier to protect himself, as already explained; it requires no positive attention.

(iiii) Finally, provision must be made for rapid exit from the trench, which no longer serves any useful object, to deliver the counter-charge.

More recently however, such assaults have been covered by—

I. Hand grenades thrown from the front line in an assaulting column. This can be checked by placing the obstacle sufficiently far out to prevent the bomb throwers getting within hand range of their main trench, that is to say, not less than 40 yards. This is an important point which should not be overlooked in placing the obstacle.

II. Recently by asphyxiating gases; this has been met up to the present to a certain extent by the employment of respirators and airtight helmets.

It is however certain that the enemy will develop and improve this method of covering the attack, which suggests the advisability of holding out lines in future less by large numbers of men, than by the employment of a very much larger number of well protected machine guns with special protection against gases for the gun detachments, and supported by Artillery ready registered on to the glacis. It is possible that providing each man with an air cushion which can be deflated and carried flat in the pocket but which can be connected by tubing to an airtight helmet and blown up by a bicycle pump, (not by the lungs), while in the trenches might prove a satisfactory solution.

Owing to the unreliability of telephonic communication under shell fire, a pre-arranged rocket signal might be used to signify the moment when the actual assault has been launched.

III. And more recently still by the use of liquid fire jets. The best protection known for this is overhead cover with 6 or 12 inches thickness of earth. There is always a danger with overhead cover of the occupants being caught like a rat in a trap, especially after a preliminary bombardment by high explosive shell.

IV. And finally, provision must be made to facilitate the immediate delivery of a counter attack upon the supporting line if temporarily occupied by the enemy. The success of this depends entirely upon its being delivered absolutely on top of the *mélee* in the front trench, which at once indicates the importance of—

- (i) Initiative by the regimental officer in command of the supporting troops, and
- (ii) The proximity of the supporting trench which should not be more than 100 to 150 yards behind.

D.—DAILY WEAR AND TEAR.

For protection against daily wear and tear the following must be provided:—

I. As already indicated, a passage behind the fire step for protection standing.

II. The provision of head cover and therefore of loopholes. If the trench is to be held effectively from day to day and the enemy's organized superiority is to be kept down it is absolutely essential to maintain a superiority of fire at the close ranges which obtain. For this loopholes are an absolute necessity and are usually supplied at about one per 2 or 3 yards.

Three types of loopholes will be met with as follows:—

(i) The type, usually run up hurriedly by the troops themselves when first occupying a trench, made from sand bags. Sand bag loopholes are, as usually constructed, extremely dangerous, being very conspicuous and seldom bullet proof; they will not last more than a few days and at best should be looked upon as an entirely temporary expedient and discouraged as much as possible.

(ii) In the absence of steel loop plates wooden box loopholes can be used which will usually be made up by the R. E. and brought up to the trenches and fixed in place at night in place of the sand bag loopholes. It is a great advantage to all concerned if the Infantry can fix these themselves but this requires previous training. Such loopholes are usually fixed slightly skewed with the small opening towards the enemy and rendered invisible by a small 5-inch canvas curtain painted to imitate the soil which can be dropped while not in use.

(iii) Steel plates. These give the greatest feeling of confidence but are very hard to conceal. Every effort, however, should be made to conceal as far as possible by smearing the fronts with mud and concealing the upper edge by horizontal boards loaded with clods of earth, etc. A wavy-top loophole plate would probably be less conspicuous.

III. The organization of a complete system of systematic annoyance which is dealt with under the head of "Protection against deliberate attack."

IV. The provision of miscellaneous arrangements for hygiene and convenience such as water supply, latrines, communications, magazines, and officers' and telephone shelters, etc.

E.—DELIBERATE ATTACK AND BOMBING.

For protection against deliberate attack and bombing it is essential first to understand the German method of dominating our position by sap. Imagine two lines facing each other approximately 200 yards apart. The Germans push out saps at intervals up to within 20 yards of our lines and so establish what may be termed bomb heads from which they throw hand grenades into our trench, thus making the majority of our front trench line practically untenable, besides seriously affecting the moral of the garrison. For some time considerable controversy raged over the best method to be adopted to counteract this policy, and costly sorties were made on the enemy's sap heads, usually resulting in the capture of the sap head without the loss of a man but its eventual evacuation with a loss of more than 50 per cent of the garrison, owing to their being cut off from all supplies by the unbreachable glacis between. It is now generally agreed that while occupying a position even on the defensive it is advisable to push out saps as soon as, if not before, the enemy is seen to be doing the same. It is true that this results in contact being made in half the time and therefore loses that "time" which it is the object of all defensive measures to gain, but on the other hand this method ensures contact in the centre of the glacis, well out of reach of your own main trench and under conditions of equality for both sides, which may not only prolong the preliminary bomb contest sufficiently to make up for the time lost, but also protects your main line from continual annoyance and loss of moral and nerve, the inevitable result of being daily pelted with bombs and hand grenades. It is thus now agreed that even on the defensive saps should be pushed out at once to a distance of certainly not less than 40 yards in advance and approximately 60 yards apart with the object of keeping the enemy at arm's length and preventing him from approaching and dominating your main position.

This policy of domination by sap and bomb can be reversed and the tables completely turned by running out saps opposite those of the enemy, allowing him to advance until within 10 or 15 yards, and taking care not to be mined in turn. When the saps have approached as close as this, the sap is rushed, preferably at night, and a barricade established as near to the enemy's main line as possible; meanwhile the gap between the two saps is dug through as rapidly as possible and the whole captured sap made good and part of your own system.

This happened near Givenchy last December, the gap between the two saps took 22 hours to sap through, working both ways at once and the garrison was in the meantime supplied with bombs, ammunition, food and water, by means of a rope attached to a string thrown across the glacis in between the two approaching sap heads.

For actual protection against bombs, various methods have been tried involving the use of wire netting, but few, if any, have proved entirely satisfactory or worth the trouble and labour involved in their provision, the men usually prefer to take their turn in a sap head and trust to luck.

Where there is a likelihood of the enemy penetrating your own network, it is advisable to loophole the traverses at intervals, and establish double blocks which will be described later, on each side of the threatened length. This will enable you to effectually prevent him from extending his lodgment laterally, by bombing along your track.

