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**FIELD ENGINEERING
(ALL ARMS)**

**MILITARY TRAINING PAMPHLET
No. 30**

**PART V: PROTECTIVE WORKS
(PROVISIONAL)**

1941

*Prepared under the direction of
The Chief of the Imperial General Staff*

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MILITARY TRAINING PAMPHLET No. 30

FIELD ENGINEERING (ALL ARMS)

PART V.—PROTECTIVE WORKS, 1941

PART I.—INTRODUCTION

1. *Object of pamphlet*

1. This pamphlet is for the use of all arms. It describes only those protective works for the execution of which, in war, units of all arms are themselves responsible.

2. In war a large amount of skilled and unskilled labour must be employed in engineering work both in and in rear of the forward area, if combatant troops are to develop their fighting capacity to the full.

Skilled labour is provided by the engineers, and is used either with or without the assistance of working parties of other arms or civilian labour.

The working parties must, if in the proximity of the enemy, be provided by the combatant troops.

2. *Classification of field engineering*

1. Field engineering may be divided into two categories :—

- Work for which all units and formations are responsible.
- Work for which engineers only are responsible.

2. Work for which all units and formations are responsible includes :—

- Siting, organization and construction of their own protective works, clearing field of fire, light shelters and battery positions.
- Concealment. (*See Military Training Pamphlet No. 26.*)
- Obstacles, including simple anti-tank obstacles. (*See Military Training Pamphlet No. 30, Part III.*)
- Assault crossings and simple work connected with fords. (*See Military Training Pamphlet No. 23, Part VIII.*)
- Improvements to tracks and communications.

3. Engineers should be employed on work which is technical, and for which they alone have the necessary training and equipment. They should not be employed on work which lies within the capacity of other arms, unless in the opinion of the commander such a course is necessary owing to the urgency of the operations.

A close liaison between engineers and other arms is essential at all times.

In particular, although engineers carry out reconnaissances themselves, they will depend largely on information received from forward troops of other arms, e.g., width and depth of streams, nature of obstacles, to enable them to provide quickly men and material.

In work for which other arms are responsible, engineer assistance will be restricted to the provision of technical advice or minor assistance in technical details.

PART II.—ELEMENTS OF FIELD ENGINEERING

3. Tools

1. To obtain the best value out of tools they must be kept sharp and clean.

2. Tools used in the field may be grouped under three heads:—

- i. Entrenching tools.
- ii. Cutting tools.
- iii. Miscellaneous tools.

3. **Entrenching tools** are the pickaxe, the shovel, the spade and the crowbar.

The pickaxe is intended for loosening soil, the pointed end is for use in hard ground and the chisel end for soft ground. Weight $4\frac{1}{2}$ lb.

The shovel is used for clearing away the soil loosened by the pick. Weight (G.S. pattern) $3\frac{1}{2}$ lb., helve 2 ft. 8 in.

The spade is used chiefly for cutting sods and trimming slopes. It is also used for digging in stiff soil, such as clay, and in narrow ditches. Weight $5\frac{1}{2}$ lb.

The crowbar has many uses. Besides being employed as a lever in lifting weights, it is used for breaking up lumps of masonry, brickwork, etc., moving large stones and for making holes in walls.

4. **Cutting tools.**—The service cutting tools are:—

- i. The *falling-axe*, *cross-cut saw* and *folding saw*—are used for felling trees and cutting timber.

- ii. The *hand axe*, *bill-hook*, *matchet* and *hand saw* are used for clearing brushwood, hedges, and for trimming. The *reaping hook* is used for cutting corn, etc., to clear field of fire.

The *falling-axe* can be used with effect only by a man trained to use it.

The *cross-cut saw* is safe and easy to use in the hands of unskilled men, and is worked by two men who pull the saw in turn across the timber. No pushing is required. When used for felling trees, wedges are required to prevent the saw from jamming.

When cutting tools are in use, means to keep them sharp must be provided, e.g. grindstone, saw sets, files and honing stones.

5. Miscellaneous tools.—

i. *Mauls and sledge-hammers.*—These are wooden and iron hammers, weighing about 14 lb. They are used for driving wooden or iron pickets into the ground.

To use them the picket should be held at the proper angle and given one or two taps to make it enter the ground. The handle should then be held with both hands near the end and the hammer head swung in a circle, bringing it down on the head of the picket. As the maul or hammer strikes the picket it should be moving along the line of the picket, and the handle should be at right-angles with the picket. The flat face of the maul or hammer will then strike the flat head of the picket, the picket will thus be driven in at the right angle and will not split.

ii. *Spanners and wrenches.*—These are used for screwing nuts on to bolts. The nut must be screwed with care on the bolt, and not be forced. Nuts which have become rusty may be loosened by soaking them in kerosene or by heating them.

iii. *Augers* are used for making holes in timber. Great care must be taken that the small point at the end of the auger is not broken. The auger should be screwed in, whenever possible, at right-angles to the face of the timber.

4. Materials

1. **Earth** can be used in many ways for giving protection in field defence. For filling sandbags, earth is used in preference to other materials.

Earth slopes, when freshly cut, will stand nearly vertical for a short time, but quickly disintegrate and crumble after exposure to air, sun, rain and frost, and in time will stand only at the slope of excavated earth, which varies from 1/1 to 2/3.

Therefore, to make earth stand at a steeper slope, it must be revetted.

The weight of earth varies from 80 to 100 lb. per cu. ft.

2. **Sand, shingle, chalk and clay** have to be used in field works. The following points should be borne in mind :—

Sand cannot stand without revetment.

Shingle possesses good stopping power against bullets, but splinters easily; between stout planks it is very useful and effective. (See Protection Table, page 39).

Chalk is very conspicuous. Clay is not good for filling sandbags as voids must occur; therefore, penetration of a bullet is greater than in earth.

3. **Stones.**—Stones in a parapet stop bullets but cause damage from splinters.

4. **Sods** are pieces of turf used for revetting. They are laid like bricks, and are cut approximately to 18 in. by 9 in. by 4½ in. thick. They are laid grass downwards. Except the top layer which is laid with the grass uppermost.

5. **Timber.**—The most common forms of timber which are used by all arms include :—

- i. Scantlings, 3 in. by 3 in. and 6 in. by 4 in., used in construction of shelters.
- ii. Round pickets, 3-in. to 5-in. diameter, used in revetment work and for wiring.

6. **Brushwood.**—Consists of thin straight branches of bushes. It is used for making hurdles for revetting purposes and for hutting, and for road-making, in which case it is tied up in bundles. It is bulky to transport.

When it is cut the leaves and twigs should be removed.

7. **Sandbags.**—The service pattern sandbag is of jute and measures 33 in. by 14 in. when empty.

Sandbags should be three-quarters filled and the neck tied round with string provided for the purpose. The mouth should be tucked under when the bag is laid, and the corners tucked in; seams should, if possible, be laid on the inside. The sandbag should measure 20 in. by 10 in. by 5 in. when laid.

Sandbags are used for revetments, loopholes, etc. They are issued in bales of 200, weighing 84 lb.

8. **Sacks.**—Grain bags or sacks which may be available on service can be substituted for sandbags.

They usually contain 2 bushels (2½ cu. ft.) of grain. If used for field defence, they should not be more than half filled, otherwise they are too heavy to handle easily.

9. **Spikes** are large nails used for joining heavy timbers. A hole for the spike must be bored with an auger of a length equal to the length of the spike from below the head to the commencement of the taper. The spike is driven in with a sledge-hammer, so that its chisel end is across the grain of the wood, otherwise the wood will split.

10. **Expanded metal**, commonly called XPM, is mainly used for revetting frames. It is made in sheets 6 ft. 6 in. long by 3 ft. wide. Weight, 8½ lb. It is usually issued in cases of twenty sheets.

11. **Corrugated iron** is used for revetting trenches and for shelter roofs. It is used in sheets 6, 7 and 9 ft. long by 2 ft. 2 in. wide, and weighing, respectively, 16, 18 and 28 lb.

12. **Plain wire.**—Mainly used for binding purposes and in anchorages. It can be used for wire obstacles if barbed is not available. No. 14 standard wire gauge wire is issued in coils weighing 28 lb. and 56 lb. and measuring about 500 yds. and 1,000 yds. respectively.

13. **Canvas, hessian.**—Used behind wire-netting frames in revetting and for screens. Issued in rolls 110 yds. long, 36 in. wide, weighing 70 lb.

14. **Canvas strips.**—A light, coarse, very open-meshed canvas material. Issued for camouflage purposes in rolls 2 in. and 3 in. wide, and 100 yds. long.

15. **Hurdles.**—These are used for revetments and hutting. They are usually made 6 ft. long and 3 ft. wide. Six strong rods are driven into the ground about 10 in. apart. Then rods of brushwood are pressed down between them so that each rod first comes in front of and then behind an upright. When the hurdle is ready it is bound with plain wire at top, centre and bottom to hold it together. Hurdles can also be made of XPM.

16. **Fascines** are long bundles of brushwood tightly packed and bound together. They are used for foundations for roads in marshy ground and for steps. The brushwood is laid on trestles and is then bound with wire at intervals of 18 in. The fascine "choker" for binding is put round the bundle, which is compressed by men pulling on the long ends of the handles. The fascine is then bound with wire close to the choker.

17. **"A" frames.**—"A" frames are of wood and are made for revetting or repair of trenches. They would only

be issued for defences of a semi-permanent character. A small "A" frame weighs 30 lb. Fig. 42 (page 77).

18. Trench-boards.—Trench-boards are wooden gratings of dimensions shown on Fig. 47 (page 86). They are used to give a firm footing in trenches—usually used in combination with "A" frames, and on overland tracks. A trench-board weighs 35 lb.

19. Wire-netting is used in specially made revetting frames which, with canvas behind them, are used in revetting sand. It is also used for screens in concealment work and in constructing roads over sand.

Issued in rolls of 50 yds., 3 ft. wide; weight, 80 lb.

20. Tracing tapes have many uses, e.g. for tracing trenches, marking tracks, lines of wire obstacles, etc.

They are 50 yds. long.

5. Tool and digging drill

1. General.—

i. The pick and shovel cannot be used to the fullest advantage without careful and frequent practice.

ii. The sequence of instruction is as follows. The soldier should first be taught to handle and march with his pick and shovel, then the motions of picking and shovelling, and then to dig small tasks. Later he should dig, under supervision, a full task of trench work.

iii. The purpose of the drill given in the following sections is to teach the soldier to use his pick and shovel in such a way that he will get the best value out of his tools with the minimum of fatigue.

iv. The soldier must understand that the whole secret of this drill is to maintain an even, rhythmic motion. He must never be allowed to make sharp movements, and pause between the movements, as in rifle exercises, otherwise he will rapidly become tired.

2. Issue of tools.—

i. Tools are issued from stores in one of the following ways:—

(i) When those in charge of the stores have little time, the picks are stacked in one heap and the shovels in another, with a narrow passage between heaps. The men pass in single file between the heaps, taking up a pick with the left hand and a shovel in the right.

(ii) When those in charge of the stores have time to lay out the tools and know the number coming, the tools are laid out in sets, shovel on the right, helms 18 in. apart, irons of both to the front, point of the blade of the shovel in line with the pickhead, the sets at one pace interval, those for the rear rank are at three paces' distance. The party can then be marched in file, straight on to its tools.

3. Tool drill.—

i. *Falling in with tools* (Plate 1).—The soldier will fall in at the trail, pick in the left hand, shovel in the right, irons of both to the front, point of the pick downwards and the face of the blade of the shovel inwards.

ii. *Grounding and taking up tools.*—

"Ground tools"

Take a short pace forward with the left foot, bend down and place the tools quietly on the ground, irons of both to the front, pick on the left, shovel on the right, face downwards, the point of the blade in line with the pickhead. The left hand as it places the pick on the ground to be 3 in. in front of the left toe. Then return smartly to the position of attention.

"Take up tools"

Take a short pace forward with the left foot, bend down, take up the tools and return to the position of attention, tools at the trail.

Common mistakes.—The usual mistake is to place tools too far forward. The result of this is that men have to bend too far down, and if they have rifles slung and are wearing equipment, their rifles fall over their heads. The body should be kept as erect as possible and the left hand be put quite close to the left toe, as ordered above.

iii. *Marching with tools.*—As in war nearly all marching with tools is done by night, and near the enemy, men must learn to handle them so that they make no noise. This point must be carefully watched in practising the following drill:—

"Right turn"

Drop the head of the pick and raise the blade of the shovel (Plate 2), turn to the right and bring the tools back to the trail; if in file at close order, the handles should be allowed to splay outwards.

"Left turn"

As above, except that the turn is to the left.

"About turn"

Drop the head of the pick and raise the blade of the shovel, turn about and bring the tools back to the trail.

When marching at "Attention" tools are always carried at the trail (*see* sub-para. i, above).

When marching at ease the tools may be carried over the shoulder.

4. Digging drill.—

i. *Pick drill* (*see* Plates 2 and 3). The words of command for using the pick are given in the following sub-paragraph.

ii. *Picking*.—Right hand forward; right foot forward.

"Ready"

Turn half left and carry off right foot to right. Body evenly balanced on both feet. Pick horizontal in front of body. Both arms loose. Right hand about 4 in. from pick-head. Left hand at small end of helve.

"Raise"

Fix eyes on point to be struck. Raise pick over right shoulder, keeping right upper arm horizontal, centre of pick directly over right shoulder, left arm slightly bent across front of body. Right hand moves slightly towards left, weight of body on rear foot.

"Strike"

Eyes on mark. Holding firmly with left hand, strike downwards, allowing helve to slip through right hand. At the moment of striking the ground both hands grip tightly, weight of body coming on to forward hand.

"Break"

Force small end of helve upwards and move forward hand towards pick-head.

"Rake"

Rake the loosened earth towards feet by pulling pick back with both hands. Weight of body on rear foot.

"Raise"

Straighten the forward knee and trunk and continue; if necessary, the "Rake" may be repeated before "Raise" by carrying the pick forward and raking.

The drill is continued by the repetition of the commands "Raise," "Strike," "Break," "Rake," as necessary. It is important to teach a regular rhythm. The rate should be from 28 to 30 strokes a minute for periods of from 15 to 30 seconds, followed by a short pause, during which, if it is desired to continue work with the shovel, the pick will be grounded and the shovel taken up.

iii. *Picking*.—Left hand forward; left foot forward: the position of feet and hands and the action are reversed.

iv. *Shovel drill* (Plates 4 and 5).—The words of command for using the shovel are given in the following sub-paragraph.

v. *Shovelling*.—Right-handed. For throwing to left and front.

"Ready"

Turn half right and advance left foot to left near loosened earth. Body balanced on both feet. Right hand on "T" with thumb round. Left hand grasping bend of shovel, palm up.

"Swing and fill"

Swing shovel back with weight of body on rear foot: left arm straight and left hand near right knee. Right arm incline shovel towards base of loosened earth. Swing body and shovel forward so that the pan slides along base, bending left knee, weight of body behind thrust.

"Handle low"

Depress "T" piece of helve to free shovel load from pile of earth.

"Swing and throw"

Swing shovel backwards, just clear of ground, until pan is over right toe. Weight of body on rear foot.

Cast the load away by a forward, upward and slightly lateral swing, bringing weight on forward foot, left arm straight, shovel sliding freely through forward hand, right arm directing shovel, the body straightening according to height of throw.

Aids.—For heavy soil or rough base. Place left knee against left forearm and the inside of right thigh just above the knee against the back of right hand. Bend both knees with a crouching movement and bring the weight of body behind the thrust.

The drill is continued by the repetition of the commands "Swing and fill," "Handle low," "Swing and throw." It is important to teach a regular rhythm, and the rate should be from 18 to 20 throws a minute without aids, and 16 to 18 with aids. The periods should be from 15 to 30 seconds, followed by a short pause during which, if it is desired to continue work with the pick, the shovel will be grounded and the pick taken up.

vi. *Shovelling left-handed*.—For throwing to right and front.—The position of feet and hands and action are reversed.

5. Points for instructors.—

i. Men should be taught to use the pick and shovel equally well with either hand in front. Unless they can do this they cannot work facing the front of their trench and will be dangerous to those working near them. Nor will they be able to throw the earth as required to right or left. Moreover, by changing hands they use different muscles and so get rest. Men must practise throwing earth in one lump on the place where it is to go.

ii. Individual instruction by numbers should not be complicated by an endeavour to excavate a trench at the same time. The soldier will have enough to do learning the correct motions without working to dimensions.

iii. Soldiers should not be placed closer together than two paces while carrying out tool drill, otherwise they cannot have free play for their tools.

iv. The energy expended in digging is reduced by half if the work is done with a clean "face" and a clean "base."

To illustrate this, let the soldier strike his pick into hard flat ground and he will find that only a handful of earth comes out.

Then let him strike his pick about 9 in. back from the edge of a vertical "face" of earth (Plates 2 and 3), and he will see that each stroke will break out several shovelfuls of earth. This shows that if a man arranges his work so as always to work against a "face" he will only use his pick once, while the man who has no "face" will use it twenty times.

v. Unless the "base," or the ground on which the man is standing, is kept clean and smooth and flat, the shovel will not slide along the ground under the loose earth, and the man will not get a full shovelful of earth.

The base should also be kept clear of loose earth, otherwise the man will tread it down, so that it has to be dug up again with the pick, and so duplicate his work.

vi. All ranks should be taught that when the earth is very hard and full of stones, they can help their arms by using their knees when filling the shovel. Plate 6 shows this. The left knee should be placed against the left forearm, if working with the left hand in front. Place the inside of the right leg just above the knee against the back of the right hand. Bend both knees and bring the weight of the body behind the thrust. The rate of working will be 16 to 18 throws a minute when doing this.

vii. When the ground is very soft the work can be taken out quicker without using the pick (Plate 6).

The shovel is driven into the ground by placing a foot on the shoulder of the shovel. If working with the left hand forward—that is, when throwing to the left—the left foot should be used for this. Work with a face as shown in this plate.

After pressing the shovel into the ground, the earth is broken away by pressing the handle downwards with the rear hand, then the earth is lifted and, with a swinging motion, is thrown out of the trench or pit.

It will be necessary to clean the base from time to time, as some loose earth will certainly fall out of the shovel.

viii. When digging wide trenches, the pick should swing towards the front of the task, otherwise there is danger of striking the man in the next task.

In a narrow trench all men should start work on the left of their tasks, and will face towards their right when using the pick so that they may not hit each other.

A man does most work in 4 hours if he rests for 2 minutes after every 8 minutes' work and has a longer rest for 5 minutes at the end of 55 minutes.

ix. If the points given above are followed, a soldier should be able, in average soil, with a maximum throw of 12 ft. and maximum lift of 4 ft., to dig out of a trench the following amounts:—

In the first hour	..	30 cu. ft.
In the second hour	..	25 "
In the third hour	..	15 "
In the fourth hour	..	10 "

Total in 4 hours .. 80 "

(NOTE.—An average shovel load weighs 10 lb.)

The above figures apply to digging in daylight—by night the total may be decreased to 60 cu. ft. For general estimating, however, it is safer only to assume 60 cu. ft. by day and 50 cu. ft. by night.

x. *Intensive digging.*—When digging a position which has been captured in an attack, the number of tools available will often be not more than 1 pick and 1 shovel to three men. Men should be practised in digging-in quickly with these numbers of tools. This may be done as a drill. Each man digs as fast as possible for 2 minutes, the other two men lying behind the trench. At the end of 2 minutes the instructor blows a whistle. The next man (No. 2) jumps into the trench

and goes on with the work while No. 1 rests. After two more minutes No. 3 takes No. 2's place, and so on. Each man works as hard as possible for 2 minutes and rests 4 minutes. Men should be taught to work so hard for 2 minutes that they can work no longer without resting.

6. *Excavation of tasks*

1. *General.*—The method in which a task is excavated depends on circumstances.

If in proximity of the enemy each man must obtain cover by digging a pit, placing the excavated earth as a parapet on the side exposed to enemy fire. A pit measuring $3\frac{1}{2}$ ft. by $2\frac{1}{2}$ ft. is the smallest in which a man can use his pick and shovel.

When circumstances permit, he will start widening and lengthening the pit until his task is completed. Fig. 17 (page 50).

2. *Commencement of digging.*—

i. If the trench is to be dug to the full section as shown in Fig. 16 (page 49), when the spitlocking to mark the front and rear edges of the trench has been done the man will commence work by digging out a hole, 6 in. to 9 in. deep across the back of his task, until the whole task has been taken out to this depth. He will then begin work again at the back, and take out a second layer in the same way, and so on till the trench is excavated to the full depth. The sides will then be sloped as described in para. 6, below.