It stands to reason that every effort should be made to hinder the enemy's work, particularly on his saps, and thus enable you to construct your saps as quickly as he does. With this object in view systematic annoyance should be organized, every possible encouragement given to the troops to show an aggressive spirit, an attitude of mind which is not natural to the British character, which infinitely prefers to live and let live. Snipers should be organized and made as independent and free from regimental duties and control as possible. They should be given encouragement and facility for annoying the enemy on every possible occasion at all hours of the day and night, by the assistance of telescopic sights, rifle tests, and other devices.

Bomb guns and rifle grenades should be employed systematically against the enemy's approaches. For this purpose however, it is essential to have a bomb thrower and rifle grenade which are accurate to within a few inches. Until recently the ordinary type of trench mortar as well as the Hale's rifle grenade could not be depended upon to fire accurately within 10 yards of the target with the result that they are seldom if ever taken seriously, being looked upon more as a plaything whose employment usually ends in drawing both the enemy's gun fire and the consequent curses of the garrison.

3. RETRENCHMENTS.

Retrenchments fall into three classes as follows:—

(a) The second or bombing line first employed by the Germans against the French. This consists of a shallow trench established from 10 to 20 yards behind the front line, which is occupied during

the assault by a second line of Infantry armed with hand grenades, the approaches from this to the front line being blocked and covered by rifle fire. On more than one occasion the French succeeded in capturing the whole of the German first line but having got there were immediately bombed out of it by the second line; being unable to fire back over the parapets or to retaliate in any other way, they were compelled to withdraw after the capture of the main trench and the loss of 80% of their numbers. A similar method was employed by us during the winter for the construction of posts at intervals immediately behind the front trench, which was flooded, using the parapets as a parapet.

It has not to date been adopted by us as a regular principle, the idea is clearly conveyed in Fig. 51, p. 92, Field Entrenchments.

(b) The second supporting line approximately 100 yards behind the front from which the immediate counter-attack would be delivered and which should be as carefully built up for ultimate resistance as the front line and not consist, as often happens, of a series of shelters and dug-outs constructed entirely for the comfort of the supporting troops. This second supporting line should have all the approaches from it to the front line carefully double blocked.

(c) Strong points established at intervals in both the front and second supporting lines. These should be located usually at the heads of all communication trenches and the routes of all saps resulting in a cross or tee work.

PART III.

Attack of an Entrenched Position.

The attack of any entrenched position usually takes place in four phases, as follows:—

1. Deliberate advance up to within assaulting range.
2. Obtaining a lodgment in enemy's network.
3. Maintaining the lodgment in enemy's network.
4. Extending the lodgment in enemy's network.

1.—DELIBERATE ADVANCE.

Should the front main trench previously held, not be within assaulting distance of the enemy's position, an advanced position must be taken up, within that range, before any attempt is made to carry the position by assault. It stands to reason that the fire swept zone across which an assault has to be made should be as short as possible, about 100 to 150 yards. If, however, this is much less than 100 yards it is impossible to bombard the enemy's front line without risk of serious loss to one's own men. This range may possibly be reduced in view of the more extended use of high explosive shell in place of shrapnel. An alternative method is to establish a trench within 50 or 60 yards of the enemy and withdraw the garrison during a bombardment. This, however, is attended with serious difficulties in launching the actual assault at the correct instant, unless it is carried out from a retired position in rear, necessitating the crossing of the front trench which, however well bridged, will form a very effective obstacle to the assaulting line.

Another advantage of establishing the front line as close as possible is the difficulty the enemy will experience in strengthening their obstacle. If 200 or 300 yards of glacis are left between, the enemy can continue improving their obstacle at night with steel posts, etc., till it is almost impossible to destroy it.

There are two methods of taking up this advanced position:—

- (a) By means of night advances and entrenching under cover of darkness.
- (b) If the above is not practicable, by alternative saps and parallels as fully described in the Text Books on Siege and Fortress Warfare.

Having established and consolidated this advanced position, the second phase commences.

2. OBTAINING A LODGMENT.

This also consists of two phases:—

- A. Preliminaries.
- B. The actual assault.

A.—PRELIMINARIES.

Before any assault can be launched against the enemy's front line, five points must be carefully attended to beforehand, as follows:—

I. Covered communications must be established across the glacis so as to enable the garrison of the captured trench to be communicated with as soon as possible after the assault has been launched. This can usually only be done by running saps out as far as possible immediately opposite any advanced posts or enemy saps so as to shorten the amount of work to be done afterwards. It is possible by this method to establish saps, the forward and most advanced section of which will probably have to be blinded or actually tunnelled in the form of a shallow mine, up to within 10 or 15 yards of the enemy's advanced sap heads, thereby leaving only a few hours work necessary to complete the whole communications.

II. The enemy's strong points, keeps, and above all his machine guns and their emplacements must be located beforehand, by every means at the disposal of the staff, i.e., by aerial reconnaissance, (supplemented by large scale maps based on aerial photographs), careful observation by telescope from observing stations, and also by night patrols and engineer reconnaissance carried out by the R.E. This work is of the utmost importance and fully justifies the employment of a special staff officer whose sole duty is to locate these strong points. When it is considered that a few machine guns, well wired in, can arrest the attack of a whole division, it is impossible to exaggerate the importance of this point.

III. Guns and troops must be massed beforehand, behind the front to be attacked, without giving warning to the enemy. Men have to be massed 4 to 5 per yard and under cover from shell fire. To ensure this it is necessary to construct several successive lines of trenches containing small shelters behind the front line. To prevent the construction of these trenches giving warning to the enemy, similar dummy trenches may have to be constructed on other portions of the front.

IV. Vast quantities of various kinds of stores must be collected in depots as near as possible to the firing line for use the moment the assault has been launched, consisting of:—

- (a) Small Arm Ammunition.
- (b) Grenades.
- (c) Sand bags.
- (d) Portable obstacle frames.
- (e) Barbed wire.
- (f) Timber, planks, etc.
- (g) Corrugated iron sheets.

V. Arrangements must be made for the rapid delivery of the assault from the trench by—

- (a) Clearing gaps in the home obstacle.
- (b) Making steps in the front wall of the trench to facilitate rapid exit.

This is best done by cutting notches for the feet in the front wall of the trench, reinforcing, when the ground is soft, by driving in a 16" to 20" length of 4" plank pointed at one end. A picket driven into the parapet to act as a hand grip is of great assistance when climbing out of the trench.

(c) Arrangements as an alternative to the above two, for enabling the troops to start the assault from in front of the home obstacle, as often done by the French. This can be done in two ways—

- (i) By digging a small trench over night in front of the obstacle connecting up to the sap which pass through it, or—
- (ii) Filing out and lying down in front of the obstacle during the preliminary intensive bombardment immediately prior to the assault.