All the time he will work as fast as possible, with his pick and shovel swinging towards the front and rear, so as not to hit the man in the next task.

ii. If, as will usually happen, the first task is only taken out to 3 ft. 6 in. broad (Figs. 18 and 19, page 53), there is no room to leave 9 in. on each side to make a proper slope (para. 6, below). The slope must therefore be judged by eye.

In this case the man will begin by excavating a piece of earth, 6 in. to 9 in. deep, across the left of his task. This will give him a face on his right, on which he must work, facing to his right or half right.

After completing the trench to this depth, he can then start again at the left-hand end.

3. *Length of task.*—The length of trench allotted to each man as a task, depends on the section of trench to be dug, and on the number of cubic feet given in a task.

The usual distance is 6 ft. The length of a task should never be less than 5 ft., or men will hit each other. Even in a 6-ft. task, men will often have to wait till the next man has finished a part of his work.

If possible over 6 ft. should be given.

A 6-ft. task gives $49\frac{1}{2}$ cu. ft. in the smallest trench (i.e. 3 ft. 6 in. wide at top, 2 ft. wide at bottom, and 3 ft. deep), $7\frac{1}{2}$ ft., or three paces, gives 62 cu. ft.

4. *Work on sides of a traverse.*—The men working on the sides of a traverse have a more difficult task. If they throw their earth straight on to the traverse, it will be very high and there will be a gap in the parapet at each end of the firebay.

The men working on the sides of traverses must be taught to throw their earth towards the front of the traverse.

This is difficult, even if men are trained to do it. If possible, special men should be provided for shovelling the earth forward.

5. *Communication trenches.*—In digging communication trenches the earth should first be thrown up on that side of each length of trench from which the enemy bullets are most likely to come.

6. *Sloping the sides of a trench.*—

i. Sloping the sides should be left till the excavation has been done. Fig. 1 shows what happens if a man tries to make the slopes by eye. Fig. 1A shows the section of a trench, 6 ft. deep, of which the right-hand side slopes at 4/1 and the left-hand side 3/1.

The first task is 3 ft. deep, sufficient space is then left on each side to allow for the slope, and the part marked A is dug first, with vertical sides.

When this is finished the parts marked B.B. are dug out. This gives the sides the proper slope. The man doing the next task will similarly dig out the part marked C with vertical sides and afterwards excavate the parts marked D.D.

ii. The amount of space to be left on each side—for the various slopes—is calculated as follows (Fig. 1A). Taking a slope of 4/1.

This means for every 4 ft. of depth, 1 ft. must be left; or for every 1 ft. of depth, $\frac{1}{4}$ ft. must be left.

Therefore, for every 3 ft. of depth, $\frac{3}{4}$ ft. must be left.

In the same way for a slope of 3/1, a width of $\frac{3}{3}=1$ ft. must be left, and in Fig. 1B, which shows a slope of 2/1, a width of $\frac{3}{2}$ ft., or 1 ft. 6 in., must be allowed for every 3 ft. of depth.

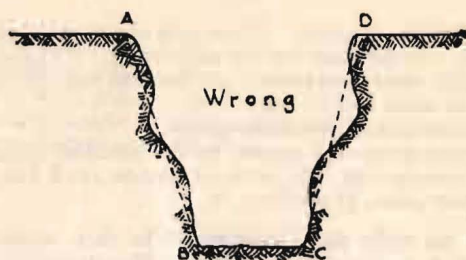


FIG. 1

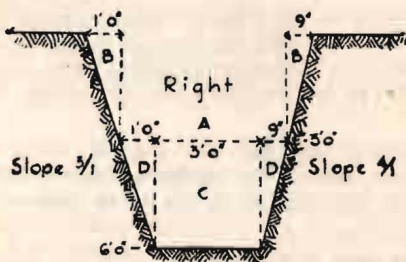
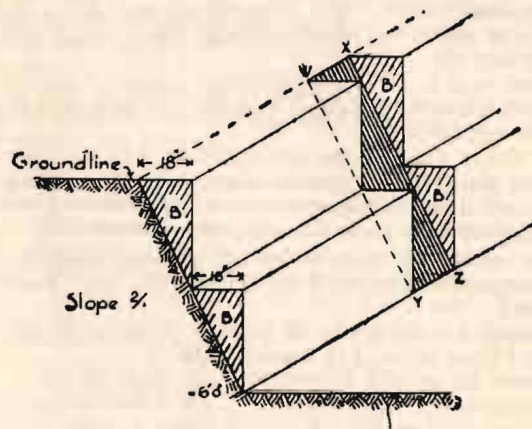


FIG. 1A

Bottom of trench
FIG. 1B

iii. Fig. 1B shows how to begin sloping the sides. Each man should begin by cutting very carefully a strip like the part marked W.X.Y.Z. This will act as a profile and help him to get the rest of the slope right.

iv. The provision of a template is of great assistance.

PART III.—ORGANIZATION OF WORK

7. General considerations

1. General.—

i. Speed in construction of field works in close proximity to the enemy is always essential. Time, labour, tools and materials available will invariably be insufficient to meet all demands. Work will often have to be carried out in darkness.

It is therefore essential that all ranks should be familiar with the general principles, methods and responsibilities involved in the correct organization of work.

ii. The case which will be chiefly considered in the following sections is that in which only a limited time is available for work on a defensive position.

iii. The underlying principles and responsibilities remain the same whether work is on a large or small scale, whether it is carried out in contact with the enemy or not, and whatever time is available.

2. Object of organization.—

i. A system of organization of work should ensure :—

Control.

Speed.

Efficiency (i.e. economical use of the resources available).

ii. The more centralized the control the greater will be the efficiency in getting full value out of resources available. Speed will often be so important, however, that efficiency will have to be sacrificed and control largely decentralized.

Control is obviously best attained by adhering to normal military organization. Complete sections, platoons, companies or units should be employed on particular tasks or portions of the work.

iii. Speed depends largely on training and adhering as closely as possible to a well-known procedure and drill in the organization and execution of work.

iv. Efficiency depends chiefly on the rapid issue of adequate orders, resulting in the correct quantities of labour, tools and materials being available at the right time and place.

8. *Control of work*

1. **General.**—Except in the case of very small works there are three links in the chain of control :—

- i. The formation or unit commander who has ordered the work to be done.
- ii. The officer in charge of the work—appointed by the formation or unit commander.
- iii. The officer in command of the working party.

2. **Summary of duties.**—The duties of officers concerned in the initiation and execution of field works are summarized below :—

- i. *Formation or unit commander ordering the work to be done.*
 - (a) Reconnaissance.
 - (b) Priority of work.
 - (c) Instructions to officer in charge of work.
 - (d) Arrangements for provision of men, tools, materials and transport.
 - (e) Arrangements for control and continuity of work.
 - (f) Provision of covering party if necessary.
- ii. *Officer in charge of the work.*
 - (a) Detailed reconnaissance.
 - (b) Design.
 - (c) Estimates.
 - (d) Marking out the work.
 - (e) Guides for working parties.
 - (f) Explanation of the work to officers in charge of working parties.
 - (g) Correct execution of the work.
 - (h) Progress and completion reports.
- iii. *Officer in command of working party.*
 - (a) Explanation of the work to his subordinates.
 - (b) Allotment of tasks to, and disposal of, his men on the work.
 - (c) Ensuring that his men have the necessary tools and materials.
 - (d) The diligence of his men.
 - (e) The discipline of his men and observance of orders regarding lights, smoking and silence.
 - (f) The execution of the work in accordance with the instructions of the officer in charge of the work.
 - (g) Handing over of work, tools and materials to the next party, or as instructed by his commander or by officer in charge of the work.
 - (h) Withdrawal of his party when the work is completed.

The officer in command of the working party may be senior to, and belong to a different arm from, the officer in charge of the work. This must never be allowed to affect their loyal co-operation in observance of their respective responsibilities.

3. In the event of serious casualties being incurred by a working party, the *senior officer on the spot* will be responsible for deciding whether the working party should be withdrawn temporarily or whether an attempt should be made to carry out the task at all costs.

If heavy casualties are anticipated, the commander who orders the work should give definite instructions as to its urgency.

9. *Reconnaissance*

1. The preliminary reconnaissance will be carried out by the formation or unit commander ordering the work to be done.

The officer in charge of the work will, if possible, accompany him. This will result in decisions and orders to the officer in charge of the work on the following points :—

- i. Approximate siting and nature of the work.
- ii. Approximate resources in time, labour and materials available.
- iii. Outline of organization for the execution of the work.
- iv. Provisional priority of the work.
- v. Covering parties, if required.

2. The officer in charge of the work will then make a detailed reconnaissance of his task. The points to be considered in this reconnaissance will include :—

- i. *The work to be done.*—Its place, nature and quantity. The exact position of every portion of the work which is to be done must be decided. Time may be saved if the work is actually marked out as the reconnaissance proceeds. (See Sec. 11, 6, and Appendix III, for details of tracing parties, which should accompany officer in charge of work.)

The definition by natural or artificial marks, of areas to be cleared for improvement of fields of fire or view requires particular care, especially if work has to be carried out at night.

- ii. *The design of the work*, including the most suitable type of work (e.g. weapon pit, breastwork, etc.).
- iii. *Labour.*—What labour is required: its quality and quantity. Appendix I will be an aid to this calculation, which should include a reserve for unforeseen contingencies.

- iv. *Tools and materials.*—The nature and quantity required (Appendices I and II), whence obtained, and how brought to selected places.
- v. *Time.*—When work may be begun and how long it will take to complete.
- vi. *Rendezvous, routes and guides.*—The rendezvous should be on the route to the work. It should be easily recognizable and, if possible, near cover. If routes are across country, they should, when possible, be marked. Guides should know the rendezvous and the routes by which working parties will approach.
- vii. *Transport.*—What kind of transport should and can be used.

10. Preliminary arrangements

1. **General.**—If time is short responsibility must be decentralized and more must be left to the initiative of subordinates.

2. **Tracing.**—All work should be marked out, before the arrival of the working party, by pegs, pickets, tracing tapes or spitlocking, etc. This applies not only to trenches but to wire entanglements, emplacements, areas to be cleared, tracks, etc. Tracing will generally be done under the personal supervision of the officer in charge of the work.

3. Estimates.

i. Estimates are prepared, generally by the officer in charge of the work, as a result of the detailed reconnaissance described in Sec. 9. A complete detailed estimate should deal with the following points:—

- (a) Labour.
- (b) Time.
- (c) Tools.
- (d) Materials.
- (e) Carrying parties.
- (f) Transport.
- (g) Any other requirements, such as guides, covering party, etc.

Appendix IV (load tables) should be used as a basis for estimating.

ii. Time, labour, tools and materials are interdependent factors.

It is evident that the officer making an estimate must first note approximately the resources likely to be available before he can proceed intelligently with his estimate.

iii. If local materials are to be used allowance must be made for the time and labour required to collect, prepare and distribute them.

iv. No more men should be asked for than are absolutely necessary.

4. Demands.

i. Having prepared detailed estimates for the portions of the work to be commenced at once, if not for the whole work, the officer in charge of the work should then submit his demands for labour, etc., to the authority laid down by the officer ordering the work.

ii. It will be noted that in the demand the actual number of men required is stated. It will be the duty of the formation or unit supplying the working party to make up this number by detailing complete units, companies, platoons or sections in accordance with the actual strength of units at the time.

iii. The working party demands will be submitted in the form given on page 20.

11. Organization of working parties and allotment of resources and tasks

1. **General.**—The efficient employment of working parties depends chiefly on:—

- i. Discipline.
- ii. Allotment of suitable tasks, tools and materials.

The first is the responsibility of the officer in command of the working party, and the second depends primarily on accurate estimating by the officer in charge of the work, but also on intelligent control by the officer in command of the working party during the execution of the work.

2. **Reliefs.**—Whenever possible each relief should arrive complete with all tools required for work and should return them on conclusion. It is impracticable to hand over tools direct from one relief to the next in the dark. In such cases, if separate tools for each relief are not available, the tools must be dumped in one place for distribution to the next relief on arrival.

3. **Task work.**—The main advantage of task work over time work lies in the moral effect due to:—

- (a) knowing what is to be done;
- (b) knowing that there is no chance of going until it is done.

SPECIMEN WORKING PARTY DEMAND, NIGHT 22/23 MAR. 1941, "A" Fd. Coy.

Serial No.	Date (2)	Number of working men (3)	Unit providing party (4)	Rendezvous (5)	Time Hrs. (6)	Guides (7)	Tools (8)	Task + (9)	Officer in charge of work (10)	Remarks (11)
1	22	40		(Map ref.) Corner Ham Wood	1800	Fd. Coy., Spr. Pick	1 shovel per man 1 pick two men	Communication trench between posts B and C, 4 hours' task work	Lt. Jones, R.E.	Serial Nos. 1 and 4. Officers and N.C.Os. not dig- ging bring 6-foot sticks marked in feet.
2	22	30		(Map ref.) R.E. dump, Guy's Farm	1800	Fd. Coy., Spr. Screw	Nil	Carrying wiring stores to post B, 2 journeys	Lt. Jones, R.E.	Route :—
3	22	20		As for Ser. 1	1900	Fd. Coy., Spr. Spade	Nil	Wiring in front of posts B and C, 4 hours' task work	Lt. Jones, R.E.	
4	22	40		As for Ser. 1	2400	Fd. Coy., Spr. Wire	1 shovel per man 1 pick two men	Communication trench between posts B and C, 2nd task, 4 hours' task work	Lt. Smith, R.E.	

* This column will be filled in by the General Staff.

† State whether task or time work and probable duration.

Copies—2.....91 Inf. Bde.
1.....R.E. 31 Div.
1....."A" Fd. Coy.

If duty is carrying stores, state number of journeys.

Sd.....

Comd. "A" Fd. Coy.

i. In most work, especially of a straightforward nature like digging or wiring, better results are generally obtained by task work than by time work.

ii. It is essential, however, that tasks should be set fairly. They should be so calculated that the average man can complete them just inside the period of work being considered, which is generally 4 hours. The nature of the soil should be carefully considered in setting the task.

iii. If possible, a template should be provided, otherwise a 6-ft. measuring rod should be carried by each platoon or section commander. In the absence of measuring rods, pick helves, which are 3 ft. in length, can be used.

iv. The system works best when tasks are not allotted to individuals, but to small parties, such as sections.

v. When working with reliefs on task work care must be taken that all parties of one relief have completely finished their tasks before the arrival of the next relief, so that the latter are not kept waiting. A short interval of time should be allowed between the estimated time of completion of any relief and the arrival of the next relief.

4. Time work.—

i. This system should not be used unless task work is impracticable.

ii. Time work may be used when the local conditions are unknown or very variable.

iii. The amount of work which the officer in charge of the work expects to be completed must always be indicated to the officer in command of the working party.

iv. In fixing the length of reliefs on time work (or estimating tasks in task work) consideration must always be given to the urgency of the work, to the distance the troops have to march to and from the work, and their condition.

5. Tools.—

Except for small works additional tools are always required over and above those forming part of unit equipment.

If further tools should be required a demand can be made on the divisional tool reserve (Appendix II) which is carried by the field park company, R.E.

6. Tracing.—

i. If tracing cannot be done by day, it should be done at dusk while it is just light enough to ensure that the trace is suitable to the ground. Spitlocking is unsuitable for work which has to be carried out by night.

When tracing by night, direction should be frequently checked by compass or other means.

ii. The front "cutting line" of a fire trench is the line which must be marked. It is an advantage to mark the back line as well.

iii. Care must be taken that tracing marks of work which is to be concealed do not disclose the work to enemy observers.

iv. A tracing party should rehearse its work beforehand if possible, as this will add to the speed of the work.

v. The detailed organization of a tracing party is given in Appendix III.

7. Extension of working parties for digging.—

i. It is important that, on arrival at the site of work, the working party should be distributed along the line of work without noise or confusion. As this may often take place during the hours of darkness, practice is essential. The nature of work and task must be explained to the party beforehand.

ii. The following is the procedure when a working party is extended, starting from the left of the line of work:—

- (a) An officer or N.C.O. will stand at the left of the line on to which the party is to be extended, prepared to pace or measure out each man's work.
- (b) The party will be formed in single rank at a convenient distance from the line and marched up in single file, at right-angles to the line, until the leading man is within two paces of the officer or N.C.O. charged with pacing out the tasks. Tools will be at the trail, and rifles slung.
- (c) The officer or N.C.O. will then indicate the left of the task, and the leading man will step forward and drive the point of his pick into the ground at that spot, helve to the rear, and lay his shovel along the line of his task, blade to the left, face downward.
- (d) The officer or N.C.O. will pace along the line and show the second man his task; this man will wheel to the right until opposite his task, then wheel to the left and carry on as detailed for the leading man. The remaining men repeat this.
- (e) If extending from the right the procedure is similar.

All men must know the correct division of a fully developed fire trench for task work (Fig. 18 or 19).

- (f) As soon as the last man of the party has reached his task, each man will unsling and ground arms, six paces in rear of his task, and commence work.

iii. When working in reliefs the second and following reliefs should not be allowed to move along the half-dug trench, unless it is too dangerous to move across the open.

iv. An alternative method of extension, suitable in the event of heavy fire from the enemy, is for the men to be extended in rear of the line to be dug and marched straight on to the work, taking care to keep the proper interval.

v. Yet another method is as follows:—The leading man goes right through to the far end of the work and the remainder space themselves out behind him along the line of the work. This method is not quite so rapid but is well suited for work in close proximity to the enemy.

8. Carrying parties.—

i. These must be organized as for working parties. The tools or stores to be carried should be arranged in loads before the arrival of the party. The men must be told the composition of the loads before they start collecting them. At the end of the journey the loads must, according to instructions, be put down so as to form an orderly dump, or distributed at the points on the work where they are needed.

ii. If casualties are probable and various types of store are being carried, the stores of any one kind should be distributed among different individuals, or different parties if more than one party is being used. Otherwise severe casualties to one party carrying, for example, all the long pickets, would seriously hamper the progress of the work.

9. Arms and equipment.—

i. When working in close contact with the enemy, the commander of the party may decide to work with arms slung; this greatly hinders the work and should not be done unless there is danger of attack. In the forward area it is generally sufficient if each man lays out his arms and equipment close at hand, for use in an emergency.

ii. When the work is below fire-step level and there is danger of an attack, arms should be laid on the parapet, and all the earth being excavated should be thrown on the parados.

iii. In rear areas arms and equipment may be left under a guard in a convenient spot.

iv. When the enemy is likely to use gas, anti-gas respirators will be worn in the "alert" position.

10. Modifications.—

The procedure given in this section must be modified to meet all conditions. Only thus can work be properly organized.

PART IV.—GENERAL CONSIDERATIONS REGARDING PROTECTIVE WORKS

12. Priority of work

1. There will **never** be enough time, labour or material available to carry out all the useful work demanded. Careful selection of the work to be done will **always** be necessary, and much will depend on the efficiency of previous training in the rapid organization and execution of work.

2. As early as possible a comprehensive scheme of development must be planned, from which a priority list of work to be done must be drawn up.

It is necessary to concentrate in the first instance on providing the essential minimum of each type of work which will be most valuable to the defence.

3. Priority in any particular case will depend on the decision of the commander, and no hard-and-fast rule can be laid down, but the following order of priority may be taken as a general guide :—

- i. *Siting of weapons and O.Ps.*
- ii. *Improving communications.*
- iii. *Clearing and improving the field of fire.*
- iv. *Digging fire positions, constructing machine-gun positions and observation posts.*
- v. *Creating obstacles.*
- vi. *Constructing shelters.*
- vii. *Completing the fire positions and connecting them up.*
- viii. *Completing the communication or connecting trenches.*

4. Field defences are a means to an end and must be constructed to conform to the tactical plan. Well-planned field defences develop the fire effect of the defender's weapons and restrict that of the attacker's weapons. Skilfully used, they enable the commander to reduce the proportion of his force in actual contact with the enemy and to increase his reserves.

PART V.—SITING AND DEVELOPMENT OF PROTECTIVE WORKS

13. Siting of fire trenches.

1. Forward and reverse slope positions.—

i. *General.*—A forward slope position is one in which the trenches are on the slope of a hill nearest to the enemy. It is so sited as to give the defender, from his trenches, a clear, uninterrupted view of the enemy's position and the ground over which he must advance to the attack.

A reverse slope position is on the side of a hill farthest from the enemy, and the defender's trenches are hidden by the contour of the ground from direct ground observation by the enemy.

It is impossible to find a position of any extent in which the slopes are even and uniform. All irregularities of ground present either a convex or a concave surface. These irregularities offer temptations either to go too far forward on a convex slope to obtain a good view, or to draw back too much on a concave slope to escape enemy observation, with the result that pronounced, and therefore inconvenient, salients are formed in the general lines of a position.

In order to avoid these salients, and to make use of those features of the ground which offer the best facilities for defence, it may be necessary to site trenches in one place on a forward slope and in another on a reverse slope.

ii. *Forward slope position.*—Trenches on forward slopes can usually be sited so as to protect observation posts, but care should be taken to ensure they can be adequately protected by artillery fire. When siting foremost positions the probable location of reserves should receive consideration. Communications from front to rear will always present difficulties.

There is a natural tendency to place trenches on high ground, but such ground is not always the easiest to defend successfully; moreover, it is generally easier to provide depth of defence in front of high ground which will be used by artillery and other observers. The advantages of siting trenches on high ground are, that the defender instinctively feels greater confidence, that communications are more easily concealed, that a better view of the enemy is obtained, and that trenches, usually, are more easily drained. The disadvantages are that slight penetration by the enemy may gain important observation posts, that the defender's fire is more plunging than grazing, that the position of the trenches can be located more easily by the enemy when at a distance, that the assaulting infantry can be supported by the attacker's

guns until a later moment, and that the enemy may work round portions of the position and take them in flank and reverse.

iii. *Reverse slope positions.*—When the slopes of high ground are gradual on the defender's side and the crest is broad, it may be desirable to place trenches some distance on that side of the crest. Under these conditions the crest of the hill will screen the trenches from ground observation by the enemy's artillery observers, but it is often difficult to provide the necessary field of fire and observation, and, should the enemy succeed in establishing himself between the crest of the hill and the defender's trenches, the advantage will usually lie with the enemy. Observation over the forward slopes must be obtainable from ground on the flanks or from higher ground in rear, so that effective fire can be brought to bear on the ground over which the enemy must advance. When this is available a reverse slope position is very strong, as the enemy will have great difficulty in arranging his fire plan.

2. Selection of site.—

i. After being given the area of the proposed platoon locality, the position of neighbouring localities and the arcs of fire of any machine guns covering his locality, the platoon commander will select the exact position of his light automatic and rifle posts.

ii. Siting is governed by:—

- (a) The fire tasks to be carried out.
- (b) Considerations of such concealment and protection as can be gained from accidents of the ground.

(Siting must not be governed by any stereotyped ideas of the shape of works gained from diagrams in this or other manuals.)

iii. Every advantage should be taken of natural concealment or obstacles. Unconcealed section posts with long and wide fields of fire are of little value compared with posts which are concealed from enemy ground observation by hedges or folds in the ground and from enemy air observation by the overhanging foliage of trees, bushes or hedges.

iv. The following points must be remembered in siting trenches:—

- (a) The field of fire must always be checked by lying on the ground and placing the eyes at the same height as the top of the completed parapet will be. A minimum field of fire of 100 to 150 yards in all directions, and without dead ground, is desirable.

- (b) When weapon pits are sited with the intention of subsequently joining them up into a continuous trench system, the final trace of the system affects intimately the siting of the pits.

Where there is time, the complete layout for each sector must be traced before work on weapon pits is begun. This will ensure that the whole is considered before the part, and that drainage is not overlooked.

- (c) The trench must not obstruct the arcs of fire of machine guns or of neighbouring rifle or light automatic posts.
- (d) Trenches should be so sited as to facilitate enfilade fire.
- (e) Section trenches must be mutually supporting and sufficiently close to each other to enable the platoon commander to exercise control. The only limiting factor is that they should not be so concentrated as to render them all vulnerable to a single shell burst.
- (f) Low ground where water may collect should be avoided if possible. The question of drainage must always be considered.
- (g) As soon as the fire position has been selected it must be marked at once. If not under enemy observation use should be made of flags or other marks which will be visible while siting neighbouring trenches. If in close proximity to the enemy the marking may have to be postponed till nightfall or, alternatively, the whole process of selection and marking may have to be carried out by night, aided by observation from concealed positions during the previous day.

14. Development of field defences

1. General.—

i. Field defences will frequently develop as a result of a check in mobile operations in contact with the enemy. This check will generally occur during daylight. It will be impossible to commence any work on forward defences until nightfall, as forward attacking troops will be pinned to the ground by fire, and it will not be possible to bring up tools to them in daylight.

ii. As time, labour and tools will be scarce it is important that any work done during the first night should not be wasted. Subordinate commanders must, therefore, be capable of anticipating the probable lines on which defences will be co-ordinated and developed. These will be laid down as early as possible by higher commanders.

iii. For example, sections and platoons may be in widely scattered positions after nightfall; and if they merely consolidate in the position gained, much of the work done may be wasted, for the following reasons :—

- (a) Some of the posts will have to be abandoned, as the time and labour required to connect them all up would be so great as to postpone for many nights any real improvement of the defences.
- (b) The bad effect on morale of isolation in small groups of 5 or 6 men in scattered lengths of trench.
- (c) The fact that the positions in which troops become pinned during a check in mobile operations are unlikely to be the best positions for defending the ground occupied.
- (d) The fact that sections, platoons, companies, and possibly units may be considerably mixed up.

iv. Reorganization of the ground occupied into battalion and company sectors and into defended localities will, therefore, be necessary before work is commenced.

Whether it will be possible to carry out detailed reconnaissance and prepare a fully co-ordinated defensive fire plan before the first night's work is commenced will depend on particular circumstances. Whether this is done by the first night or later, there should not, however, be undue hesitation about abandoning small areas of unfavourable ground, subject to conforming with general orders defining the position to be held. Commanders must refuse to be bound by the exact dispositions at the end of a day's fight, if subsequent development of field defences is to be carried out to the best advantage. It is the duty of higher commanders to decide whether the policy to be followed is :—

- (a) Concealment, or
- (b) Extensive digging. (See Infantry Training 1937 Appendix IV.)

2. Sequence of development.—

i. The construction of field defences will generally develop in the following sequence :—

- (a) Weapon pits and machine-gun emplacements.
Clearing fields of fire.
Obstacles.
- (b) Alternative weapon pits and machine-gun emplacements.
Additional obstacles.

- (c) Connecting up weapon pits and section posts with crawl trenches. (Fig. 3.)
- (d) Digging urgently required lengths of communication trench.
Deepening the crawl trenches to 3 ft.
- (e) Development by stages to full width and depth of trenches.
- (f) Revetment of trenches.
Shelters and dug-outs.

During the development of the trench system, care must continually be exercised to avoid revealing to the enemy the dispositions of the defence. Some work must, therefore, be done in the alternative and dummy positions at the same time as the development of the occupied positions.

ii. Completion of trench communications, within the platoon and company is the first requirement, but, as more time becomes available, the value of a continuous lateral trench, whether in the form of a front-line trench or farther in rear, and later of further lateral communications in rear, should be remembered. The advantages of a continuous front-line trench and lateral communications in rear are :—

- (a) Morale. They reduce the sense of isolation.
- (b) They facilitate rapid adjustments of the defensive organization to meet withdrawals from, or additions to, the garrison, and to meet varying conditions of darkness or fog, etc.
- (c) They increase the enemy's difficulty in locating the exact dispositions of the defence.
- (d) They result in economy in the length of communication trench required, as one communication trench may be made to serve, for example, two or three company localities if the latter are connected laterally (i.e. in the most direct manner).

iii. From the commencement of work on field defences, therefore, it must be remembered that a continuous lateral trench may eventually be desirable. Provided there is no serious difference in tactical value between alternative dispositions, care must be taken to select the one favouring rapid development of field works.

3. Section posts.—

i. The first digging to be done in a position will generally be the construction of section posts and alternative section posts.

TYPES OF SECTION POSTS

Showing how Weapon-Pits may be connected up for inter-communication. The drawings are diagrammatic only, and must be adapted in every case to suit the ground. Each pit should be dug at right angles to the required direction of fire. The pits shown are for 2 men each, but they may be dug for one or more men as required. A suitable length is 3 feet per man.

First Stage (Continuous lines) is to dig the pits 3 feet deep.

Second Stage (dotted lines) is to connect them by crawl trenches.

Width of pits and trenches should be 3 feet 6 inches at ground level.

The number of weapon-pits required will be determined by the actual strength of the sections and of platoon headquarters.

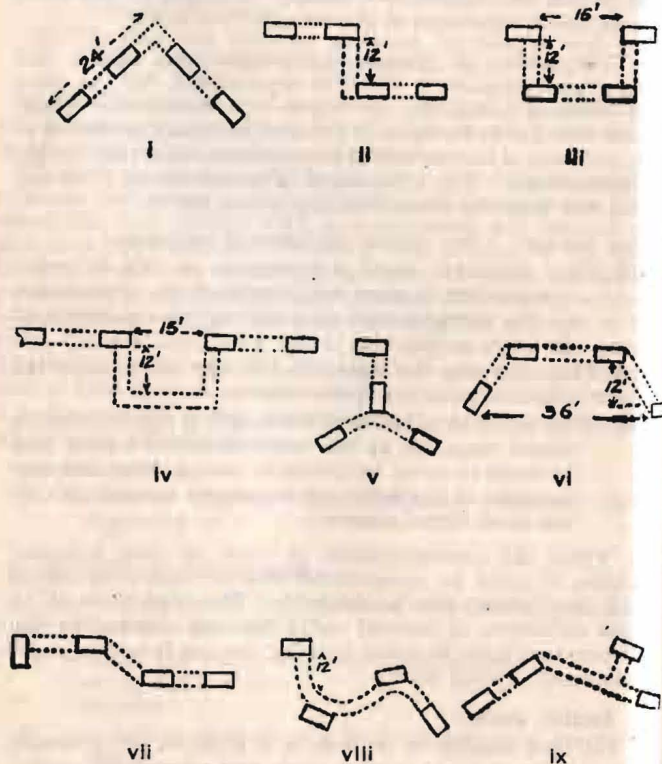


FIG. 2

The main object in the construction of a section post should be that the fire task is properly covered. It should generally be possible, if tools are provided after the necessary reorganization of the position, for forward platoons to complete the weapon pits and obstacles during the first night after a check, without additional labour from reserve platoons, companies or units. Wiring parties will, however, usually be found from reserve units. If additional labour is allotted it should be employed so that the weapon pits are connected up within the sections during the first night. If resources permit, work may also be commenced on the interconnection of section posts within platoon localities. Weapon pits and section posts will eventually be deepened into normal fire trenches.

4. Machine-gun emplacements.—These need very careful consideration in order to reduce to a minimum the information given to the enemy. Such machine-gun positions as lie within the area of the foremost defended localities must, from the start, be merged into the scheme of section posts so as to be indistinguishable from the air (Fig. 13; page 46). Cases will frequently occur, particularly if sited in depth, when machine guns are required to fire from comparatively isolated positions. It may then be advisable to postpone digging until the emplacement can be merged into the system of communication trenches or rear defended localities. In any case alternative positions and dummies must be provided as early as possible, and any connecting trenches must always be continued past the emplacement. This continuation must be completed during the same night in which connecting trenches reach the emplacement.

5. Platoon localities.—These will generally result from the joining up of section posts by lengths of fire trench connecting forward sections, and of communication trench connecting up rear sections with forward sections and with each other. These communication trenches must be sited so as to get interconnection between sections with the minimum amount of digging. Alternatively a platoon locality may be designed as such from the start. The solution will vary in every particular case. All round defence must always be given due consideration.

6. Communication trenches.

Defended localities may be linked up in two ways :—

- i. By joining them laterally, and providing a communication trench from rear to front for each group of localities.

- ii. By providing a rear to front communication trench for each locality, the localities not necessarily being laterally connected.

The former method is generally preferable, as it simplifies adjustment of the defensive organization, and involves a less amount of digging at each stage of development.

Initially, crawl trenches (Fig. 3) will normally be used for linking up the posts and localities.

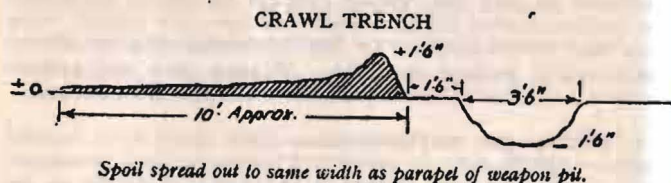


FIG. 3

15. Improvement of communications

1. The importance of good and easy communications in war cannot be over-estimated.

2. All arms should be able :—

- i. To construct and maintain cross-country tracks.
- ii. To carry out minor repairs to roads, cross simple ditches and remove minor obstacles.

3. i. The improvement of communications within a position can be of great assistance in the conduct of a defensive battle. Free movement across country is required, in order to save time and fatigue.

ii. Work is required in connection with :—

- (a) The tasks of reserves and troops to whom counter-attack roles have been allotted.
- (b) The passage of individuals, orderlies, etc.
- (c) Routine movements of troops, and of transport carrying rations, ammunition, etc.
- (d) The system of evacuation of casualties.

iii. It is therefore not only necessary to provide single tracks (with gaps through hedges and means of crossing ditches) and routes for transport, but also to clear obstructions in definite belts of ground in order to facilitate the rapid movement of bodies of troops advancing on pre-arranged lines of counter-attack, both within and beyond the position.

4. Tracks for individuals do not entail much work ; but it is clearly necessary that time and labour on tracks for transport should be economized by concentrating initially on only one or two front to rear and one or two lateral routes in each convenient sector of the defence.

5. In development of communications attention must be constantly directed to the following points :—

- i. Concealment from ground and, as far as possible, from air observation. For example, a track should follow the hedges round two sides of a field rather than go diagonally across in the open.
- ii. Avoidance of likely shell traps.
- iii. Care that selection of routes, and clearances involved, do not prejudice arrangements for concealment of other works.
- iv. Avoidance of ground likely to become water-logged after heavy rain.

6. Routes should be marked while they are being made. This can be done in various ways, such as blazing trees, sticking in the ground at intervals cut branches of trees or sticks with sandbags on top. As soon as possible notice boards and arrows should be improvised to indicate direction, and also the type of transport permitted to use the track.

Marking of routes and tracks should as far as possible be recognizable by night.

7. Routes for night patrols, forward of the actual area of defence, should also be given recognizable marks, but care must be taken that these are not apparent to the enemy.

16. Cross-country tracks

1. General.—

Cross-country tracks are required for the following reasons :—

- (a) To relieve congestion on main roads.
- (b) To avoid villages and shelled areas.
- (c) To improve and shorten communications generally.

All tracks must be reconnoitred, marked, drained and provided with sign-posts.

2. Marking of tracks.—

- i. All tracks should be marked by means of posts or tapes at both, or by heaps of stones or earth.

ii. *Posts* should be spaced at intervals (normally about 20 yds.) depending on circumstances.

iii. *Tapes*.—Tapes are only a very temporary expedient: they are soon obliterated by mud.

iv. *Notice boards* should be used in conjunction with the above methods. They have the advantage that each can be marked with the name, letter or number of the track. Black letters on a white ground are better than white letters on a black ground. Notice boards should not be higher than 18 in., or they will be knocked over by passing loads.

Direction boards should be erected at the terminals and at all places where tracks cross lateral routes.

"Up" and "Down" tracks must be clearly marked and the names of any places near which the track passes should be marked on notice boards visible from the track. Map references of important points should be shown on the notice boards.

v. *Lanterns*.—Screened lanterns are useful at junctions and important points. They can be made with candles or small oil lamps in perforated biscuit tins with calico shades.

vi. *Bridges*.—If a small bridge is made, it is important to lay the wooden bearers on a transom (which itself is embedded in the ground) and not directly on the earth; otherwise uneven settlement will occur and the bridge will tilt up sideways.

3. Tracks for men.—

i. *General*.—When making tracks, the following points should be borne in mind:—

- (a) Each track should be 3 ft. wide to enable men to move along it rapidly on a dark night.
- (b) A one-way track should be first completed; as soon as possible a duplicate track should be made to give an "Up" and "Down" route.
- (c) Lateral communication between tracks should be provided, especially in heavily shelled areas.
- (d) Trench-boards are the most suitable form of track and should be laid on transoms (roughly, 3 in. by 2 in.) bedded in the ground. In swampy ground they should be laid on trestles to keep them above water. Trestles can be constructed of two pickets driven into the ground to support the transom.

ii. *In sandy country*.—A quickly made and efficient track can be made by spreading out rolls of wire netting ($\frac{3}{4}$ -in. or 1-in. mesh) on the ground and pegging it down firmly on both sides.

17. Emergency road repair

Ruts and shell-holes.—The rut should be cut out square. If the foundation of large stones has been destroyed, the soling stones should be replaced by hand-packing over which a surface layer of macadam (2 to 2½-in. gauge stones) should be placed and then rammed. The base of the rut should also be rammed before replacing the soling stones.

The earth-berm (i.e. the earth part between the macadam and the drain) of a road, even if it is liquid mud, should not be cut away without replacing it with stone, if available, or some other hard material such as chalk or broken bricks, if stone is not available. Shell-holes require similar treatment.

If a hole in a road under traffic is allowed to remain unrepaired even for 24 hours great damage may be caused, as rapid disintegration will take place at the edges of the hole and the foundations may be ruined.

18. Improvement of observation and field of fire

1. General.—

i. If it is necessary to conceal the dispositions of the defence, it is equally necessary to make it difficult for the attacking troops to conceal themselves before and during their attack. This will naturally have been one of the main considerations in choosing the defensive positions and siting individual works, but much can be done by clearance to improve the observation of the defenders.

ii. Clearance must, however, be considered simultaneously with concealment, as unintelligent clearance may nullify efforts made to obtain concealment. In all cases the advantages of improvement of observation must be weighed against any loss of concealment involved. Weapons which remain concealed, even with a restricted field of fire, will be of more value than others, with a large field of fire, which lack concealment and are put out of action by the initial fire plan of the enemy. The valuable element of surprise in fire of the defence, particularly of localities in depth, may be lost through unwise clearance.

As a general principle, therefore, only the minimum clearance necessary to attain the object in view should be carried out.

iii. Clearance work should generally be undertaken early in the preparation of a defensive position, as once in contact with the enemy it is more difficult to continue than other work, owing partly to the difficulty of carrying it out efficiently by night.

2. Organization of work.—Clearance work is expensive in labour and tools and must be very carefully organized and controlled if waste is to be avoided and rapidity of work achieved. Detailed preliminary reconnaissance from the position of observation must be made, and the objects to be cleared must be defined exactly. If work is carried out during successive nights, its value must be checked each day.

When possible the results of work should be observed from the enemy's point of view.

Before beginning, an estimate must be made of the amount of work that can be done in the time available with the men and tools which can be spared.

It can then be decided what work is to be done first. As a general rule, work should progress outwards, commencing close to the observation post or fire position.

3. Types of clearance.—

i. Work to improve observation falls under two heads:—

(a) *For observers.*—To assist them to observe enemy movement and the fire effect of the weapons of the defence.

(b) *For weapons and riflemen.*—To increase the area over which they can fire with effect.

ii. Work under i. (a), above, will usually entail the removal of obstacles which obscure the view from observation posts.

iii. (a) Work under i. (b), above, will usually mean clearing obstructions in an area, in order to improve the field of fire of small arms weapons.

(b) It will generally be unnecessary to clear away everything in front of fire positions. Hedges, lines of trees, patches of bush may often, if left standing, help to screen the fire trenches from the enemy's observers. They may often be of value as obstacles, especially if wire is added to them. Very often the partial clearance of the lower part of hedges will allow adequate vision without sacrifice of any concealment.

(c) Work on clearance should include leaving range marks, natural or artificial (if screened from the enemy), suitable for assisting the fire effect of the weapons concerned.

4. Detailed considerations.—

i. *Trees.*—Large trees give more cover to the enemy when cut down than when left standing. Their lower branches only should be cut away if they alone are causing the obstruction.

ii. *Bush.*—Areas covered with thick bushes are difficult to clear. They should be treated like a wood. Clearings or lanes should be made, and the edges of the part that is left should be filled with obstacles.

iii. *Buildings and walls.*—Small buildings and walls can be smashed down by a number of soldiers using a beam as a battering-ram. The debris must be levelled so as not to give cover to the enemy. Large buildings cannot be destroyed, and should be burnt so as to prevent enemy access to the upper floors for observation.

iv. *Crops.*—High crops, such as wheat, can seldom be cleared entirely, but by marching formed bodies of men through them, or by the use of cutting machines, if available, rides and indentations are quickly made. Clearing crops with sickles or scythes is a very slow process and requires skilled reapers.

PART VI.—FACTORS GOVERNING DESIGN OF PROTECTIVE WORKS

19. General principles

The principles governing design of protective works should be understood so that normal designs can be altered or adapted to suit local conditions, without loss of efficiency.

The three main principles are:—

i. The work must permit the effective use of the defenders' weapons.

ii. The work must provide protection from the enemy's weapons.

iii. The work must be inconspicuous.