This method cannot of course be adopted in conjunction with an interrupted bombardment as described later on.

B.—THE ACTUAL ASSAULT.

The actual assault again consists of three phases:—

- (a) Destruction of enemy's obstacle.
- (b) Suppression of the enemy's fire.
- (c) The actual delivery of the charge and crossing of glacis and obstacle residue.

(a). *Destruction of enemy's obstacle.*

This is the so far unsolved problem of this war. The following methods have been tried with varying success:—

(a) Destruction by gun fire both shrapnel and high explosive. There is no doubt that this method can destroy an obstacle effectively, provided the bombardment is continued for a sufficient length of time at maximum intensity and with the exact range obtained and kept throughout the bombardment. Under modern practical conditions of fire observation it is not always possible, especially in extremely flat country, with considerable difficulties for direct observation, to ensure these results, especially if the bombardment is continuous and no opportunity of correcting the fire exists while it lasts.

(b) Other miscellaneous methods have been tried on a small scale but are scarcely applicable on a large scale, namely, mining which of course is strictly limited in its application, firing of grape-shots, chain shot, and destruction by bombs, gun-cotton torpedo tubes, etc. All these methods are slow and deliberate and cannot be carried out rapidly in a short time immediately prior to the assault, which is essential if warning is not to be given to the enemy.

(c) The experience of the last winter goes to show that rifle fire through an entanglement, maintained continuously for several weeks completely destroys its value as an obstacle, thereby leading to the necessity of continuous repair against this form of wear and tear.

It will be seen from the above that up to the present no method yet adopted can be considered as entirely successful or thorough in the destruction of the enemy's obstacle, so that no matter what method is adopted, we are always face to face with the existence of an obstacle residue along the whole length of front, whose condition will vary from complete obliteration here and there in short lengths, to be absolutely intact in others. This has happened again and again, the most recent case being on the last assault in Gallipoli.

We are therefore compelled to accept the existence of an obstacle residue which must always be crossed or destroyed by hand, emphasising therefore the necessity of a simultaneous suppression of fire while this is being done.

(b). *Suppression of Fire.*

This also occurs in two phases:—

(a) Preliminary suppression of fire, usually by Artillery either simultaneous with or immediately following the destruction of the obstacle and just prior to the delivery of the assault.

(b) Simultaneous suppression during the actual Infantry assault and while the glacis and obstacle are being crossed and its destruction completed by hand. This is the second great unsolved problem of this war.

a. *Preliminary suppression.*—This is attained by the delivery of:—

- (i) An intensive bombardment on the enemy's front trench, keeps, and strong points, particularly machine guns, and
- (ii) the establishment of a curtain of shrapnel covering all approaches, and
- (iii) the suppression of the enemy's Artillery fire by long range guns.

Of these by far and away the most important is the smashing up if possible of the enemy's machine guns which again emphasises the absolute necessity of locating them beforehand. As the enemy increases the number of his machine guns, the importance of this point will grow and develop, until it is quite possible that it will be the fire of machine guns only, which may have to be considered, that of Infantry being practically negligible. If the position of machine guns have been correctly located it should be possible to ensure their complete destruction by the fire of bomb guns, provided these can be trusted to fire accurately since it must be remembered that the target to be hit is only a yard square and the supply of bomb ammunition in the firing line very limited.

An important point which is liable to be overlooked is the necessity of extending the length of the enemy's trench under bombardment laterally on both flanks of the actual position about to be assaulted and maintaining and continuing the bombardment on these flanks after the frontal fire has ceased; otherwise there is a danger of the unshaken enemy on both flanks catching the assaulting lines in this vicinity by flanking fire.

These portions of the assaulting line require very special attention and more careful organization beforehand than the rest of the front, since after capture of the position they will be in actual close contact with the enemy and will have great opportunities of extending the lodgment laterally, which must be seized without hesitation provided preparation has been made beforehand for enabling this to be done.

b. *Simultaneous suppression.*—This problem has not yet been solved and up to date we have trusted entirely to the after effects of preliminary intensive bombardment. Other methods which have been tried are as follows:—

I. *Interrupted bombardment.*—This is a method first adopted by the French by which the bombardment is interrupted for a short interval after 10 minutes' fire during which the enemy come out of their shelters and man the parapet in expectation of the Infantry assault. The bombardment is then suddenly resumed presumably first with shrapnel and after with high explosive, and the process repeated three or four times until the enemy cease to leave their shelters

when the assault can be delivered with greater chances of success. This method is really a way of increasing the after effects of a preliminary bombardment and is in no true sense a simultaneous suppression of fire.

This method also permits of a certain amount of correction of fire during the first pause, should the observing officer discover that the actual range of the obstacle has not been obtained.

II. *Hand grenades.*—Hand grenades thrown by the first assaulting line as soon as they reach within 20 or 30 yards of the enemy's trench. This is of course only effective during the crossing of the last 20 or 30 yards, and, if the enemy's obstacle has been correctly placed, will be of no assistance while destroying the obstacle residue. Owing however, to the difficulty of placing an obstacle in the very centre of the glacis this very seldom occurs and hand grenades have already proved valuable in keeping down the fire of the defence while others cut the barbed wire. A combination of this and the after effects of a preliminary intensive bombardment are the only methods hitherto adopted by us on any scale and have proved fairly successful under certain circumstances.

III. The explosion of a mine under the enemy's trench comes under this head. It is however strictly limited in its application, but is extremely effective in the assault of special strong points. Hill 60 is a case in point.

IV. The use of asphyxiating gases comes under this head.

V. The application of liquid fire projected under high pressure has already been tried by the Germans with varying success. We shall probably hear and see more of this in the future.

VI. The necessity of this simultaneous suppression is of course obvious. The following suggestion appears a good one:—

The discharge of 3 or 4 salvos of heavy bombs and rifle grenades from trench mortars and rifles over the heads of the assaulting line while it is crossing the glacis and obstacle residue.