20. Use of weapons—Governing dimensions

1. *The rifle.*—In the positions stated a man can fire his rifle over the following heights:—

(1)	Fires over (2)	Distance needed behind (3)	Remarks (4)
i. Lying	9 to 12 in.	5 ft.	Man not covered from view, cannot move about. Badly exposed to shrapnel fire
ii. Kneeling or sitting ..	30 in.	3 ft.	Man cannot sit under cover, and can only move with difficulty without exposure.
iii. Standing	4 ft. 6 in.	2 ft.	Man can sit and crawl without exposure, extra width needed for easy movement.

2. **Other weapons.**—The maximum heights over which other weapons can fire are shown below :—

i. Light machine-gun and anti-tank rifle ..	As for rifle.
ii. Medium machine-gun on tripod mounting. (Firer in sitting position.)	24 in.
iii. 2 pr. anti-tank gun	24 "
iv. 18/25 pr. field gun	30 "
v. 4.5 in. howitzer	30 "
vi. 25 pr. field gun	34 "

21. Protection required against different types of fire

1. **The rifle bullet.**—The table opposite shows the safe thickness of various materials against small-arms fire and bomb splinters.

Prolonged concentrated fire (for example, from a machine gun) will penetrate these thicknesses. Though this effect not likely to occur often, it may be necessary, in special cases to provide extra thickness for protection.

Small-arms fire at effective ranges from the ground has flat trajectory and cannot search steeply behind a protective parapet.

2. **Shrapnel.**—The bullets come down at a steep angle and have very little power of penetration.

A brick wall 9 in. thick, a bank of earth 18 in. thick, or the roof or floor of a good building, will be sufficient to stop the

3. **H.E. shells with instantaneous fuze.**—These shells burst directly they touch the ground. The effect is mainly lateral and the splinters have a flat trajectory and sometimes for distances of 200 or 300 yds., but they have very small penetrative power and are stopped by a 9-in. wall, or a bank of earth 2 ft. thick.

4. **H.E. shells with non-instantaneous fuzes.**—These burst after penetrating for some little distance, and are of more value against material than against personnel. The splinters from these shells have less penetrative power than the mentioned above, for the force of the explosive tends to shatter surrounding material. Good protection, against the effect of splinters from shells, can be afforded by narrow trenches (Sec. 27).

Little can be done in hasty defences to protect against direct hits of these shells, as the amount of material needed for safety is too great; in deliberate defences, however, dug-outs can be made deep enough to afford protection.

PROTECTION TABLE

Material	Normal field defences	Defence against A.T. weapons	Remarks
	Safe thickness in inches at 100 yds. against (a) S.A.A. up to 7.92 mm. (bursts of 5 rounds I.A. fire or single shots A.P.); (b) bomb splinters	Safe thickness in inches at 100 yds. against A.T. weapons up to 20 mm.	
(1)	(2)	(3)	(4)
1. Brickwork in lime mortar	13½	27	Good quality brick.
2. Brick rubble confined between 1-in. boards	12	—	Consolidation decreases protection. Much depends on type of clay. Good factor of safety is allowed here. Unsatisfactory owing to pulverising effect of bullets.
3. Chalk loose as in new parapets ..	24	—	—
4. Clay loose as in new parapets ..	36	—	—
5. Coal (hard) { Confined between boards }	13	—	—
6. Coal (kitchen) { between boards }	18	—	—
7. Concrete unreinforced ..	6	15	—
8. Earth or loam as in parapets ..	36	60	—
9. Road metal 1½ ins. to 2 ins. between 1-in. boards ..	9	—	—
10. Sand between 1-in. boards ..	12	—	—
11. Sand loose ..	24	46	—
12. Sandbags filled with—	20	—	Protection given by coarse sea-sand is considerably greater.
Brick rubble ..	20	—	—
Chalk ..	20	—	—
Clay ..	30	—	—
Earth ..	30	—	—
Road metal ..	10	—	—
Shingle up to 1 in. ..	20	—	—
Sand ..	20	—	—
13. Shingle or broken stones between 1-in. boards ..	9	—	—
14. Steel plate, mild ..	1	—	—
15. Timber, soft wood ..	48	—	—
" hard wood ..	24	—	—
" poles ..	36	—	—

Thicknesses are the lowest multiples of sandbag dimensions to give the required protection.

1½ ins. against A.P. S.A.A. These figures can be taken as a guide only owing to the large number of varieties of timber.

5. The effect of direct hits by these shells is limited by:
 - i. Avoiding long, straight lengths of trench or work.
 - ii. Providing traverses.
 - iii. Holding up the sides of trenches by revetment.

PART VII.—PROTECTIVE WORKS

22. Medium machine-gun emplacements

1. **General.**—The type of earthworks to be constructed for medium machine-guns will depend upon the time, labour and tools available, upon the siting and upon the nature of the soil.

In mobile warfare there will seldom be time or material for elaborate earthworks, and protection will be obtained by concealment and by the construction of hasty emplacements.

The construction of all earthworks for medium machine-guns is the responsibility of the M.M.G. units. The construction of concrete emplacements is the responsibility of the engineers.

The dimensions of the Vickers gun, mounted in the normal position, are given in Fig. 4. The rear to front dimension may be reduced by mounting the gun in the highest position or, when the firer is to stand behind the gun, by mounting the tripod with the rear leg to the front and embedded in the parapet.

A firm and steady base is required for the shoes of the tripod.

2. Hasty emplacements.—

i. The form of M.M.G. emplacement which is quickest to dig is that shown in Fig. 5. In this type the firer will sit behind the gun. The excavated earth is used to form a parapet which may be extended to give protection on one flank if required.

If more time is available, and the command of the ground allows, the type shown in Fig. 6 can be used and will provide more protection for the firer. The excavated earth is used as a parapet, to give flank protection, or is removed to a place under cover.

Either of the above types may later be developed to allow the firer to stand behind the gun or to sit in the bottom of the emplacement when not actually firing.

The emplacement then takes the form of a normal weapon pit except that the elbow rest is two feet wide instead of one foot six inches. The gun is mounted at ground level with the

MINIMUM DIMENSIONS OF M.M.G. EMPLACEMENT

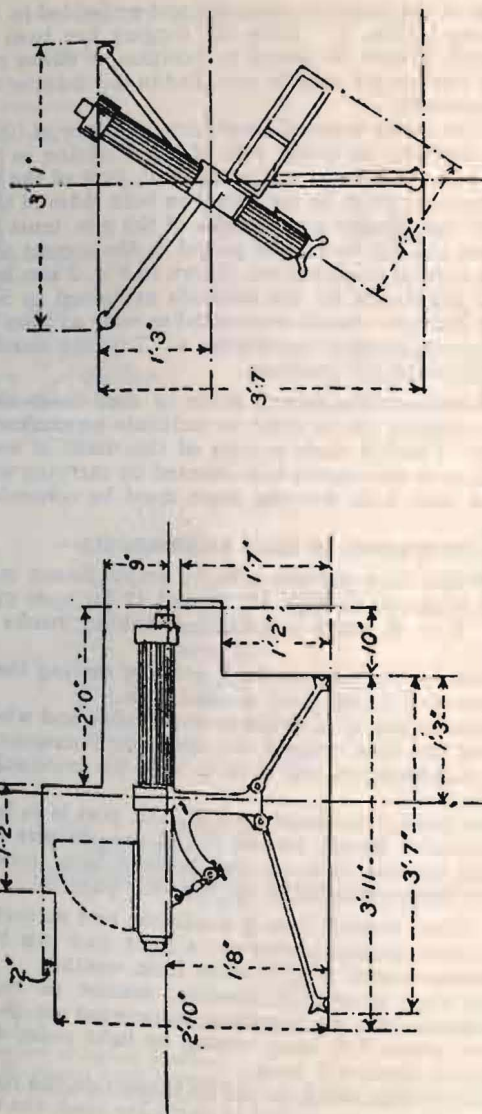


FIG. 4

rear leg of the tripod to the front and embedded in the parapet as shown in Fig. 7. After the digging has been complete sand-bags should be placed in position as elbow rests.

Any weapon pit may be modified in this manner as a M.M.G. emplacement.

All the above types of emplacement allow of fire on an arc of 45 degrees, on either side of the direction in which they are facing. If a wider arc is required, part of the front of the emplacement must be cut away on both sides of the gun, and part of the parapet on the right of the gun must be removed to allow the belt box to be placed in the correct alignment.

The type of emplacement shown in Fig. 7 can be developed into a fire-trench by the methods explained in Sec. 25, 7.

The platform should be revetted as early as possible. When the ground is soft or unsuitable, a "T" base should be placed in position on the platform.

ii. Hasty emplacements made in shell holes should be as simple as possible in order to facilitate concealment.

Figs. 3 and 9 show a type of this form of emplacement. Drainage in this case is best effected by carrying water off to deeper shell hole, but the drain must be concealed.

3. Development of hasty emplacements.—

When time permits a hasty emplacement may be developed as shown in Figs. 10, 11 and 12 for open ground, or Figs. 7 or 8, when constructed behind banks or in shell holes.

Cover for the personnel not actually serving the gun should be provided in the form of shell slits.

Concealment is of primary importance and when extensive digging has been ordered the initial emplacements or weapon pits must be so sited as to fit in with the eventual trace of the trench.

Any distinctive shape for a M.M.G. post is to be avoided.

A suitable layout for the initial weapon pits for a M.M.G. section capable of being incorporated in a trench system is shown diagrammatically in Fig. 13, page 46.

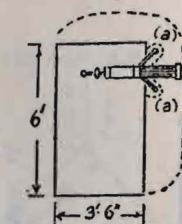
ii. When further time is available, and subject to concealment from ground observers, a light roof can be built over the emplacement to give cover from weather.

The roof should, if possible, consist of two sheets of corrugated iron or boarding, supported on 3-in. by 3-in. rafters, about 7 ft. long, resting on light poles, 4-in. by 4-in. scantling about 4 ft. long.

Only enough earth should be thrown on the roof to hide it. If more than a few inches of earth are used, the emplacement

HASTY M.M.G. EMPLACEMENTS

Fig. 5

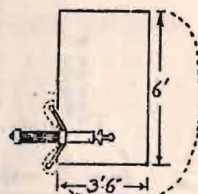


PLAN



SECTION

Fig. 6.

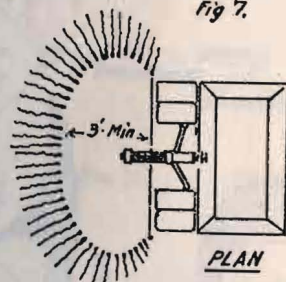


PLAN

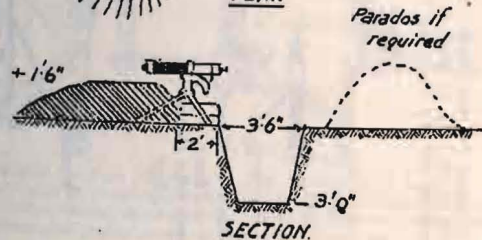


SECTION

Fig. 7.



PLAN



SECTION

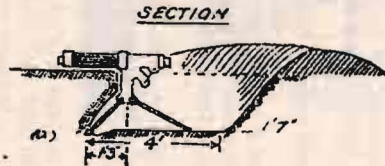
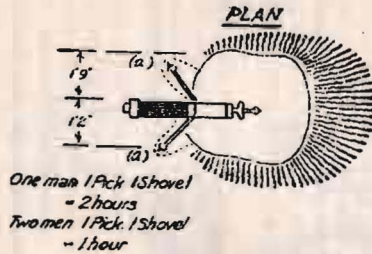
- (a) Slight undercut (can be revetted with wooden slats from Ammunition Box for each leg).
- (b) Gun mounted in highest position.
- (c) 2 ft. is Maximum depth to enable No. 1 to fire in sitting position.

Fig. 7 shows normal development of Figs. 5 and 6 when time permits.

FIGS. 5, 6 and 7

HASTY M.M.G. EMPLACEMENTS

The reason for more room on the right of M.G. is to allow for ammunition and No. 2. Fig. 8

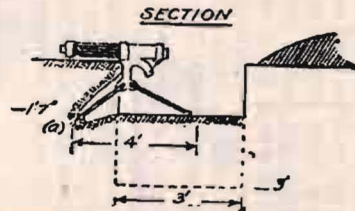
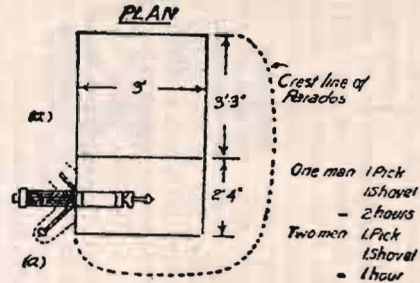


M.M.G. in Shell Hole.

(a) Slight undercut (can be revetted with wooden Slats from Ammunition Box) for each leg.

Figs. 8 and 9

Fig. 9



M.M.G. in Slit Trench.

TYPES OF M.M.G. EMPLACEMENTS IN OPEN GROUND

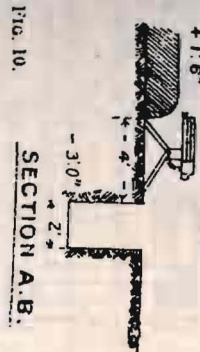
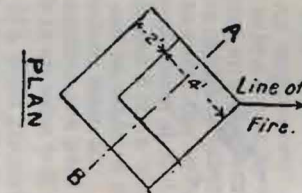


FIG. 10.



FIG. 11.

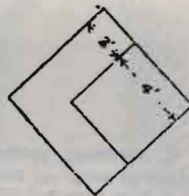


FIG. 12.

When time is available the Gun Platform in Fig. 13 should be revetted. The Emplacements may also be converted by cutting a trench rearwards from the rear angle of the Emplacement, these trenches joining a lateral communication trench and giving access to the control post, etc.

WEAPON PITS FOR M.M.G. SECTION

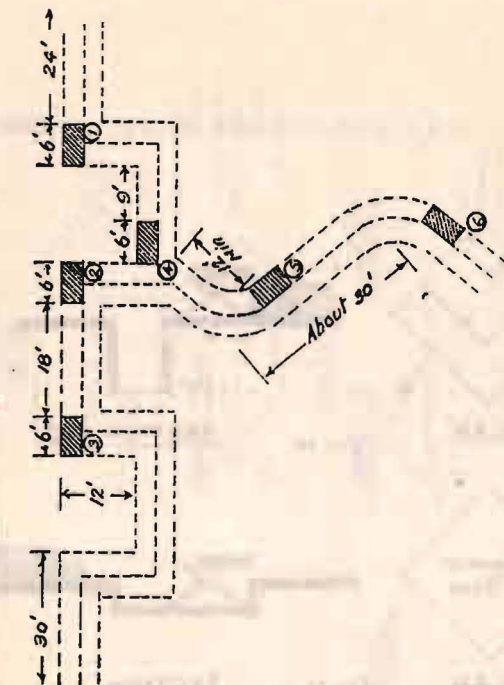


FIG. 13.

No.	(1)	(2)	(3)	(4)	(5)	(6)
	One M.M.G. with 2 gun Nos.	" " 2 " "	Section commander and range-taker.	2 men—Nos. 3 of each sub-sec.	2 " 4 " "	2 " 5 " "

The section corporal places himself in 4, 5 or 6, according to which of these positions affords the best facilities for supervising the chain of supply. The section orderly would normally be at platoon headquarters.

will collapse when a shell bursts near it, the occupants will be buried and the gun put out of action.

iii. The inside of the emplacement should be revetted (Sec. 32) and an opening left for the gun to fire through.

4. Wall emplacements.—

i. An emplacement can readily be made behind a garden wall, or in a house, by knocking a hole (Sec. 34) in the wall and building up a platform for the gun behind it.

Care should be taken that the hole is wide enough for the gun to cover the necessary arc of fire.

The platform should be firm and not smaller than 4 ft. in length and 4 ft. in width.

It can be made of old bricks or boxes filled with earth or improvised material.

A machine-gun sited behind an inner wall and firing through a hole in an outer wall is extremely hard to locate.

ii. If a pivot platform is used, the gun, when placed upon it, pivots about its muzzle. This avoids the necessity of a wide loophole and so facilitates concealment.

23. Light machine-gun emplacements

i. Light machine-guns can be fired over the parapet of an ordinary weapon pit, which is all that is required if the role of the gun is firing on an arc.

L.M.G. EMPLACEMENTS

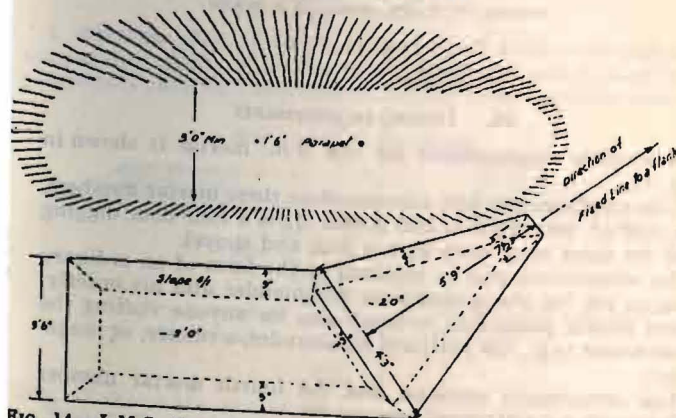


FIG. 14.—L.M.G. EMPLACEMENT FIRING ON FIXED LINES TO A FLANK.

ii. Suitable emplacements for a light machine-gun mounted on its tripod to fire on a fixed line are shown in Figs. 14 and 14A.

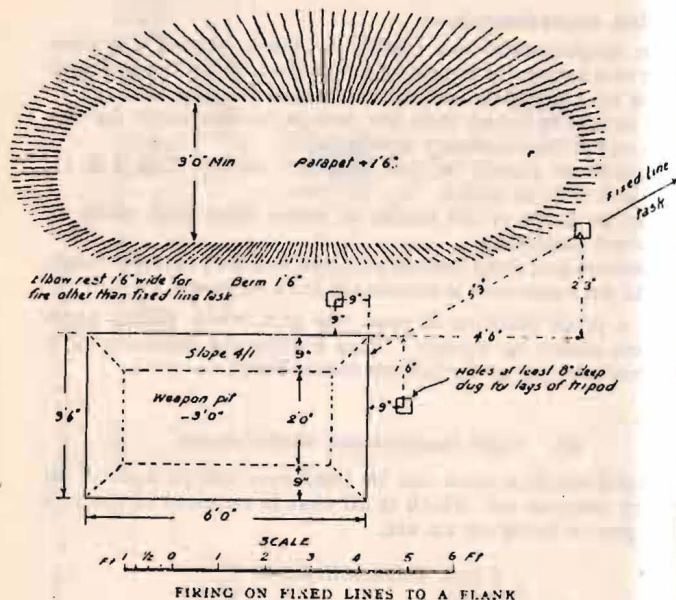


Fig. 14A

24. Mortar emplacements

A suitable emplacement for the 3-in. mortar is shown in Fig. 15.

This emplacement will accommodate three mortar numbers, the mortar, ammunition and stores. It is a four-hour digging task for three men, each with a pick and shovel.

An observation post is required in the form of an ordinary weapon pit for the detachment commander and his orderly. There should preferably be room also for anyone visiting the detachment (e.g., the platform commander, a runner, or range-taker).

The detachment corporal and the fourth mortar number will require an additional weapon pit.

3-IN. MORTAR EMPLACEMENT

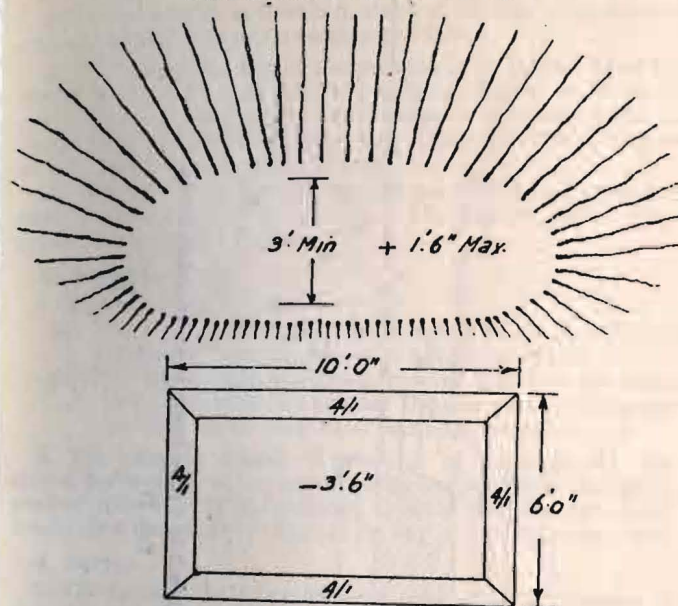


FIG. 15

25. Fire trenches

1. General.—Fig. 16 shows the section of a fully developed, normal fire trench. The following paragraphs will explain its component parts and sequence of digging tasks and revetment.

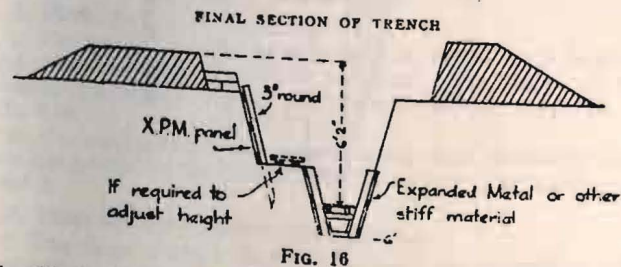
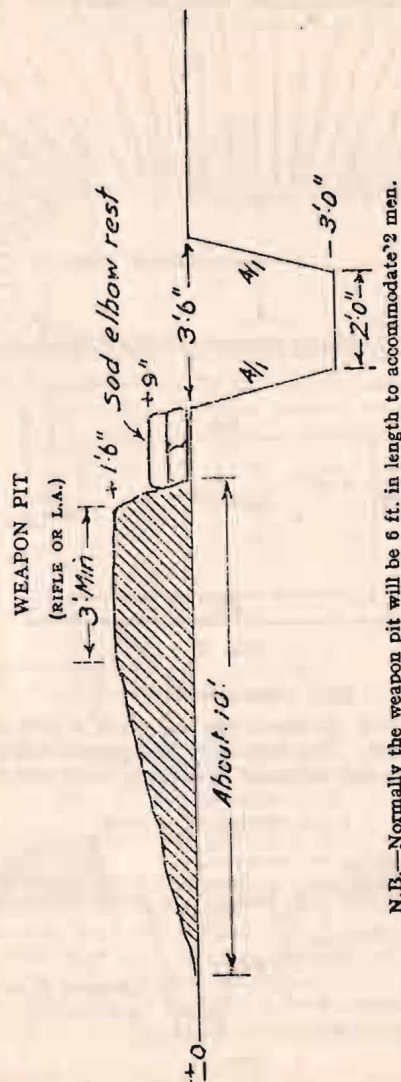


Fig. 16

Fig. 17 shows the section of a weapon pit, which is the same as Task I, Figs. 18 and 19.



N.B.—Normally the weapon pit will be 6 ft. in length to accommodate 2 men.

FIG. 17

2. Parapet.—

i. This should be at least 3 ft. thick at the top for protection against enemy rifle and machine-gun fire.

ii. The closer the top of the parapet is to ground level the easier it is to conceal, but a minimum height of 18 in. is generally necessary to give the firer sufficient command. If the parapet is lower than this, it may also be difficult to dispose of the earth dug out of the trench.

iii. The top of the parapet should not be flat and even, but should be as irregular as possible. The parapet should slope gently towards the front.

3. Parados.—

i. This serves two purposes :—

- To protect the firer from splinters of shells bursting behind the trench, and also from reverse fire.
- To form a background so that the heads of the firers may not show up against the sky or light coloured ground which may exist behind the trench.

ii. The parados should, if possible, be bullet-proof; but this is not usually as important as its height, which should be greater than that of the parapet, in order that the defenders' heads shall not show up against the sky or a light background.

4. Berm.—

i. The berm is the space between the foot of the parapet or parados and the edge of the trench. It should never be less than 12 in. wide.

ii. It is essential in order to prevent :—

- the excavated earth on the parapet or parados falling into the trench.
- the weight of the parapet or parados breaking down the edge of the trench.

5. Firestep.—

i. The firestep should be at least 2 ft. wide, must be firm, and when possible should be revetted. The depth of the firestep below the top of the parapet should normally be 4 ft. 6 in.

ii. On occupying a fire trench every man should at once test the height of the parapet and make sure that he can fire over it.

6. Cross-section—General dimensions.—

i. The sides of the trench are dug as steep as possible—for protection—but not steeper than 4/1 so that they may stand for a time without being revetted.

ii. The fire trench must be wide enough to fire from efficiently, and, later, widened further so as to permit walking behind the firing.

The varying conditions, such as enemy armament, nature of ground, in different theatres of war will influence the question of width.

iii. When time permits there should be a passage 2 ft. wide behind, and deeper than the firestep.

7. Sequence of digging tasks and revetment of fire trench.—

i. In situations not in contact with the enemy, and when it is intended that the trench shall be dug to a "fully developed" section forthwith, the digging will be carried out in three stages as follows:—

- (a) In the first instance Task I will be excavated. All the earth from this task must be thrown on the parapet.
- (b) Then this trench, 3 ft. 6 in. wide and 3 ft. deep, will be widened by digging out Task II.
- (c) Finally, the passage way as shown in Task III will be excavated, the earth being used to make the parapet proof against light A.-Tk. weapons. (See Protection Table, page 39.)
- (d) As soon as possible the firestep should be revetted. If further time is available the remainder of the trench may be revetted.

Fig. 18 shows the division of the fire-trench into these three tasks.

ii. In the presence of the enemy, or in situations where contact with the enemy is expected before the third task has been dug, the following procedure will be adopted:—

- (a) Task I will be dug as in sub-para. i (a) above.
- (b) Then this trench will be widened to 5 ft. 6 in. at the top, and deepened to 5 ft. The rear slope and the trench below the firestep level will be dug at a batter of 6/1. The width at the bottom of the passage way will be 1 ft. 7 in.
- (c) Finally, the trench will be widened and deepened to the "fully developed" section, and revetment carried out.

Fig. 19 shows the division of the fire-trench into these three tasks.

The names of the parts of a fire-trench are shown in Fig. 20.

ORDER OF WORK

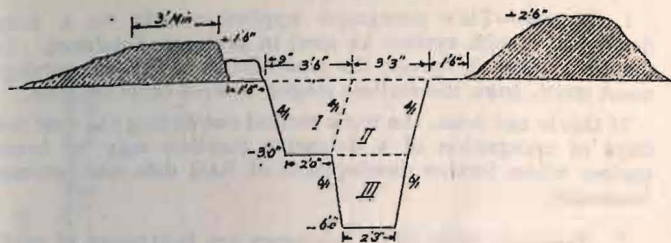


FIG. 18

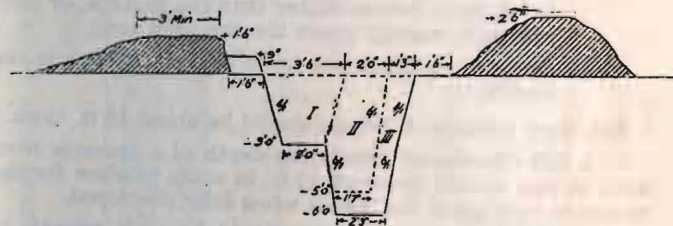


FIG. 19

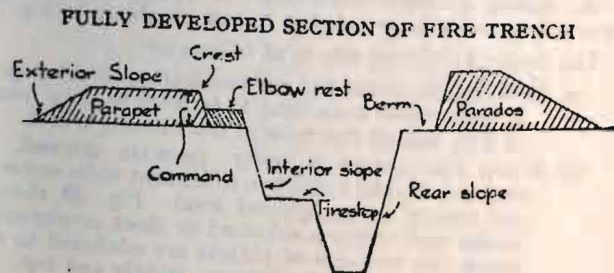


FIG. 20

8. Traverses and trace of fire trench.—

i. *General.*—This paragraph applies mainly to a fully developed trench system as used in protracted defence. In mobile warfare, however, the possibilities of further development must, from the earliest stages, receive consideration.

If this is not done, the work carried out during the first few days of occupation of a defensive position may be found useless when further development of field defences become necessary.

ii. *Traverses* (Fig. 22).—Traverses are buttresses of earth left projecting backwards from the forward edge of the trace of the trench, and so splitting up the forward face into short lengths (fire bays)

They serve two purposes :—

- (a) To give protection against enfilade fire, for which purpose their top should be higher than the top of the parapet, but no higher than the parapets, or they will show exactly where the fire bays are.
- (b) To localize the effect of a bomb or shell bursting in the trench.

For these purposes traverses should be about 15 ft. thick.

In a fully developed trench the depth of a traverse from front to rear should be about 12 ft. in order to allow for the necessary overlap of the trench when fully developed.

The passage round traverses should be wide enough to allow stretchers to be carried through them.

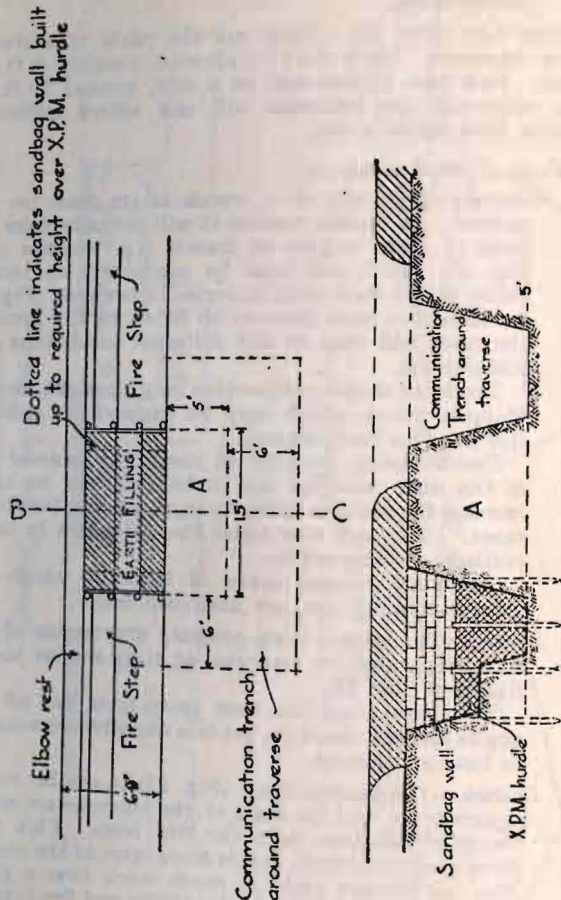
In a section post or defended locality where all-round defence is necessary, the passage behind traverses may be provided with firesteps.

iii. *Adding a traverse to a trench.*—It is sometimes necessary to add a traverse to an existing trench, as shown in Fig. 21.

The method of doing this is as follows :—

- (a) First dig the additional communication trench required to pass round a traverse 15 ft. wide with an overlap of 5 ft. behind the back of the existing trench.
- (b) When this trench is ready, properly drained, and trench-boarded, build two revetment walls across the old trench up to ground level. Fig. 39 shows picket and either brushwood or sheet revetment, in which the two sets of pickets are anchored to each other by wires at the bottom, middle and top.

SHOWING TRAVERSE MADE IN UNTRAVERSED TRENCH



- (c) After the revetments are ready, or as they are being built, fill in the spaces between the revetments with the earth which came out of the trench.
- (d) Make up the parados and the top of the traverse to the proper shape.

iv. *Fire bays* (Fig. 22).—These are the parts of a trench between traverses. Each firer is allowed roughly 6 ft. of fire bay. Fire bays should not, as a rule, exceed 30 ft. in length, otherwise the traverses will not afford sufficient protection from enfilade fire.

v. *Trace of fire trenches* :—

- (a) *General*.—The trace of a trench is its plan on the ground. In mobile warfare it will initially take the form of short lengths of trench (i.e. weapon pits Fig. 17) which will later be connected up into a series of fire bays with traverses in between (Fig. 2). As these fire bays have to be fitted to the ground the trace will vary to suit different conditions and undulations.

The trace should not contain long, straight lengths of open trench which may be exposed to enfilade fire (see Fire bays, above).

Besides being irregular in itself, the general line of the trace must be laid in bold curves, so as to increase the enemy's difficulty in organizing bombardment. This will also assist the defenders in using enfilade or oblique fire.

There are various types of trace of which the most commonly used are described below.

- (b) *Square*.—The square trace consists of a series of fire bays, separated by traverses at right-angles to the fire bays (Fig. 22).

This type gives the best protection, for all the angles are well closed in, but it is slightly extravagant in time and labour.

- (c) *Bastion*.—The bastion trace (Fig. 23) is similar to the square trace, but the sides of the traverse are set at about 135 degrees with the fire bays. This type gives good protection, but is more open at the angles does not involve quite so much work over a given length of line, and is easier for traffic and fire control.

As any portion of a trench dug with this trace can be prepared as a fire position to give fire in any direction it is particularly useful for communication trenches.

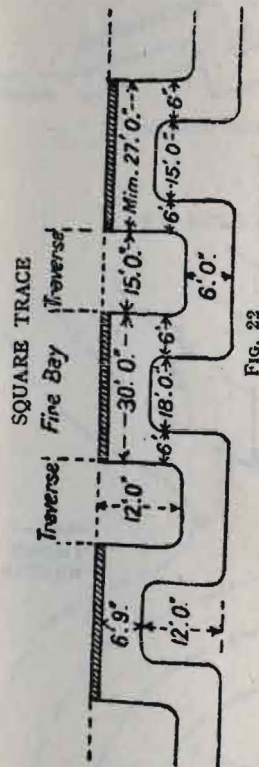


FIG. 22



FIG. 23

- (d) *Zig-zag*.—The "zig-zag" trace (Fig. 24) consists of a number of fire bays laid out in a series of zig-zags.

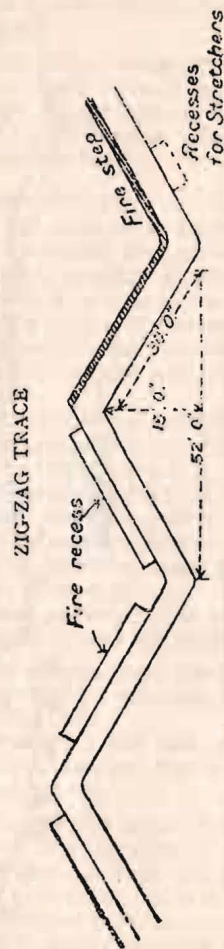


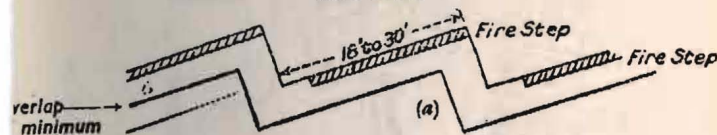
FIG. 24

of which no angle can be greater than 135 degrees, or less than 90 degrees.

This trace is simple to lay out, quickly constructed, but depends for protection on its irreg-

- ularity of line, for there are no traverses. In warfare against a well-armed enemy it is not recommended.
- (e) *Dog leg*.—The dog leg trace (Figs. 25 and 26) is useful for a continuous line across a valley with deep sides.

DOG LEGS



(a) Angle may be from 90 to 120 degrees

FIG. 25

EXAMPLE OF USE OF DOG LEGS

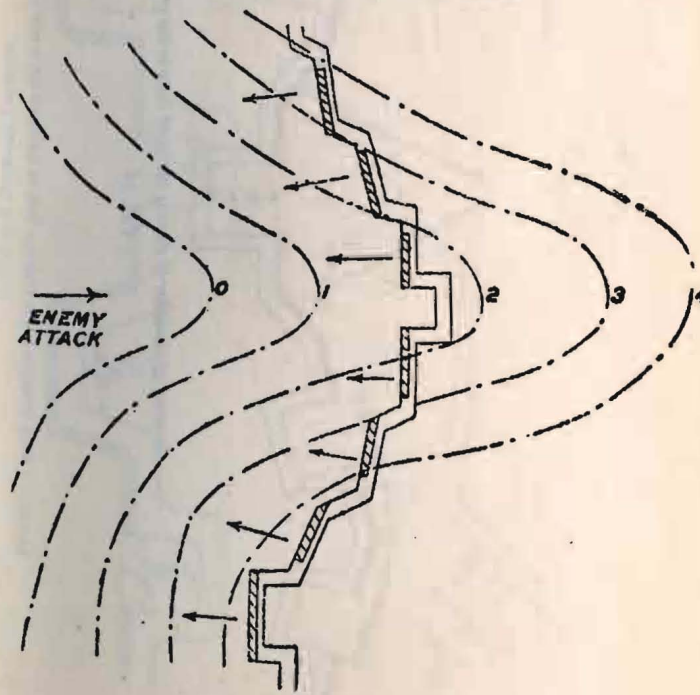
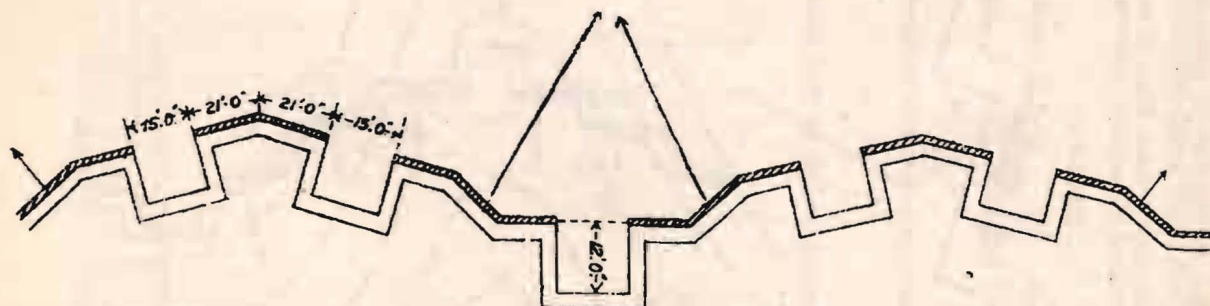


FIG. 26



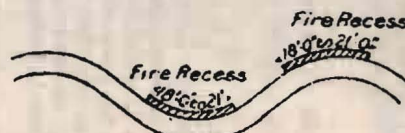
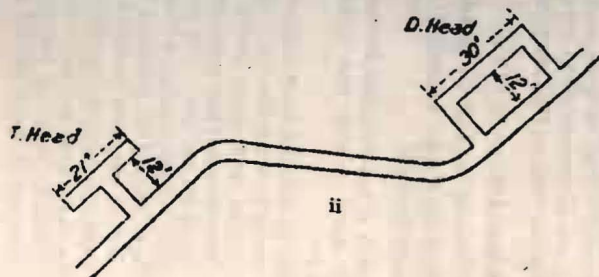
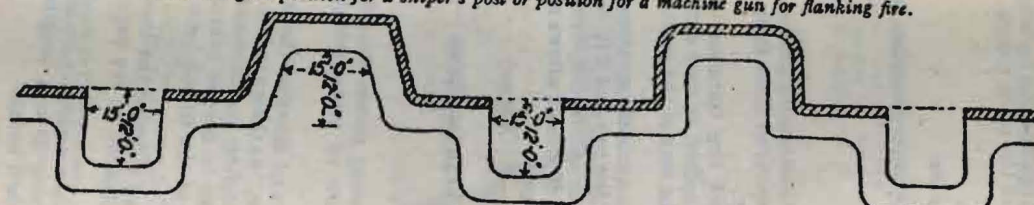
Showing application of various forms of trace to the ground.

FIG. 27

60

Occasional Forward Traverse

Provides a good position for a sniper's post or position for a machine gun for flanking fire.



CURVED WITHOUT TRAVERSES
A traversed trench is the better but takes longer to dig.

FIG. 28

61

U Alternatives.—Some alternative traces based on combinations of the above are shown in Figs. 27 and 28.

(g) *Common type*.—A common type which has been much used is a combination of the "square" and "bastion" trace.

(h) By using T-heads and D-heads advantage can be taken of accidents of ground forward of the main trench.

26. Communication trenches

1. **Object**.—The objects of communication trenches are to provide :—

- i. Concealment.
- ii. Protection.

It is essential, however, that all communication trenches be prepared so that in places fire can be delivered from them in any direction in the event of penetration.

Communication trenches may connect fire trenches in a defended locality, or one locality with another, or may extend from different parts of forward area to the rear of the position.

2. **Dimensions**.—To start with, communication trenches will be dug 3 ft. deep, 3 ft. 6 in. wide at the top and 2 ft. wide at the bottom. Then as time permits they will be deepened to the full depth as shown in Fig. 29 or Fig. 30, which allows men using them to walk upright without exposure.

3. Development.—

i. The development of the trench will be in two forms :—

- (a) Deepening and widening.
- (b) Lengthening.

ii. *Details of construction*.—The following points should be borne in mind during the construction of communication trenches :—

(a) For protection from enfilade fire and shrapnel the trace must be irregular, i.e. "winding," as shown in Fig. 31.

The minimum curve in winding communication trenches so that a stretcher can be carried round it, is 16 ft. radius. The portion of the trench between two bends is called a "leg."

(b) There should be parapets on both sides of the trench, but in the first instance the parapet on the exposed side is the more important.

(c) The length of a "leg" should not generally be more than 10 yds., to avoid exposing a long length to fire and to limit the effect of shell bursts.