The great difficulty about this is the necessity of absolute accurate ranging and control of the trench mortar and rifle grenade and also of the supply of sufficient quantities, since it stands to reason, if it is to be effective, that arrangements must be made to land one bomb or rifle grenade in every two or three yards length of the enemy's trench. It would appear that the trench mortars, owing to the difficulty in obtaining sufficient ammunition, should be reserved for use against machine guns and the whole of this simultaneous suppression obtained by the use of rifle grenades. The rifle grenade at present employed is

practically useless for this purpose owing to its inaccurate ranging. Whatever method is adopted, involving the discharge of projectiles over the heads of the assaulting lines, arrangements must exist for the direct control of this fire from the front fire trench, since by this method only can complete co-operation with the Infantry be assured.

(c). *Crossing of glacis and destruction of obstacle residue.*

To ensure the success of the assault, assuming that all the preliminary requirements have been carried out, the following points must be arranged for.

(a) The whole assaulting line must rise simultaneously on a given signal. Sufficient attention has not been paid to this to date, and there would appear to be room for the employment of better organized visual signals or other means for ensuring this.

(b) The front line must be equipped with—

(i) Hand grenades.

(ii) Cutting tools to complete the destruction of the obstacle residue.

(iii) Means for crossing the obstacle residue where it has not been possible to complete its destruction, such as light foot bridges, etc.

A light "one-man" trussed foot bridge was made up in quantities at the front for this purpose, which could be carried in the assault at the double by one man. It is not known to what extent they were used.

(c) The first line in places may be entirely destroyed and must be immediately followed up by a second line at close interval similarly equipped, but perhaps omitting the bridges for crossing wire.

(d) The third lines should be thrown in so as to decide the issue during the melee, to nullify the effect of any immediate counter attack, and to push on and occupy the enemy's second line if possible, which will probably be safer from counter attack from shell fire. It will thus be seen that the assault in line must contain at least 3 men per yard who have to be housed under cover as already indicated. To this must be added another 1 or 2 men per yard to hold the original main trench in the event of failure or counter attack.

The procedure after the capture of the enemy's first line trench depends entirely upon the method adopted for extending the lodgment in the enemy's network and is dealt with under that head.

3. MAINTAINING THE LODGMENT.

A.—POSITION FOLLOWING ASSAULT.

The situation immediately following the delivery of the assault would be much as follows:—

The major part of the enemy's front line will have been occupied, leaving probably short portions here and there still in the enemy's hands.

Portions of the assaulting line will have passed behind the enemy's first line and succeeded in capturing a second and perhaps a third line of trench, the major portion of which will still be in the enemy's hands, with short portions occupied by the assaulting line, just the converse of the enemy's first line, i.e., some will have penetrated too far and others not far enough, resulting in the existence of two parallel lines of trenches in the enemy's network occupied by both sides as follows:—

First line, mostly British, partly Germans, with Germans on both outer flanks forming the limits of the position attacked.

Second line, mostly Germans, partly British.

Once operations have come to a standstill arrangements must be made at once to hold the works already captured against the counter attack which must be expected as an absolute certainty.

B.—FEEDING THE GARRISON.

The garrison of this captured position, if it is to hold its own, will have to be supplied with the following materials:—

I. Ammunition, both small arm and grenades.

II. Stores for making barricades and reversing the trench.

III. Machine guns.

IV. Reinforcements.

V. Communications for messages.

VI. Possibly food and water.

In those places where the assault has been successful and where the enemy have been cleared out the bulk of this can probably be carried across the open glacis immediately following the assault.

Where, however, the Germans are still in occupation and also on both flanks of the captured position, that is to say, anywhere where the enemy can thus bring a flanking fire to bear across the glacis, it will be impossible to carry these stores across the open, and covered communication must be established immediately between the two networks, i.e., the communications originally started and described under the head of "Preliminaries to the Assault," must be completed without delay.

There are three ways of carrying this out:—

(i) Where the fire has been fairly well suppressed or can be kept under, or under cover of darkness, ordinary communication trenches can be dug by normal entrenching.

(ii) Where there is flanking fire from one direction only as would occur in the vicinity of the flanks of the captured position, a sand

bag breastwork and shallow sap can often be thrown up rapidly with cover on one side only.

(iii) Where fire is delivered from both flanks simultaneously a shallow sap must be dug sapping both back from the enemy's position and forward from our own, throwing up a parapet on both sides. No end cover to the sap is however essential in this case as in ordinary sapping.

Communication for messages must also be established without delay by—

(i) Reeling out a telephone immediately following the assault.

(ii) By visual signalling lamp, flag, or semaphore, or any other method which may be devised. All this should be carefully organized and arranged for beforehand.

C.—MEETING COUNTER ATTACK.

In order to meet the expected counter attack three points must be arranged for—

(a) *Trench barricades* must be established in the enemy's communication trenches and wherever the enemy happen to occupy portions of the same fire trench, as in the flanks of the captured position. These barricades will usually be constructed by sappers told off and arranged for in operation orders. In blocking trenches which connect with the enemy the "double block" system should be adopted, which is as follows.

Before establishing a barricade in a trench a bombing party, followed by the barricade party carrying the necessary stores, should be sent up that trench as far as possible, until stopped by fire down the trench, when a barricade should be constructed round the nearest corner.

A length of 30 or 40 yards straight trench should then be left and a second barricade constructed with a loophole in it and if possible a small passage round which can be readily blocked by a portable obstacle. The barricade is then held by a party of riflemen established at the loophole block which is practically a loophole traverse.

The length of 30 or 40 yards between, prevents it being possible for the enemy to bomb this party out of their trench without venturing out of the first block into the 30 or 40 yards length of straight trench which, being covered by rifle fire, is rendered untenable.

(b) *Reversing the enemy's trench.*—The first thing to be done after occupying the enemy's trench is to reverse the parapet, so as to enable the garrison to fire over what was originally the parapet. The quickest way of ensuring this is to cut out recesses in the back of the trench thereby establishing a small fire step within 4½ feet of the top of the

back parapet. This can be immensely improved by hoeing the back parados and flattening it down to form a bullet proof parapet, while gaps in the back of the trench must be immediately blocked by sand bags. If the ranges are short, loopholes will be essential and the old German loophole can usually be taken out of the parapet and fixed up in rear of the trench. To ensure rapid reversion, an ample supply of sand bags is essential, while as many hoes as obtainable should be arranged for beforehand.

The next thing is to obtain some protection from shell fire, otherwise, the enemy having the exact range of their trench, the position may be rendered untenable by shell fire alone. For this reason it may be advisable to push on and capture the second line or supporting trench, which will be less damaged, by the preliminary bombardment and may possibly contain more shelters, but in any case the enemy's own shelters should be repaired and rebuilt and rendered serviceable with the least possible delay.

(c). *Temporary obstacles*.—It will often be found that many of the enemy's obstacles are to a certain extent intact and if portable can be lifted from one side of the trench to the other immediately following the assault. If this cannot be done by daytime it should be done under cover of darkness during the first night.

In the event of there being no such portable obstacles available, arrangements should be made beforehand for the supply of sufficient portable obstacles by the R. E. ready for placing during the first night. This is a matter of the utmost importance and should be carefully arranged for beforehand.

4. EXTENDING LODGMENT IN ENEMY'S NETWORK.

This may be extended in two directions:—

- A. Laterally.
- B. In depth.

A. LATERAL EXTENSION.

Where there are portions of the same trench still occupied by the enemy it is essential to have them turned out without delay; the method usually adopted up to date is to "bomb along" the trench on the system first adopted by us at Festubert.

An expert bomb team advance along the trench preceded by a party armed with rifles and bayonets until stopped by coming in contact with the enemy. The position of the enemy is then located and bombs are then thrown over the heads of the bayonet men and

the next traverse into that portion of the trench occupied by the enemy, probably round the next traverse. The moment the bombs have exploded the bayonet men rush in and dispose of the enemy. This process repeated two or three times will generally result in a complete rout of the occupants or else their surrender. It should be borne in mind that the enemy will and often does adopt this method against us and the only known preventative is the establishment of a double block. Should a double block be met with while bombing along a trench the best remedy is to organize an assaulting party to attack the barricade across the open from the enemy's rear side for preference. The Germans usually instal a machine gun at such points and it stands to reason that if the assault is carried out rapidly the machine gun which has been fixed to fire along the trench cannot be brought into use across the open in sufficient time. This method may not, however, always be possible if the enemy commands the open ground all round the trench, in which case the following improvements might prove effective as a general method for lateral extension.

I. An intensive Artillery bombardment of a 50 to 100 yards length of trench first to be rushed followed immediately by:—

II. A bomb attack along that trench as already described covered simultaneously by:—

III. Concentrated machine gun and rifle fire from our own original front as if preparing for a frontal attack assisted by:—

IV. Simultaneous machine gun and rifle fire from the enemy's rear from machine guns pushed up into advanced saps or the enemy's old communication trench.

The position of the bomb party must be clearly indicated to all parties including the Artillery observing officer by holding up coloured discs, flags, or signals, showing the extent to which the party have advanced.

B. EXTENSION IN DEPTH.

In the attack of an extensive network of trenches two methods may be adopted.

(a) The "Hoorah" method which is typically British and was found entirely successful at Neuve Chapelle, in which three or four lines of trenches are rushed one after another in rapid succession following the general assault on the first line. This method is more applicable where the network is not very extensive, is poorly organized and the assault comes as a complete surprise.

(b) The systematic method which has been adopted of late with such success by the French and which is the only possible method in attacking a well organized and extensive network.

The first method (a) depends entirely for its success upon the previous location of the enemy's strong points and keeps, and if these have not been marked down absolutely completely before the assault is organized it is only courting disaster to attempt this method.

Having carefully located the whole of the enemy's strong points, these must be carefully smashed up during the preliminary bombardment and the assault must be launched in as many lines of men at close interval as there are enemy's trenches to be captured plus one for holding the original line against possible failure or counter attack.

By this method one line captures the enemy's front trench, the second line following immediately sweeps over that on to the second trench and the third line immediately following that, sweeps over both those and so on. This necessitates the supply of a large number of light bridges for crossing the already captured trenches which must be carefully arranged for beforehand and carried up by each line in succession, the captured trench being rapidly bridged in time for the following line to cross it.

The whole success of this method depends upon the completeness with which every single detail has been thought out and arranged for beforehand.

This method is fairly free from the danger of counter attack by shell fire alone, which is not the case when only the first trench is held.

In the second method (b) one definite objective and one only, as for instance the enemy's second line trench, is given to the attacking troops, this is usually made absolutely certain of and held against all attempts at recapture. This objective is then carefully and thoroughly consolidated and a fresh reconnaissance made of the second objective which is then treated in exactly the same manner as the first, the hold on the network being gradually extended by degrees from day to day, the whole being carefully wired in, enclosing the telephone and Officers' shelters, Magazines, Ammunition Stores and all other important features, the loss of which might result in serious consequences. The trenches at the limits of this strong point should be carefully double blocked and the traverse in the fire trench carefully loopholed.

The construction of keeps, the modern term for entirely closed works situated from 200 to 300 yards behind the front line and built up by degrees so as to form absolutely impregnable forts containing machine guns, emplacements, lookouts, shelters, and a complete double ring of obstacles and parados to all trenches.

The excellent protection from shell fire afforded by good cellars has often resulted in large houses and factories forming the nucleus

of such works. They are usually sited to cover important cross roads and approaches with a field of fire up to 100 yards all round, neighbouring buildings, if necessary, being cleared and the whole rendered as safe as possible from rapid assault. Each keep should have a defence scheme drawn up for it, a complete Garrison told off, with a guard in permanent occupation and kept ready stocked with the following:—

- (i) Copy of defence scheme.
- (ii) Small arm and hand grenade ammunition.
- (iii) Water, food and fuel, sufficient for a three days' siege.
- (iiii) Tools, stores, timber, sand bags, and other materials.

In the absence of a suitable building or garden to form the nucleus of such a work it is possible that a tee shaped work would prove the most immune from shell fire and assault, combined, the trenches in which are made to fire both ways, as first adopted by the Service outside Adrianople.

The deliberate construction of a complete second line of defence some miles to the rear, the existing front line being held merely as a screen to cover the construction of the second line in which every artifice known to modern engineering, both military, civil, mechanical and electrical, should be employed to the full. This however transgresses on the domain of strategy and industrial policy and is therefore outside the scope of these notes.

PART IV.

Co-operation of Infantry and Engineers.

I. TRAINING OF INFANTRY IN FIELD ENGINEERING.

The enormous amount of construction work indicated in the above outline of the consolidation of a modern entrenched position indicates the absolute necessity of training Infantry to carry out the major portion of the more simple operations of trench improvement, sapping, and the use of bombs and hand and rifle grenades.