UNREVETTED SECTION

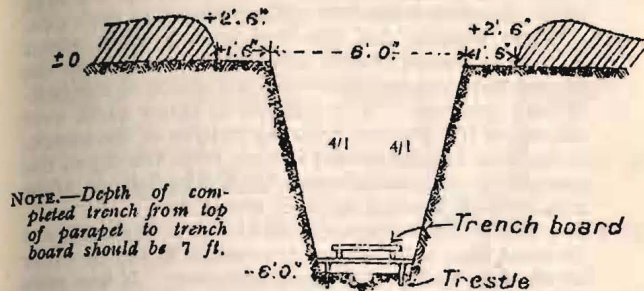


FIG. 29

REVETTED SECTION

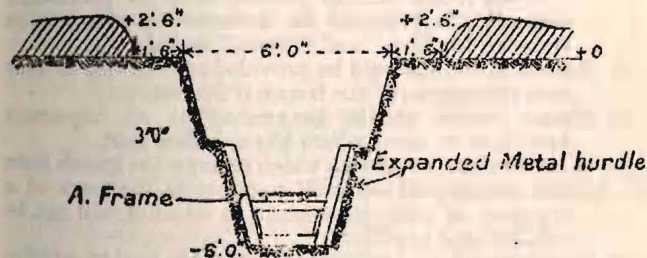


FIG. 30

TRACE



The bends in the trench must conform to the ground so as to get the best advantage in cover, but roughly the distance between bends should not be more than 15 yards up to reserve trenches and not more than 10 yards between reserve and fire trenches.

FIG. 31

- (d) A berm 1 ft. 6 in. wide must be left between the edge of the trench and the foot of the parapet on each side. When digging out the first task a berm about 3 ft. wide should be left so that the earth from the second task can be thrown on the inside of the half-formed parapets. It is difficult to throw earth over the top of the parapet from the bottom of the trench.
- (e) The depth of the completed trench, from the top of the parapet to the trenchboard, should be 7 ft. to allow men to walk along it without exposure.
- (f) The width at the bottom should be 3 ft. It should not be more than this, as then the trench would be wider at the top, and protection diminished. If less than 3 ft. wide at the bottom, passing will be difficult.
- (g) The slope of the sides should be 4/1 or 3/1 according to the soil.
- (h) Passing places, and in a long trench occasional sidings, should be provided for, to facilitate passage of large parties of men.
- When time permits (usually only in protracted defence) there should be different communication trenches for "up" and "down" traffic.
- (i) Ramps or steps should be provided at intervals so that men can get out of the trench if desired.
- (j) Notice boards should be erected at all important junctions to show where the trenches lead.
- (k) A communication trench which enters a fire trench from the rear should do so if possible at the back of a traverse, or some other position where it will not be exposed to direct fire.
- (l) The importance of drainage, as stated in Sec. 28, applies with equal force to communication trenches.

27. Shell slits

1. Slit trenches, shown in Figs. 32 and 33, are useful to give protection from shelling and aeroplane bombs.
2. They should be about 3 ft. wide at the top and 4 ft. deep. They are usually dug at right-angles to communication trenches and on each side of them. The slits should be made zig-zag in plan and each should be long enough to take 10 or 12 men, or about 25 to 30 ft. in length.
3. They should be shored or strutted as early as possible to prevent collapse, and when time is available steps, for egress, should be provided at the end away from the communication trenches.
4. They should be drained.

SHELL SLITS

TO GIVE QUICK IMPROVISED SHELTER

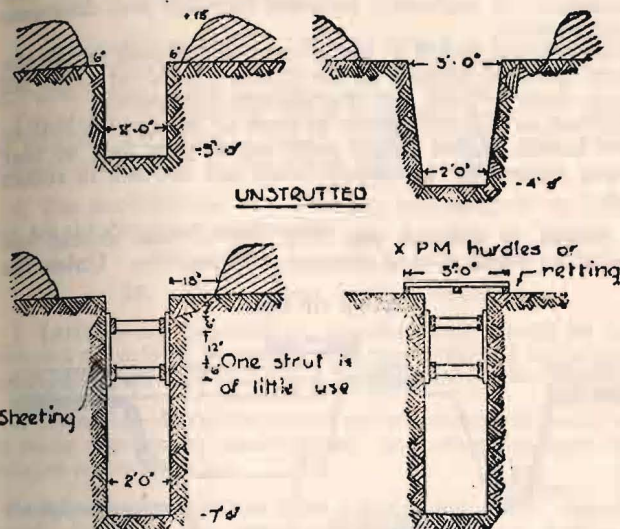


FIG. 32

STRUTTED

CONCEALED FROM AIR OBSERVATION

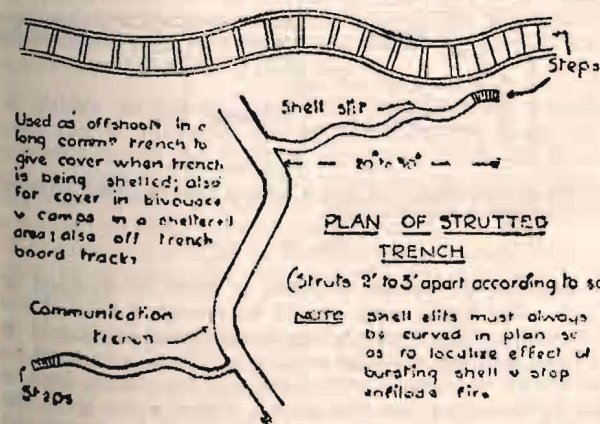


FIG. 33

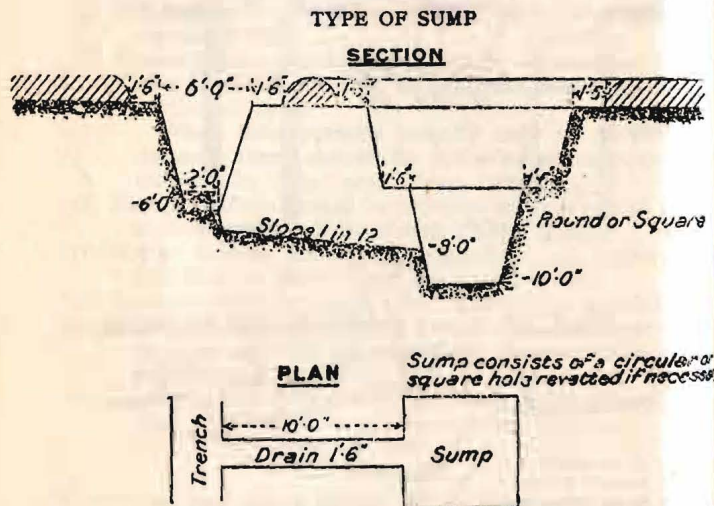
28. Drainage of trenches

1. Drainage of trenches and fire positions is of the greatest importance. If neglected, trenches collapse, and disappear in bad weather.

Drains should be put at the lowest point of each fold in the ground, and the bottom of the trench graded so as to fall towards them without any intermediate depressions.

Excavation of drains should be done up hill and the bottom of the trench graded before work ceases each day, so that pockets, formed by unfinished tasks, are not left to collect water.

2. Sumps or soakage pits (Fig. 34).—These should not be relied on unless natural drainage is impossible. Unless the



Note:—Sump should never be put in where drainage out to lower ground can be arranged.

FIG. 34

sump reaches a permeable stratum, it must be pumped or baled out. The main sump should be provided clear of the actual trenches. Until trench-boards are issued use should be made of any suitable material available. Sump pits must be revetted above water-level with a skeleton revetment, kept in position by bracing across the sump. Below water-level, the pits must be revetted with brushwood, XPM, or corrugated

iron. When constructing a trench system, until the main sumps can be provided, it will be necessary to provide small sump pits in the trench itself.

3. In occupied trenches, the mud which is churned up by traffic will make drainage impossible unless trench-boards are laid with a clear space for water to flow beneath them.

Trench-boards should be laid as soon after digging the trench as possible, for, after a heavy shower, traffic will quickly convert the bottom of the trench into a slough.

4. The maintenance of a drainage system must be carried out by the troops in occupation.

29. Miscellaneous details of trenches

1. **Latrines** are required in trenches and should be constructed as early as possible. They are arranged for in small trenches dug off communication trenches.

2. **Recesses.**—Parapets should on no account be under-cut to make recesses for ammunition, etc., otherwise they may collapse under shell fire.

3. **Name-boards.**—When time permits name and direction boards should be erected, especially in connection with communication trenches and junctions. These can be very rough pieces of board in the first instance.

4. **Exits.**—Fire trenches should, when labour is available, be provided with numerous exits towards the front and rear. These exits are required for patrols, working parties, and for counter-attack parties to move out.

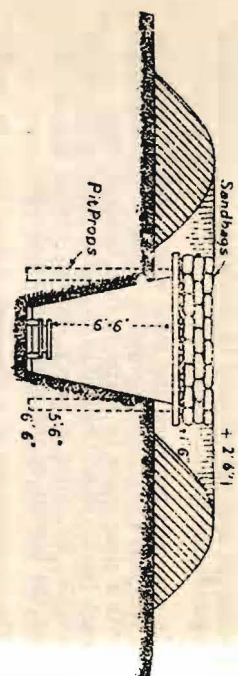
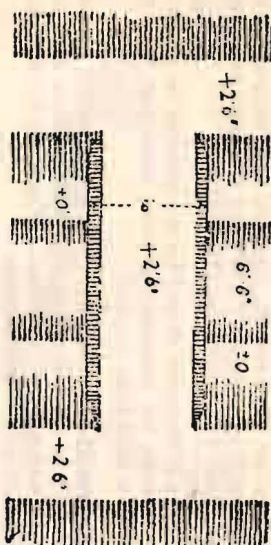
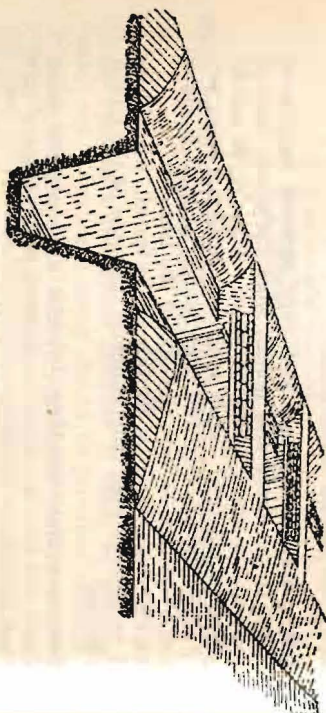
5. **Bridge traverses.**—Long and very exposed lengths of trench can be protected and hidden from the direct view of the enemy by the use of bridge traverses. Figs. 35, 36 and 37 show a bridge traverse. They must not be higher than any other part of the parapet and their weight should be taken on wooden uprights let into the side of the trench.

If the traverse is built on the side of the trench, without its weight being supported independently, the side of the trench will collapse.

6. **Defence against bombing.**—Special arrangements must be made to prevent the enemy's bombers making their way down communication trenches.

Where a communication trench projects from a fire trench towards the front, there should be a straight portion for the

BRIDGE TRAVERSE

FIG. 35
ELEVATIONFIG. 36
PLANPERSPECTIVE SKETCH
FIG. 37

METHODS OF DEFENCE OF COMMUNICATION TRENCHES

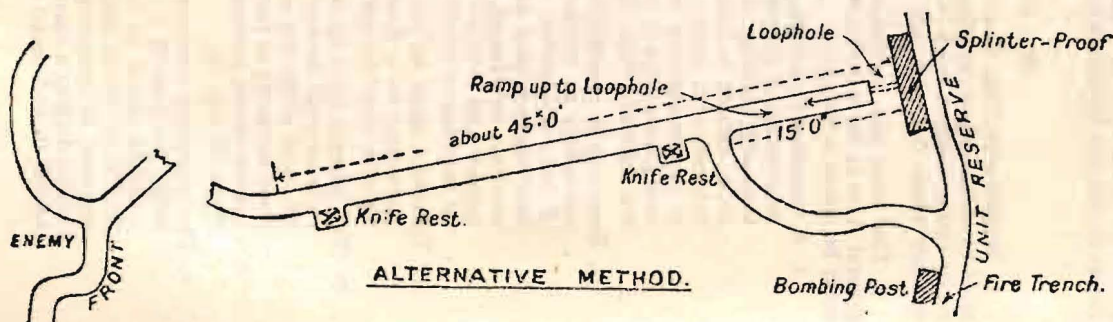
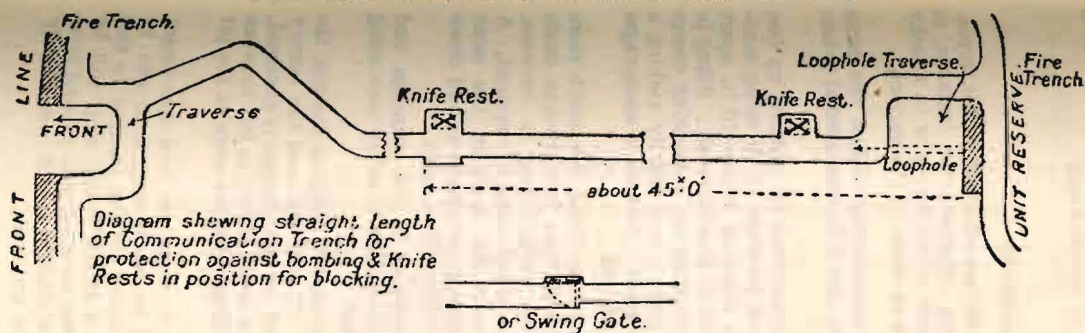


FIG. 38.

first 45 yards, and arrangements must be made for rifles or a light automatic gun to fire down this "straight" (Fig. 38).

The straight piece of the trench must be wired on both sides, and some obstacle, such as a knife rest, which can be pulled down as required, must be provided and placed in a recess at the side of the trench or on the berm.

30. Breastworks

1. Breastworks (Figs. 39 and 40) are made when it is impossible to obtain cover by digging trenches; for instance, in rocky country where there is little or no earth, or in marshy country where the water lies on or close to the surface.

2. The trace and profile of breastworks follow the same general rules as for trenches, but the following special points must be borne in mind:—

- i. A breastwork may be constructed by putting up two revetments of gabions or hurdles—or, if using sandbags, by building two sandbag walls—10 ft. apart (from outside to outside at ground-level); filling in between with earth; building up a bursting course of harder material in front; and finally making a very gentle slope to the front. Details of anchorages are shown in Figs. 39 and 40.
- ii. Breastworks constructed of sandbags are much more vulnerable to artillery fire than breastworks made of two revetments with earth-filling in between. Sandbags are used when silent work is required. A sandbag breastwork must be built in the same manner and with the same precautions as laid down for sandbag revetments (Sec. 32, 3, viii).
- iii. Traverses must be provided as in fire trenches, and there must be a firestep to allow of every man using his rifle over the parapet.
- iv. The parapet must be at least 3 ft. thick at the top, the exterior slope between $\frac{1}{2}$ and $\frac{1}{3}$, and the borrow pit, from which the earth for the parapet is obtained, must be traced so that a berm of 3 ft. is left between the toe of the exterior slope and the edge of the pit (Figs. 39 and 40).
- v. The necessary amount of cover for free movement along the line (6 ft. 2 in. as a minimum) can be obtained, either by building up the parapet to this height, in which case a raised firing step will be required, or by having the firing step at ground-level and by digging a narrow, shallow trench immediately behind it, and round the traverses.

BREASTWORK TYPE A
DEVELOPED FROM 3-FT. DEEP TRENCH OR DUG IN BELOW GROUND LEVEL AS FAR AS POSSIBLE

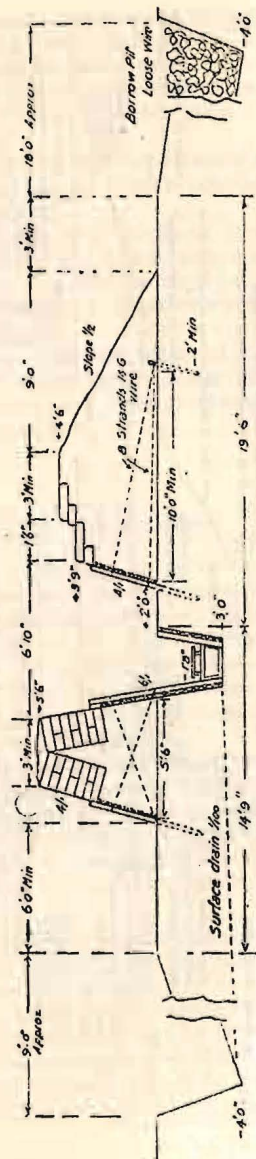


FIG. 39

BREASTWORK TYPE B

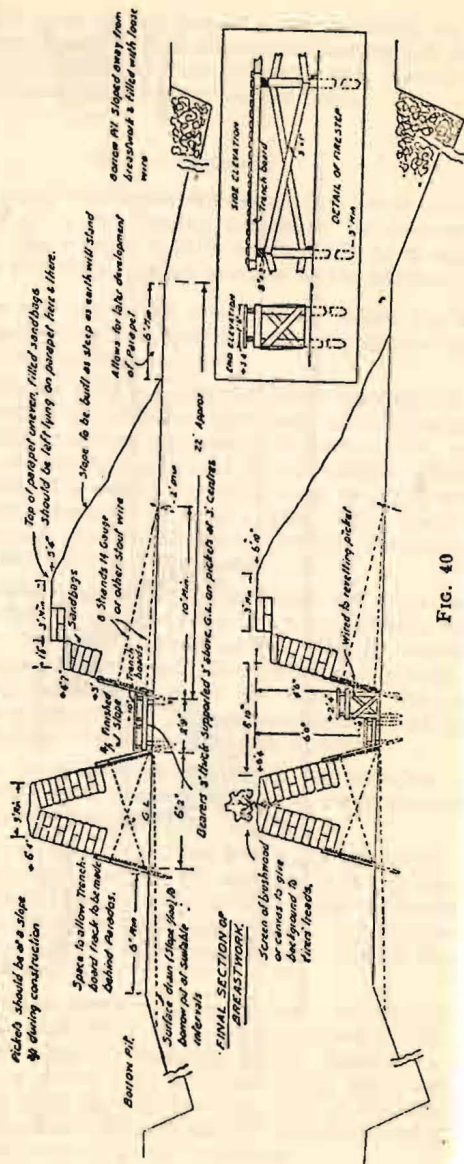
SECTION THROUGH FIRE BAY IN VERY WET GROUND WHERE NO TRENCH CAN BE DUG
FIRST STAGE.

FIG. 40

vi. A parados must be constructed to protect the garrison from the back blast of high-explosive shells. This parados should be bullet-proof (3 ft. thick) at its top and strongly revetted on both faces. It should be as high as or slightly higher than the parapet.

vii. The space between the breastwork and the parados should if possible be trench-boarded, and drainage must be provided.

A path paved with bricks or trench-boarded just behind the parados is a great convenience. It should communicate with the fire bays by openings through the parados behind at least every other traverse.

viii. If shelters for men are required these must on no account be constructed under the parapet, but behind the parados. Each shelter so constructed will require a parados of its own.

31. Light shelters

1. Small shelters (Fig. 41), to give protection against shrapnel and splinters, can be constructed without a great expenditure of labour and materials. This protection is given by 12 in. to 2 ft. 6 in. of earth. It is unnecessary to have more than this amount as an earth cover is not shell-proof unless some 20 to 30 feet is used, and any thickness much less than this and more than 2 ft. 6 in. only increases the explosive force of the shell which may penetrate it.

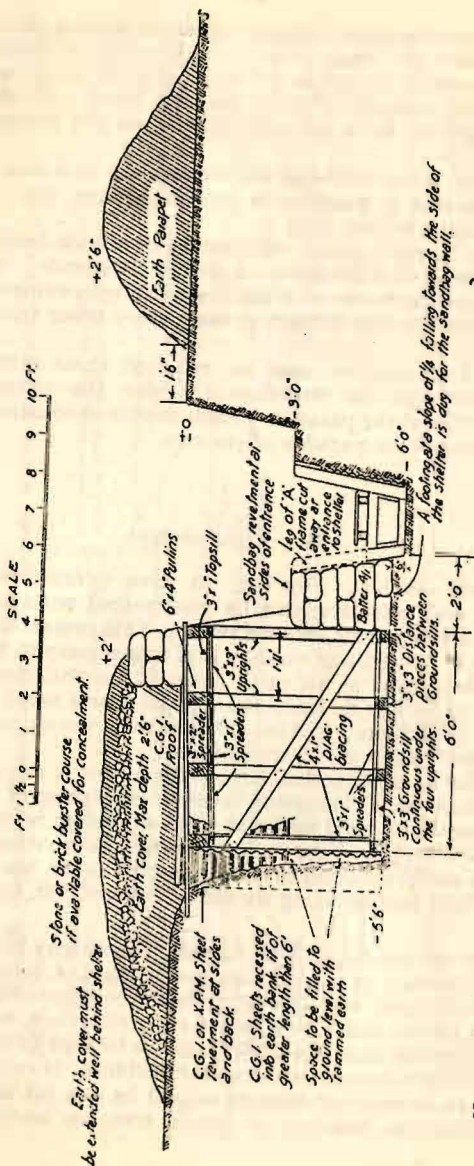
In order to cause a shell to explode before it can penetrate the earth cover, a "bursting course" consisting of a layer of 9 in. of hard non-rigid material (such as broken bricks, stones, etc.) is laid on top of the earth covering. A bursting course is always a useful addition to shrapnel-proof cover, but the depth of the whole roof covering should not exceed 2 ft. 6 in.