Great differences of opinion exist among different regiments as to the limits and scope of the duties of the Infantry and R.E. respectively. This is in reality entirely due to the different standard of training reached; some regiments whose standard of training is low, expect the engineers to do everything for them, even down to the placing of loopholes and the revetment of fire steps, while there are others who scarcely ever expect to see a sapper in their trench, and who are, not only able to construct their own shelters, barricades, etc., but even construct their own barbed wire entanglements, thereby enabling the Field Companies to concentrate their energies on more difficult and important work. No regiment can be too highly trained at field entrenchments and every sapper liberated for other work means greater security to the whole position. Nothing is more unfortunate than that the main energies of the R. E. Field Company should have to be expended in assisting a badly trained regiment in its own fire trench, instead of carrying out its own legitimate duties.

Once a regiment has left for the front, it is almost impossible to obtain this training and every opportunity should be taken to train every single soldier to the highest possible pitch of efficiency in the construction and improvement of field entrenchments before departure from England.

The training of Infantry in field engineering therefore falls under three heads:—

A.—TRENCH IMPROVEMENT.

All non-commissioned officers should be instructed in trench improvement in addition to a party of approximately 25 pioneers per company. The actual work which Infantry can carry out in their front line trench and which moreover it is absolutely essential that they should carry out, if the Engineers are to be free to devote

their attention to the more technical work which is alone sufficient to fully employ all their energy, is as follows:—

- I. Fire step revetments.
- II. Construction of shelters on both systems.
- III. Fixing of loopholes.
- IV. Constructing traverses and barricades.
- V. The placing and erection of portable obstacles.
- VI. Construction and maintenance of latrines, communications, etc.
- VII. And finally, by the machine gun detachments only, the construction of machine gun emplacements.

All the above work can be done by infantry with very little training, provided the necessary materials are supplied by the engineers.

B.—SAPPING.

The object aimed at should be to have a party of one non-commissioned officer and about 12 men per company completely trained in the use of the sapping tools and the construction of the three or four different kinds of saps. To assist in rapid sapping the following sapping equipment has been devised and has been found useful, consisting of a modified type of mattock improvised from a pick, a small miner's shovel and two sapping aprons.

All sapping is done kneeling down, the material falling into the apron and being drawn back to the rear and placed into half filled sand bags and thrown up to the front or flanks, depending upon the type of sap under construction. Infantrymen quickly learn to use this equipment, and appreciate it as being far superior to the ordinary pick and shovel.

C.—BOMBING.

Use of bombs and hand grenades. There are two distinct uses for hand bombs, for which two entirely different pattern of bomb are advisable as follows:—

- (a) The small hand grenade as used by all troops during an assault or for general bombing in line. For this the light one pound hand grenade with friction igniter has been most in vogue. The standard Ordnance pattern percussion grenade has also been used after cutting off the long handle and tape tail which renders its use in narrow trenches so extremely dangerous. The disadvantage however is the difficulty of ensuring the grenade landing on its nose and exploding.

(b) The heavy hand grenade as used by the Germans for bombing along a trench by lobbing over traverses and charging in with the bayonet. For this work there is no doubt that the heavy two pound "hair brush" bomb as used by the Germans is far the most effective pattern, it is most devastating in its effects and is practically a miniature hand mine. These have up to date only been made up locally at the front by the Royal Engineers and are not a standard Ordnance supply. In their absence the small hand grenades and standard percussion grenades have been used. Until recently most of the hand grenades used have been fitted with fuses and had originally to be lit by matches. More recently, however, the fuses have been fitted with a Nobel's friction igniter. This is still far inferior to the German pattern igniter which is made of brass, is machine turned throughout and is much safer and more reliable. More recently opinions have favoured the percussion hand grenade. If a pattern without a long handle or tail and therefore safe for use in narrow trenches, but certain of landing on its nose, could be devised, it would probably prove superior to all other patterns. Opinions differ as to the necessity of adopting a second pattern of heavy bombs, and it is possible that a shower of the newest small pattern grenade, which appears excellent, might prove only slightly less effective, the difference being insufficient to warrant the extra complications due to the adoption of a second pattern.

For training teams in bomb throwing the methods described in Appendix I. have been found satisfactory.

When training Infantry in the use of the rifle grenade, two objects have to be attained:—

(i) Practice in the loading, setting, and firing of the percussion grenade for which any standard pattern is suitable.

(ii) Practice in ranging and firing at a target, for without skill at this, the whole apparatus is useless. For this a dummy grenade which does not explode or get damaged by discharge on landing, is essential, and can be fired over and over again. Without this dummy grenade the immense expenditure in live grenades is prohibitive of any practice in this the most important part of the training. Unprimed standard grenades are of no use as they bend and smash on landing after two or three shots. Attempts were made at the front to make up a few dummy grenades but without any practical success.

Owing to the impossibility of carrying out any extensive training in ranging the effect has not yet been sufficiently realized or appreciated that the standard Hale's rifle grenade when fired at a high angle into the air like a trench mortar, as is generally the case and as is essential when firing over the heads of assaulting infantry, is incapable of any accurate practice upon a small target such as narrow trench or sap head.

There are great possibilities in the rifle grenade if properly used by well trained infantry, as it is the weapon for short range trench warfare, if only this difficulty regarding accuracy of range can be overcome; which has not yet received the attention it deserves.

The idea of the trench weapon would probably be the existing new pattern time fuse hand grenade inter-changeable for throwing by hand, or, by simply screwing in a steel rod for discharge from the rifle. Attempts were made to do this at the front, but it was not found possible to obtain suitable straight steel rods, the present percussion grenade being still retained for direct fire against loopholes and advancing infantry.

2. SUPPLY OF SPECIAL TOOLS, MATERIALS, ETC., BY R.E.

It stands to reason that if the infantry are to carry out all the above work, special arrangements must be made for supplying them with the necessary tools and materials. For instance, for revetting the fire step mauls are necessary for driving in pickets, hoes are advisable for improving the parapet while under fire and for fixing loophole boxes. Scrapers are necessary for cleaning loopholes, while if not supplied by the Ordnance Department, special sapping tools and other devices, not to mention bombs, hand grenades, igniters, fuses, etc., must be supplied. For the construction of shelters, revetments, loopholes, etc., enormous quantities of material have to be collected and made up to the necessary sizes, and sent up to the trenches. The whole of this work falls upon the R. E. Field Companies and it is the duty of the officer commanding the Field Company to ascertain as early as possible what the probable requirements are and to make early arrangements either himself or in conjunction with the C. R. E. of the Division for the supply of the necessary materials without delay. This forms quite 50 per cent of the work and duties of the R. E. Companies and requires a vast amount of foresight and organization.

In addition to the above an enormous quantity of other materials and articles will be required for the more technical work being carried out by the R. E. Companies themselves in distinction to the Infantry, but assisted by large Infantry working parties. These will consist of portable obstacles, loophole boxes, shelter roofing beams and frames, ladders, bridges, and revetting panels, in addition to the construction of more elaborate devices such as bomb guns, rifle rests, bomb throwers, portable obstacles, and such like. The turning out of large quantities of such materials wholesale, necessitates the organization of a regular factory system and with this object in view it has been found of great

assistance to take over and organize as an R. E. workshop any existing saw-mills or workshops which can be commandeered in the district.

The carriage of all this material has also to be arranged for by the R. E. in two stages as follows:—

(a) Carriage by road transport from the collecting points, workshops, etc., to cart limit behind trenches, which is usually done by employing the whole of the Company horse transport, including pontoon wagons often assisted by the loan of some motor lorries.

(b) Carriage by hand from cart limit up to the firing line or wherever used, which has to be done at night by troops specially detailed as carrying parties at the request of the R. E. officer by the Brigade staff concerned. More than 500 men per night have sometimes been used by one R. E. Company.

The bulk of this work should by rights be carried out by a Works Company attached to each Army Corps as in the Indian system.

Unfortunately the two Indian Divisions left India without their R. E. parks and this excellent organization has never been available.

3. TECHNICAL ASSISTANCE BY R. E.

The remaining half of the R. E. Company's work falls under three heads as follows:—

A.—SKILLED ASSISTANCE.

The actual construction of defences requiring special skilled labour such as machine gun emplacements, strong points, keeps, the construction and placing of obstacles, barricades and the developments of points requiring special skill in the general line itself, in addition to any skilled assistance actually required by the Infantry themselves in the improvement of their own trenches due to their not having been sufficiently trained in this work beforehand.

B.—ENGINEER RECONNAISSANCE AND TECHNICAL ADVICE.

Owing to the peculiar nature of the R. E. officer's duties which necessitates a thorough knowledge of the whole of his section of the defence as well as that of the enemy's immediately opposite, it follows that a very considerable amount of his time has to be spent, especially after going into a new position, in studying and reconnoitring that position, and in the preparation of sketch maps on a large scale for the information of the C. R. E. and staff. This can usually be combined with the daily inspection of works and is much assisted by

the employment of a good telescope used from well selected observing points, in addition to the regular R. A. observing stations and a good Ross's 14-inch periscope used from the front fire trench. Excellent information can often be obtained during a few minutes look around after dawn from high chimneys, trees, buildings, etc., right up in the front line, which could never be employed as regular artillery observing stations.

The possession by the R. E. officers of a complete detailed first hand knowledge of the whole of their section, will often enable them to give invaluable assistance to the Brigade and Divisional staff with regard to the possibility and feasibility of carrying out certain schemes, the position and type of proposed works, saps, barricades, posts, keeps, communications, etc., and the more the R. E. officer knows of his section of the position the more assistance can be to the C. R. E. and staff not only in the preparation of defence schemes, but also in the drawing up of operation orders for attack.

C.—INVENTIONS.

There is a third and most important duty of the engineers of special interest in this war, connected with the solution of the many unsolved technical problems of trench warfare.

It has always been one of the most fundamental duties of the military engineer, since the time of the crossbow, catapult, and battering ram, to have to solve such problems and to be continually inventing means for overcoming similar difficulties, and then having invented it to hand over the completed machine, device, or whatever it is to other troops to use after training them in its use. It is not the duty of the engineer to use these appliances, it is his duty to devise and invent them. The whole technical history of warfare is nothing more than a continuous repetition of this process. First the crossbow, then the archer, then comes the first gun at Crecy, followed by the artillery, later the musket, followed by the rifle, and now the grenade followed by the grenadier, and the trench mortar followed by the bomb gun detachment.

This important duty of the engineer is not sufficiently organized or co-ordinated with that of the Ordnance Department whose duty it is to manufacture the appliance once it has been perfected. The Germans set us an example of efficiency in this respect which might well be followed. It is not sound economy to leave the most important duty to the officers of a Field Company, whose hands are already full of most important field work and who by their very training are not acquainted with the solution of mechanical problems and whose equipment provides no facilities for such work. The whole intellectual

energies of many of the Field Company officers in this war have been devoted to inventing mechanical appliances of this nature many of which it was impossible to manufacture or make up at the front. The whole of this work as well as the running of factories and workshops behind the front line should be carried out by a large R. E. works company or park attached to each Army Corps but working within a short distance of and in daily communication with the Field Companies which it serves. This unit should be officered by mechanical, electrical and other specialists who are fitted better for the solving of such problems. These Works Companies should be in close touch with the Ordnance and Engineer Departments at home, which should in their turn be free to draw upon the knowledge and experience of the whole engineering and scientific world of civil life.

4. RELIEFS OF INFANTRY AND R. E.

Infantry and Engineers attached to certain sections of defence should not be relieved on the same day, otherwise it is difficult to ensure continuity of policy. Experience tends to show that the R. E. should be relieved two or three days before the Infantry. The new R. E. Company then coming into the section can get a thorough grasp of the policy governing the works under construction and can arrange for the collection of materials and organize working parties so as to enable work to be started without delay the moment his own infantry comes into occupation.

(a).—R. E. RELIEFS.

Owing to the amount of detailed knowledge required by the R.E. officer regarding his section and the amount of time and energy which must be expended to obtain it, the bulk of which cannot be obtained from maps, it stands to reason that R. E. units should be shifted from one position to another as seldom as possible. A system which was found to work well last winter where Divisions relieved each other weekly, was for two companies to be linked and to relieve each other at regular weekly intervals, the company in rest carrying out the bulk of the supply of materials and the running of the workshops. After two complete reliefs both companies thoroughly understand the whole section and can carry on one definite policy continuously without interruption, and with this object in view, the Company Officers should make every endeavour to sink personal differences of opinion and to work together without friction.

(b).—INFANTRY RELIEFS.

There are two systems for holding a line of trenches each of which has its own special advantage:—

(i) The small unit system in which a certain definite small frontage is permanently allotted to a comparatively small unit, such as a Brigade, which makes arrangements for its own reliefs. That particular unit then comes to know and understand the peculiar features of its own frontage and since it knows it is certain to occupy that frontage permanently it takes greater interest in its development and puts in better work in its consolidation, while that continual change of policy which results from frequent change of garrison is avoided. This method however comes very hard on the Brigade Staff who get no rest at all.