2. The earth cover with its bursting course may be supported on a framework of wood (described in para. 4 below).

The earth cover may also be carried on corrugated iron sheets, hurdles, planks, etc., laid across a revetted trench, but fire and communication trenches should not be treated in this way as they quickly become blocked under shell fire. If such overhead protection is required recesses should be dug off the fire and communication trenches or special trenches leading off the latter.

EXAMPLE OF A SPLINTER-PROOF TRENCH SHELTER

(IN A COMMUNICATION TRENCH)



NOTE.—Purlins are designed for a 6-ft. width of shelter. Two 3-in. \times 3-in. uprights are fixed between the purlin and bottom 3-in. \times 3-in. distance piece at the back of the shelter at 1-ft. 11-in. centres, to support the back revetment.

FIG. 41

3. The following covers have been used with success against shrapnel :—

- i. 12 in. to 1 ft. 9 in. of earth with bursting course, 9 in. thick, of broken brick supported on C.I. sheets, hurdles or planks, resting on a wooden frame.
- ii. 2½ ft. of earth supported on a layer of 8 in. logs resting on a wooden frame.

4. General construction points.—Shelters intended to be shrapnel-proof are generally made on the "cut and cover" principle; an excavation being made in which the shelter is built and then covered up. No roof, whatever its resistance to penetration, is of any value unless it is supported on a properly designed structure.

This should be in the form of a box braced in every direction, as the dug-out must be strong enough to stand the concussion of shells bursting a few yards away, even though the roof is only splinter-proof.

The essentials are :—

- i. Strong sides and roof.
- ii. Sides must be prevented from collapsing inwards by being strutted apart top and bottom.
- iii. The whole box must be prevented from distortion by diagonal bracing on the sides and end.
- iv. Sills or bearing plates must be placed under the uprights supporting the roof to prevent them sinking into the ground.
- v. The shelter must be rendered weatherproof by including in the roof a layer of corrugated iron or similar material, graded to throw off water. When corrugated iron is used any nails should be driven through the ridges and not through the valleys of the corrugated iron.

In addition, water must be prevented from draining into the dug-out.

Where the dug-out is made off a trench this can best be effected by making the floor of the dug-out about 6 in. above the bottom of the trench.

5. Hints on the use of timber for framework of shelters.—The following points should be observed :—

- i. Beams must be laid on edge to obtain the full strength.
- ii. In covering a given area beams should be placed across the shortest span.

- iii. If there are any large knots in the beams they should be placed uppermost and not on the underside of the beam.
- iv. Heavy weights must not be taken by nails or on an unsuitable support such as sandbags.
- v. The best upright is the natural pit prop. When round timber is not used, uprights should be as nearly square as possible in section and one side should never be less than five-eighths of the other.
- vi. Uprights must rest on a footing or ground sill, usually a thick plank, to distribute the pressure, or they will sink into the ground when the weight comes on.
- vii. Measures must be taken to prevent uprights being forced in sideways by earth pressure or shell bursts; both the heads and feet must be secured. When round uprights are used they can be notched not more than $1\frac{1}{2}$ in. into the roof supports. When square timber is used the heads and feet should be kept apart by a spreader nailed on; cleats are useless. Notches must on no account be used.
- viii. Saw cuts must not be too deep and more must not be notched out than is necessary.
- ix. An upright must be provided to support a beam wherever it is crossed by a purlin.
- x. Timbers of small scantling, e.g. 4 in. by 1 in., 3 in. by 3 in., etc., cannot be expected to carry more than light splinter-proof cover.
- xi. Economy in timber is essential, and heavy timbers, e.g. 9 in. by 3 in., etc., should not be used when a smaller size will suffice.

6. **Dogs.**—When fastening heavy timbers together, dogs and spikes must not be driven within 3 in. of the edge or 4 in. of the end of the timbers; dogs must be placed on both sides of the frame. Auger holes must be bored for spikes or the latter will split the timbers.

PART VIII.—MAINTENANCE AND REPAIRS

32. *Revetment*

1. **Object.**—The object of revetment is primarily to prevent the sides of trenches falling in.

Unrevetted trenches which are exposed to bad weather, or to even moderate shell fire, will soon collapse.

2. **Materials.**—

i. Revetment requires materials such as pickets, brushwood, planks, hurdles, corrugated iron. When these are not issued, local material should be used.

ii. In this section the use of revetment with store materials is explained, and although these are not always obtainable, men who are practised in their use will be able quickly to apply the principles to the use of any local material which may be available in the field.

iii. In revetment work there are two parts to consider :—

(a) *Firesteps*, or lower part of a trench.

(b) The *upper* part of a trench.

iv. *Firesteps*, or lower part of a trench. Ordinary brushwood packed behind pickets, or brushwood hurdles, planks, sheets of corrugated iron or expanded metal hurdles, supported by pickets or small "A" frames are used.

Sandbags should not be used for making or revetting the firestep, as they become very slippery in wet weather.

"A" frames with a trench board on top, as shown in section of a fire trench in Fig. 16, make the best revetment, as they make it easy to drain the trench.

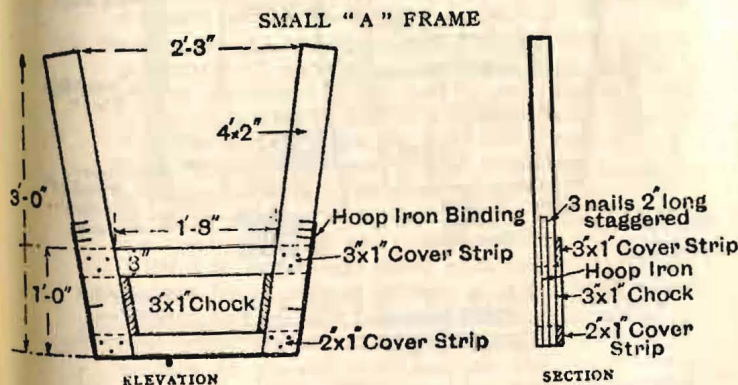


FIG. 42

"A" frames will seldom be available except in protracted defence.

Whenever material like brushwood is used torevet the firestep, a plank or pole should be fixed to the top of the pickets, on the edge of the step, to prevent men from treading down the edge of the revetment.

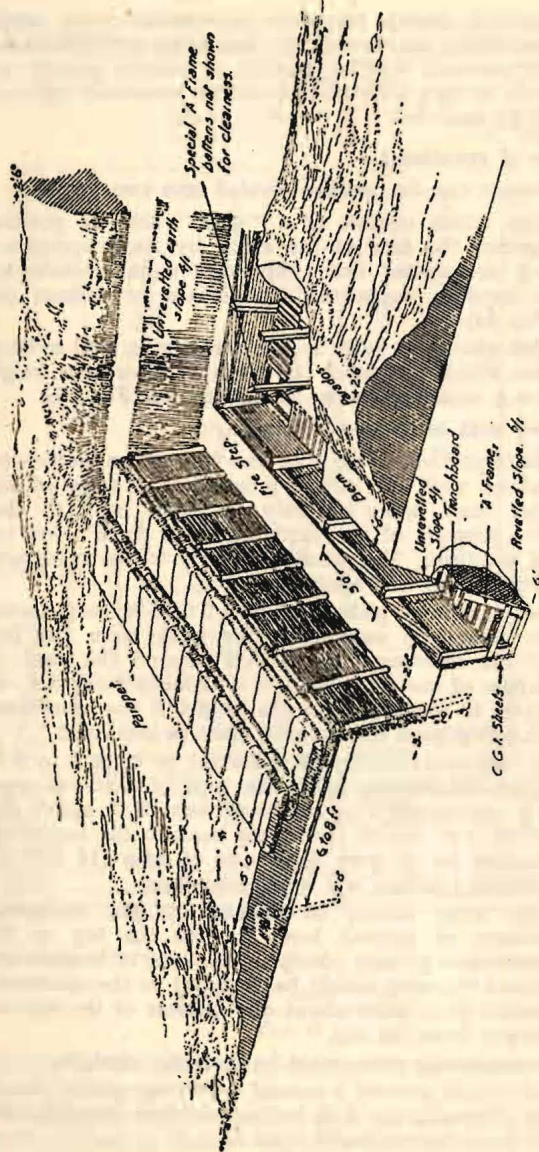


FIG. 44

- (g) Anchorage pickets should, as a rule, be driven in or laid at right-angles to the line of pull.
- (h) Screw pickets when used as anchorages should, on the contrary, be screwed in, in prolongation of the line of pull.

iii. *Brushwood* when used in the upper part of a trench should not be made into hurdles, but should be pressed down behind the pickets. Care must be taken that the ends break joint so that the end of one piece of brushwood does not come over the end of the piece below. The leaves and twigs of the brushwood should be removed before being used.

iv. *Brushwood hurdles* will, like other hurdles, be used only for the lower part of the trench. They must be placed behind the pickets, as described above. It is not sufficient to anchor back the pickets of the hurdles themselves. Planking can be used, but not in places where it is likely to be hit by shells.

v. *Corrugated iron* makes the neatest and strongest revetment, but it should not be used in the upper half of the trench, as when cut with shell fire it is not easy to remove. The sheets should overlap at the ends for at least 3 in.

In very wet ground holes should be made in the sheets, to act as "weep" holes for the water to drain through.

vi. *Expanded metal hurdles* make a good revetment. They are 6 ft. long and are placed touching only, not overlapping.

Pickets must, therefore, be 3 ft. apart and the hurdles should be tied to them with wire. The XPM, and not the woodwork, should be placed against the earth.

vii. "A" frames and sheeting or brushwood:—

- (a) "A" frames are used for supporting the revetment of the bottom half of a trench, as when revetting the firestep. A small "A" frame is shown in Fig. 42.

About 1½ in. clear is required on each side of the "A" frame in which to put the revetment.

- (b) Revetment with "A" frames has to be carefully done. All the frames must be vertical and at the same level, or on an even, regular slope.

The distance apart of revetment pickets and "A" frames depends on the stiffness of revetting materials used; in ordinary ground they should be from 2 to 3 ft. apart when hurdles or brushwood are used.

There must be an "A" frame wherever two of the sheets used for revetment meet, and an "A" frame at the middle of each sheet. There must also be an "A" frame wherever the trenchboards

meet. Trench-boards and XPM hurdles fit together well. The XPM hurdles should be placed touching each other and should not be overlapped. They must be tied by wire to every "A" frame.

- (c) Corrugated iron sheets are usually more than 6 ft. long, but they can be made to fit by making them overlap as necessary.

The joints of XPM hurdles and corrugated iron sheets on one side of the trench must be exactly opposite, or exactly half way between, the joints on the other side, so that the "A" frames may support them properly.

- (d) When the "A" frames have been put in and have been proved to be straight and level, the sheets should be put in and pressed down, so that their bottom edge goes right down to the bottom of the "A" frames. Earth must then be poured in behind the sheets and must be rammed hard with pick handles.
- (e) Corrugated iron sheets are generally less than 3 ft. broad, and planks may then be nailed to the "A" frames above the sheets on the side of the firestep, and also, if available, on the other side of the trench, to bring the revetment up to the right height.
- (f) In turning the right-angled corners of a traverse with "A" frames, it is usual that the "A" frame be placed diagonally across the corner so that the trench-boards will be properly supported.

Two ordinary "A" frames can be nailed together with their transoms level, the outer legs being the width of the corner apart and the inner legs cut off at transom level, to form the wide "A" frame required diagonally across the corner (Fig. 45).

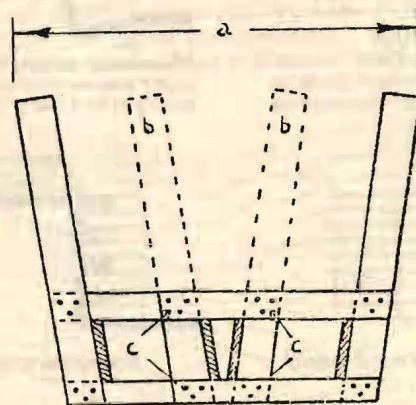
viii. Sandbag revetment:—

- (a) For revetments, except in the case of damaged parapets, or when silent work is essential, sandbags are expensive, rot quickly and require constant attention.
- (b) Sandbags should be filled as described in Sec. 4, 7.
- (c) The formation, which should be on sound ground, must be sloped at right-angles with the face, as shown in Fig. 46, i.e. at a slope of 1/4.
- (d) The sandbags are then laid in one course with their long sides at right-angles to the wall, and in the next course parallel to the wall, and so on.

Those at right-angles are called "headers" and the others "stretchers."

- (e) Headers must be laid with their mouths or chokes inside the wall and stretchers with the seam of the bag inside the wall.

The first course at the bottom of the wall should always be made of headers, the next course must be stretchers and so on. The joints in each course must not be over the joints in the course below. Unless the bags "break" joint—the wall has no strength. The top course must always be of headers.



(a) Width diagonally across corner of trench.

(b) Two inner legs cut off.

(c) "A" Frames nailed together.

FIG. 46

- (f) Fig. 46 shows how a sandbag revetment should be built and the kind of mistakes which are often made.

- (g) When a corner is turned, some of the bags must be filled less than normal in order that the correct bond may be obtained.

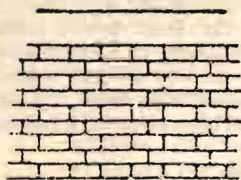
Fig. 46A shows how a right-angled corner may be built.

The bags marked "A" must be three-quarters as long as a normal "stretcher," i.e. 15 in.

The bags marked "B" must be half as long as a normal "stretcher," i.e. 10 in.

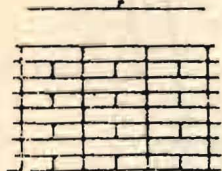
SANDBAG REVETMENT

ELEVATION

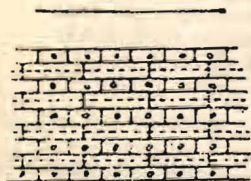


Correct
English Bond
Seams and Choked Ends on
Parapet Side of Revetment.

Parapet



Wrong (Joints not Broken)

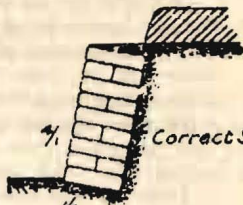


Wrong (Seams and Choked
Ends of Bags outward).

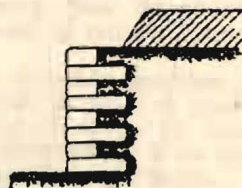


Wrong (all Stretchers and no Headers).

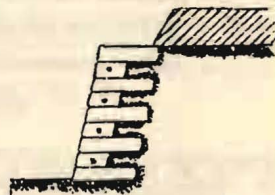
SECTION



Correct Section
Foundation should be cut at
right angles to slope and always
brought to a solid bottom.



Wrong (Vertical)



Wrong (Bags not at Right Angles
to Slope).



FIG. 46

- (h) The party for filling sandbags should consist of three men; two men hold and tie the bags while one man shovels the earth into them.

Three men can fill 90 bags in an hour.

For building the men work in pairs, and one pair can lay 90 sandbags in one hour.

- ix. Sods (Sec. 4) should be laid in the same way as sandbags, grass downwards, except for the top layer which should be laid with the grass upwards. If available split pickets should be driven, at intervals, through the sods to hold them in position and so strengthen the revetment. Sods are laid at a slope of 3/1, whereas sandbags will stand firmly at 4/1.

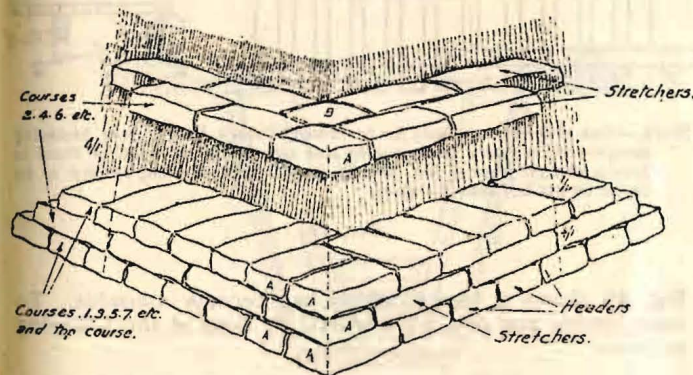


FIG. 46A.

4. Use of trench-boards.—Trench-boards may be laid on the transoms of "A" frames (Fig. 30) or on trench trestles (Fig. 29). They must be supported in the centre and at each end in such a way that there is no danger of their tipping up when a man stands on the end of the trench-board. Particular care is required in laying them at the corners of trenches.

Trench-boards should not be fastened to one another nor to their supports as they must be removable so that the trench below them may be cleared of debris.

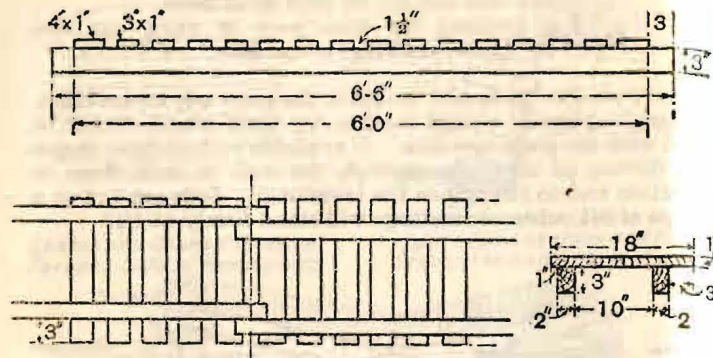
The dimensions of a trench-board are shown in Fig. 47.

33. Repairs to trenches

Trenches if not well looked after, or if left unoccupied, will often become unusable from rain and lack of proper drainage.

TRENCH-BOARD

ELEVATION



NOTE.—One of the best methods for preventing Trench Boards from becoming dangerously slippery when muddy and wet, is for each slat or tread to have a straight piece of No. 10 S.W.G. wire fastened along the top of its centre by not less than 6 staples.

FIG. 47

Fig. 48 shows a trench which has become unusable. To make usable and dry, work should be done in the following order:—

- i. Dig back the parapet on both sides so as to leave berms 3 ft. broad (a pick's length).
- ii. Widen out the top of the trench to 6 ft.
- iii. Slope the sides down to the bottom.
- iv. If the mud of the bottom is sticky and difficult to get out, leave it in. Put in the "A" frames, pushing them down into the mud as far as possible, and lay the trench boards on them as in Fig. 49.
- v. Clear the mud from between the "A" frames so as to get a good drain right along the trench.
- vi. Deepen the trench and revet it, being careful to leave a 9-in. berm at the top of the "A" frames, as shown in Fig. 50.

METHOD OF REPAIRING A TRENCH

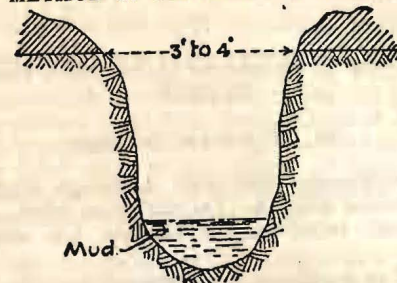


FIG. 48

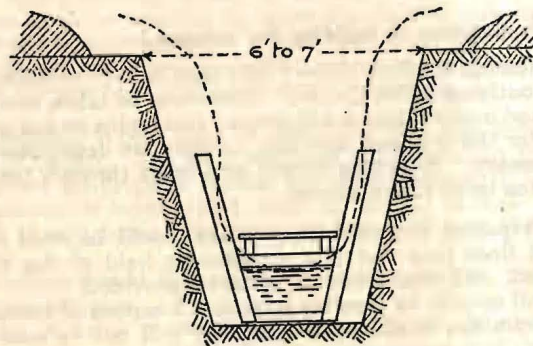


FIG. 49

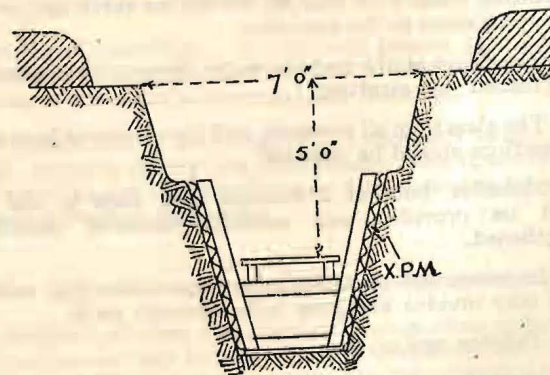


FIG. 50

PART IX.—MISCELLANEOUS PROTECTIVE WORKS

34. *Defence of buildings*

1. **General.**—Strong, well-built buildings may prove of great value to the defence. On the other hand, poorly built houses without cellar accommodation are seldom worth holding.