(ii) The large unit system in which a certain definite frontage is permanently allotted to a large unit, such as an Army Corps, which holds its front with one Division at a time relieving with the other Division at weekly intervals.

This system gives regular rest to the Brigade and Divisional Staffs and enables the G. O. C. commanding that section of the front to keep a large reserve at his disposal for counter-attack and other purpose, but renders it extremely difficult to ensure any continuity of policy in the trenches while individual units will never do as good work in consolidating a position which they know they will only occupy for two or three days, probably never to return again. In this case the whole responsibility for the continuity falls on the Army Corps Staff and it is impossible for them to ensure its being carried out.

With a frontage allotted to Divisions, the 3-brigade organization makes it impossible to retain any one brigade on the same frontage.

If Divisions had an even number of Brigades, i.e., two or four, the adoption of a Divisional frontage would probably prove the most satisfactory compromise. The war establishments found most suitable for field operations are not always the best for trench warfare.

PART V.

Unsolved Problems.

The treatment of the subject as presented above enables us to appreciate the existence of, and the circumstances attending several important but still unsolved quasi-technical problems of this war. Now every one of these problems can be solved, but if this is to be done they must be tackled systematically and this has not been done hitherto. The solution of these questions has been left to haphazard or to the ingenuity of any individual officer who may happen to have the time or opportunity for thinking about them. There is such a thing as invention "to order" at which the German technologists are particularly expert. This may appear strange to many who imagine that "invention" is a kind of inspiration peculiar to genius, but if these problems are going to be solved in the short space of time available, they must be systematically scheduled, the various phases of the problem analysed and then submitted to experts for solution as is done by all engineering institutions when tackling similar problems in civil life. One Field Company all last winter made a practice of keeping a list of problems to be solved. This was circulated throughout the Brigade and suggestions asked for and a copy of the list was kept pinned up on the Mess room walls and billets to remind everybody and ensure their spare moments being devoted to thinking them over. When out of the trenches three or four Officers of this Company would sit down to think seriously over any particular unsolved problems and discuss their probable solution, taking each in turn and in this way many excellent inventions were arrived at within a few hours, after weeks and weeks had been wasted talking about them.

When inventing "to order" in this way the following procedure should be adopted.

(a) First of all a clear general description of the exact problem to be solved and all the attendant circumstances should be drawn out by a tactician and field engineer working together. This is what has been done in the preparation of these notes.

(b) The classification of the different general lines on which the problem may be solved. This is the duty of a military engineer aided if possible by a scientific expert.

(c) This classification must then be further analysed into sub-heads and the whole problem as thus presented handed over to a number of specially selected expert Committees, each Committee being specially fitted for dealing with that particular type of solution.

Each Committee should consist of 3 or at most 4 men, since experience shows that three men working together in open discussion can often arrive at a solution in a much shorter time than one man working single-handed. Each Committee should be provided with a detailed statement of the exact conditions to be fulfilled for that particular type of solution to the problem, for instance, in dealing with the simultaneous suppression of fire the exact conditions to be fulfilled by the trench mortar, its range, weight of projectile, protability, etc., must be clearly defined. This should also be accompanied by a statement of all previous proposals and attempted solutions, their defects and why they failed.

These Committees might be formed through the medium of the governing bodies of the various scientific societies whose members might be asked to place their services at the disposal of the Government for this purpose.

A general statement of the problems yet remaining to be solved as brought to light by these notes, is contained in Appendix II, and it is to be sincerely hoped that some such systematic effort of tackling these problems may be taken in hand without delay.

Appendix I.

Methods of training Infantry in throwing hand grenades. The training consists of three practices as follows:—

No. I PRACTICE.

The hand grenade team, probably consisting of one non-commissioned officer and 6 men, practice throwing from a traversed trench in line into square targets approximately 5 ft. square at the following ranges: 20, 25 or 30 yards and also at unknown ranges. Each target consists of a small pit approximately 2 ft. deep with a bank of earth in front and rear representing the parapet and parados respectively. The practice starts with dummies, gradually adding live bombs, which cannot be readily distinguished from dummies in appearance, until the practice is carried out entirely with live grenades. Marks are given for accuracy of throwing and various teams practice against each other.

No. II PRACTICE.

Each member of the team throws one bomb simultaneously, at similar targets, and the practice repeated 6 or 7 times, the teams again being marked and competing with each other, which keeps up the interest.

It is astonishing how rapidly teams improve in this practice, and after a certain stage of efficiency has been reached inter-regimental and company competitions can be held and prizes given to the best team.

No. III PRACTICE.

The whole team practices bombing along a trench as already described in the notes starting with dummies and eventually practising with live bombs. Interest in the practice is considerably increased by placing dummies as targets in the trenches. The amount of damage done to these considerably increases the men's confidence in the weapon.

Appendix II.

SOME UNSOLVED PROBLEMS CONNECTED WITH TRENCH WARFARE.

1. Destruction of enemy's obstacle in the shortest possible time, generally:—

Including—

(a) a suitable type of chain shot or projectile especially effective against wire.

(b) a method of crossing over barbed wire or other obstacle.

2. Protection of our own obstacles against the enemy's fire.

3. Simultaneous suppression of fire during assault, generally:—

(a) an accurate short range mortar, or,

(b) an accurate short range mechanical bomb thrower.

(c) an accurate rifle grenade.

(d) adaptation of the standard hand grenade to fire from the rifle.

(e) percussion type of trench mortar bomb.

(f) a suitable method for transporting hand grenades into the trenches after fusing.

(g) a suitable method for carrying fused hand grenades on the person.

4. Location of the enemy's strong points, keeps, and machine gun emplacements.

5. Maintenance of message communications under heavy bombardment, generally:—

Including—

(a) a good system of daylight visual signalling which can be concealed from the enemy, suitable for flat country.

(b) improvement of rockets or similar appliances, possibly electrically fired from a short distance, for signalling.

6. Method of sapping rapidly.

7. Method of mining rapidly.

8. A good pattern of portable obstacle.

9. A good trench stretcher for evacuation of wounded round narrow traverses, etc.

10. Protection from gas attacks generally:—

Including—

(a) portable air or oxygen container.

(b) a system of piped oxygen and air supply in the trenches.

11. Protection of machine guns and their detachments from shell fire.

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