The fact that buildings are occupied and the method of their defence must be concealed so far as possible from enemy observation.

2. *Preparation of building for defence.*—

i. Clearing the field of fire: this may include demolitions of walls, outlying buildings, etc. Care must be taken that when walls and outbuildings are destroyed their ruins do not provide cover for the attackers and that no more are demolished than is necessary. Knocking broad, low holes through the walls will often be all that is needed.

ii. Preparing fire positions: these should be sited on the ground floor provided that a sufficient field of fire can be obtained. All round defence must be provided.

It will usually be possible to mount weapons in rooms well back from the windows so that they will not be seen from outside.

Furniture filled with shingle, rubble, or earth can be used to give protection to the defenders.

iii. The floors above and below the fire positions should be strengthened by strutting.

iv. The glass from all windows, and the plaster ceilings above fire positions should be removed.

v. Obstacles, both at a distance and close to the walls should be provided and existing obstacles should be strengthened.

vi. Improvement of communications within the building, which may involve knocking holes through walls.

vii. Defence against gas.

viii. Arrangements for storing ammunition, food and water.

ix. Sanitary arrangements and arrangements for wounded.

x. Supply of water and earth for putting out fires.

3. **Doors and windows** can be blocked up by nailing planks or corrugated iron on both sides and filling the space between with broken stone at least 9 in. thick. Instead of boards and shingle, the windows or doors may be blocked with a wall of sandbags filled with broken stone. If this is done to a window of an upper storey it will be necessary to strengthen the floor from below with wooden props.

4. **Loopholes** may be required. Loopholes should be made as far as possible in the doors and windows so as not to weaken the walls.

The small opening should be to the front. It should be kept as small as possible to cover the field of fire required and should be camouflaged. The interior of the opening should be darkened for concealment and the muzzle of the weapon should not protrude unless absolutely necessary.

5. **Cellars.**—When time is available, full use should be made of cellars. The first essential is to shore up the roof with stout pit-props or frames sufficiently strong to support any protective layer which may be added, as well as the weight of any debris which may be dislodged from the upper storeys.

All cellars should, if possible, have two entrances, protected with gas curtains.

Roofs of brick or concrete will usually be splinter-proof in themselves, but the ordinary timber joist and boarded roof will require the addition of a protective layer as described in Sec. 31.

Shell-proof protection. In well-built houses, existing walls or roofs act as bursters, and as these are knocked down the covering of the cellar is automatically increased.

6. **Weapon pits or shell slits** will be necessary to give cover to the garrison during the preliminary bombardment, and as alternative fire positions for use if the house is set on fire or made otherwise untenable.

35. *Defence of hedges, walls, embankments and cuttings*

1. **Hedges.**—Hedges and lines of bushes often make good fire positions, as they hide the parapet from the enemy's view. It is most important to conceal the fact that a hedge is

occupied. For this reason the back of the hedge must be thinned in such a way that the upper branches remain as a screen against air observation: the front of the hedge must be cleared in such a way that, though the defender can see and fire through it without being seen, the foliage or branches hide the earth which has been excavated and thrown to the front to make the parapet. The front of the trench must be close to the centre of the hedge, so that its thick stems interfere with the firer as little as possible.

If a ditch is on the enemy's side of the hedge, excavated earth can be thrown into it and then covered with the trimmings of the hedge.

A hedge constitutes a good target and it is often preferable, rather than holding a hedge itself, to site a fire trench in front or in rear of it.

2. Walls, if held, should not be fired over, but loopholes made. Some sort of roof may be required for protection against falling bricks.

3. Embankments and cuttings.—

i. Fire positions can be made in embankments and cuttings by digging T-heads or D-heads (Fig. 28, ii).

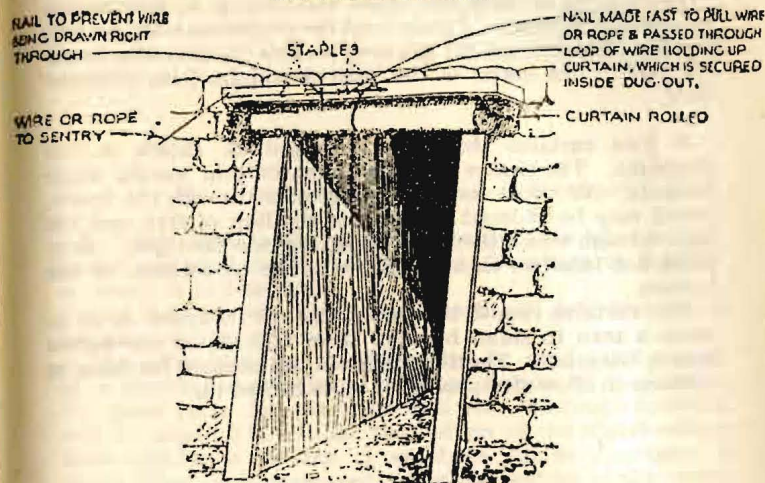
ii. It is not sufficient to dig a fire step in the slope of a cutting, as firers would in this position be exposed to damage from shells passing over their heads and bursting against the rear slope of the cutting. The trench must be dug well outside the cutting and must be joined to the cutting by short communication trenches.

36. Defence against gas

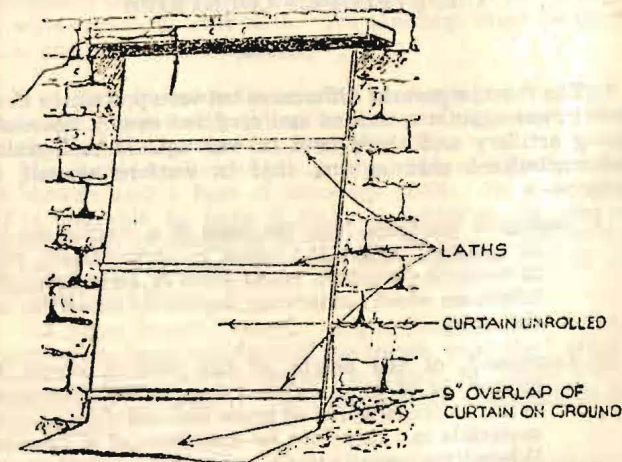
1. The entrances to all shelters should, if possible, be provided with gas-tight doors or with curtains of anti-gas material, fitted so as to give a good joint at the sides and bottom of the doorway, thus stopping all draughts. If two curtains are used, with a space between them, complete protection is obtained, and it is possible to enter or leave the shelter without introducing appreciable quantities of gas.

2. A frame of 4-in. by 1-in. timber (Fig. 51), covered with anti-gas material, is fixed flush with the wall, sloping outwards at an angle from the vertical. Anti-gas material is cut to the required size, so that when fastened to the top of the frame it will close the entrance completely, with about 9 in. resting on the ground.

GAS-PROOF CURTAIN



I.—OPEN



II.—CLOSED AFTER THE SENTRY HAS PULLED THE WIRE OR ROPE

NOTE.—The laths should be fastened in pairs, one on the front and one on the back of the curtain. Those on the back should be shorter than those on the front to allow for the curtain lying close against the wooden frame.

The lowest laths should be four inches above the ground.

FIG. 51

Three pairs of laths are nailed horizontally to the curtain to keep it stretched. The lath on the underside must be 1 ft. shorter than the one on the front, so as to clear the frame (Fig. 51). The lowest of the laths should be 4 in. from the floor.

3. Two curtains should be provided as shown in the diagrams. The frame for the inner curtain should slope inwards. All wires and pipes must pass through the frame, which may be widened on one side to allow of this, and the hole through which they pass must be made gas-tight. They must not interfere in any way with the adjustment of the curtain.

The curtains should be not less than 3 ft. apart, so as to allow a man to stand between them and adjust one before raising the other. The distance must be increased for dressing stations to allow stretcher cases to be carried in.

PART X.—PROTECTIVE WORKS IN WARFARE IN UNDEVELOPED COUNTRIES

37. General

1. The most important differences between protective works used in war against a trained and civilized enemy possessing strong artillery and those used in war against unorganized and uncivilized enemies are, that in warfare against the latter :—

- i Defensive positions take the form of a continuous line of defences round the camp or cantonment, with, in mountain warfare, small posts or forts occupying hills from which, otherwise, the enemy could fire into the camp.
- ii. Command, or the height of the parapet above the ground, is of more importance than concealment. Walls or breastworks of stone and other bullet-proof materials can therefore be used instead of trenches. When time permits their construction, small forts or blockhouses are frequently used.

2. The kind of works to be used and the materials to be employed will often be suggested by the customs of the people of the country. Thus, use is made on the N.W. Frontier of

India of stone sangars and stone or mud forts ; in Burma and Assam, of stockades or walls of trees or bamboos ; in Africa, of breastworks of sand surrounded with an obstacle made of thorn bushes, called a zariba.

38. Construction of defences in the desert

1. These notes apply especially to defences sited in soft desert and sand dunes, when the sand, as regards fluidity, is nearly as bad as water.

Fire trenches which are half trench and half breastwork are generally necessary.

The sides of a trench constructed in sand must consist of a continuous revetment from the bottom of the trench. To make room for the front and rear sandbag revetment and to obtain 3 ft. 6 in. at the bottom of the trench which, after making a firestep of sandbags, leaves a passage of about 18 in., it is necessary to dig the bottom of the trench 6 ft. 10 in. broad (3 ft. 6 in. plus twice 1 ft. 8 in.). The best revetment to use is one of sandbags, although it means digging a wide trench to start with. All sandbags must be doubled (i.e. one inside the other).

2. A five hours' task consists of digging a "scoop" or hole 3 ft. deep and building in it a sandbag revetment 3 ft. high along the front of fire bays (Fig. 52).

Men should be divided into groups of 10, each party carrying 8 shovels and 1 bale of sandbags (200). As a precaution it is desirable to have 2 picks in addition, in case hard patches are encountered below the surface. Each group is given a frontage of 10 paces, with intervals of 5 paces between groups.

1st Stage (about 1 hour). Eight men excavate, throwing sand to the back and front of the trench, until the "scoop" is within 6 in. of the bottom of the trench, i.e. about 2 ft. 6 in. below original surface. Two men double the sandbags ready for filling.

2nd Stage. Commence filling doubled sandbags and continue excavating till trench is 3 ft. deep.

3rd Stage. Two men laying, 2 men carrying, 6 men filling. The sandbags should be laid to a slope as steep as will ensure the stability of the revetment. If anchored back a slope of

APPENDIX I

Details and calculations of men, time and tools required for the execution of certain field works.

This detail is divided into:—

Part I: Details of tasks by individuals or by "units" required for work.

Part II: Simple figures showing work to be expected from a platoon of infantry.

PART I.

NOTE.—Tasks given in this table are those which can be expected from average trained infantry working parties under the following conditions:—

- i. All tracing and marking out done beforehand, and materials dumped at site.
- ii. Work carried out by day, or on a moonlight night.
- iii. It is not raining.
- iv. March to work does not exceed $1\frac{1}{2}$ hours.

In conditions less favourable tasks columns 5 and 6 must be correspondingly reduced. Additional time must be allowed for concealing work or the task must be reduced accordingly.

Item No. (1)	Nature of work (2)	No. of workers (3)	Time (4)	Quantity (5)	Task per man per hour (6)	Tools for party (7)	Remarks (8)
1	Earthwork:— Excavation of trenches— i. In soft, sandy ground.	1	1 hr.	30 cu. ft.	30 cu. ft.	1 pick and 1 shovel.	i. The tasks given in col. 5 allow for the earth being thrown out of a trench, 4 ft. deep, to a distance of 8 ft., or, for throwing earth upwards to a height of 8 ft. When earth has to be thrown farther than this, one shoveller should be added for every two diggers.
		1	4 hrs.	90 cu. ft.	—	1 pick and 1 shovel.	

	ii. In medium ground, i.e., ground of average consistency for digging, or soft ground with stones or small roots. iii. In hard ground or medium soil with stones and roots.	1	1 hr.	20 cu. ft.	20 cu. ft.	1 pick and 1 shovel.	ii. When the depth of the trench is more than 4 ft. one shoveller should be added for every two diggers, to clear berms and make up parapet and parapets to correct shape. iii. Sticks to clean shovels in wet clay. Crowbars for rocky ground. Hand axes or bill-hooks for cutting roots. Spare pick handles, etc., must be provided when required by the nature of the ground.
		1	4 hrs.	60 cu. ft.	—	1 pick and 1 shovel.	
		1	1 hr.	15 cu. ft.	15 cu. ft.	1 pick and 1 shovel.	
		1	4 hrs.	40 cu. ft.	—	1 pick and 1 shovel.	
2	Shovelling earth already excavated.	1	1 hr. 4 hrs.	40 cu. ft. 120 cu. ft.	40 cu. ft. —	1 shovel. —	Allows for 10 ft. horizontal throw.
3	Excavating earth and loading into wheelbarrows, stretchers, or baskets.	1	—	As under Serial No. 1.		No. 1.	Spare wheelbarrows, etc., must be available, so that the digger can fill one while the carrier is emptying the other.
4	Moving earth 25 yds.; depositing and returning:— i. In wheelbarrows.	1	2 mins.	1 cu. ft.	30 cu. ft.	2 wheelbarrows.	i. If the distance from the work to the dump is more or less than 25 yds., increase or decrease the time and task accordingly.

NOTE.—When scarping natural slopes as in construction of hill roads or in making tank obstacles add 25 per cent. to quantities in items 1 i, ii and iii, above.

Item No. (1)	Nature of work (2)	No. of workers (3)	Time (4)	Quantity (5)	Task per man per hour (6)	Tools for party (7)	Remarks (8)
	ii. In baskets. iii. In sand-bags (see below).	1 1	2 mins. 4 hrs.	$\frac{1}{4}$ cu. ft. 40 cu. ft.	10 cu. ft. 10 cu. ft.	2 baskets. 2 sand-bags.	ii. In calculating the distance add 5 ft. for each foot of climb for wheelbarrows and $2\frac{1}{2}$ ft. for each foot of climb for stretchers and baskets. iii. Planks are required to make roads for wheelbarrows. iv. Wheelbarrows cannot climb a steeper slope than $1/8$, or baskets and stretcher men a steeper slope than $1/4$.
5	Revetments :— Sand-bag revetments : i. Filling sand-bags.	3	1 min.	1 bag.	20 bags.	1 shovel.	i. Two men holding and tying; one man shoveling. ii. Sandbags to be three-quarters filled (holding $\frac{1}{4}$ cu. ft.). iii. In calculating tasks for carrying bags calculate distance as for carrying baskets in notes i. and ii. above.

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Revetments :— ii. Carrying sand-bags 25 yds.; dumping and returning.	1	2 mins.	1 bag holding $\frac{1}{4}$ cu. ft. of earth.	30 bags.	—	iv. Builders work in pairs when possible. v. 1 sq. ft. of revetment means 1 sq. ft. measured on the outer face of the sand-bag wall. For example: A revetment 10 ft. long and 4 ft. high = $4 \times 10 = 40$ sq. ft., and would take 1 pair of builders $2 \times 40 = 80$ mins. and would require 120 sand-bags.
iii. Building sand-bag revetment.	2	2 mins.	1 sq. ft. of revetment, i.e. 3 filled bags.	15 sq. ft. = 45 bags.	1 beater.	vi. A beater may be either a special wooden beater a bill-hook or shovel.
iv. Sod revetment : (a) Cutting sods. (b) Carrying sods to site, etc. (c) Building sods.	3	3 mins.	5 sods. See items above.	33 sods.	3 sharp spades.	vii. Size of sod $18 \times 9 \times 4\frac{1}{2}$ ins. 1 sod to be taken as $\frac{1}{4}$ cu. ft.
	2	3 mins.	1 sq. ft. of revetment.	—	1 shove or spade. 1 hand-axe	viii. Allow 5 sods each $18 \times 9 \times 4\frac{1}{2}$ in. for each sq. ft. of surface revetted 18 ins. thick.

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Item No. (1)	Nature of work (2)	No. of workers (3)	Time (3)	Quantity (4)	Task per man per hour (6)	Tools for party (7)	Remarks (8)
6	Sheeting and picket revetment.	10	30 mins.	10 ft. run.	—	2 mauls or sledge-hammers. 2 shovels. 1 pick. 1 hand-saw. 1 hand-axe or dah. 1 pair pliers. 1 crowbar (in rocky soil).	i. Sheeting consists of corrugated iron sheets, XPM hurdles, brushwood hurdles, planks or loose brushwood. ii. Distribution of working party:— 2 men driving anchorage pickets. 2 men driving revetment pickets. 2 men placing sheeting. 2 men wiring pickets. 2 men trimming and filling.
7	Sheeting and "A" frames.	7	30 mins.	10 ft. run of trench	—	2 picks. 2 shovels. 2 mauls. 1 hand-saw. 1 hammer. Nails.	i. Time given does not include digging out trench to full section. ii. Sheeting consists of corrugated iron sheets, XPM hurdles, brushwood hurdles, planking or brushwood.

							iii. For each corner add 10 mins. iv. Distribution of parties: 2 men supply materials. 3 men placing frames and sheeting. 2 men trimming and packing. v. Allow 4 lbs. of brushwood per 1 sq. ft. revetted.
8	Laying trench-boards on "A" frames.	3	10 mins.	10 ft. run of trench.	—	1 saw. 1 hammer. Nails.	i. Add 10 mins. for each corner. ii. 2 men laying and fitting 1 man supplying material.
9	Picket trestles and laying trench-boards on same.	5	10 mins.	6 ft. run of trench boarding.	—	1 maul. 2 hand-saws. 2 hammers. Nails.	i. Pickets distributed on site. ii. Trestles at 3 ft. intervals.
10	Making brushwood hurdles.	3	20 mins.	1 hurdle.	—	2 billhooks. hand-axes or matchets 1 pair of pliers.	75 lbs. of brushwood.

Item No. (1)	Nature of work (2)	No. of workers (3)	Time (4)	Quantity (5)	Task per man per hour (6)	Tools for party (7)	Remarks (8)
11	Making fascines.	1	1 hr.	1 fascine.	—	3 billhooks, hand-axes or matchets 1 hand-saw. 2 knives, 1 pair of pliers, 1 maul. 1 fascine choker.	<p>i. The fascine is described in Sec. 4. A fascine choker consists of two stout wooden handles, 4 ft. long connected by a 2 ft. length of chain. One end of chain is fastened to each handle at a point 18 ins. from one end of the handle.</p> <p>ii. The frame on which fascine is made is assumed to have been prepared.</p> <p>iii. The materials required for a fascine 18 ft. long and 9 ins. in diameter are :— Brushwood, 200 lb. Wire, 60 ft. For making the frame. 10 pickets 6 ft. 6 in. long and 3 in. in diameter, are required.</p>

12	Felling trees.	1	1 min.	1 in. of diameter of tree up to 12 ins. If over 12 ins. diameter allow time in minutes d^3 = — 144 where d = mean diameter in ins.	—	1 felling-axe or hand-saw.	<p>One man can fell a tree 9 ins. in diameter in 9 mins. If only hand-axes available time should be doubled.</p> <p>Over 12 ins. diameter time required is much greater. Hand-axe is not suitable for trees over 15 ins. in diameter.</p>
13	Cutting brushwood.	1	1 hr.	25 sq. yds.	—	1 hand-axe, bill-hook or matchet.	Diameter up to 2½ ins. About 5 lbs. brushwood per 1 sq. yd.
14	Loopholing brick-walls— Making loop-holes in brick walls up to 18 ins. thick.	1	30 mins.	1 loop-hole.	2 loop-holes.	1 pick or 1 crowbar.	<p>i. Add 50 per cent. to the time if in cement mortar.</p> <p>ii. A mason's hammer and chisel are the best for this work.</p>

Item No. (1)	Nature of work (2)	No. of workers (3)	Time (4)	Quantity (5)	Task per man per hour (6)	Tools for party (7)	Remarks. (8)
15	Bullet proofing doorway, 6 ft. wide.	3	4 hrs.	One	—	1 saw. 1 hammer. Nails.	Shingle between boards, to a height of 6 ft. 6 in. with box loophole.
16	Bullet proofing windows 3 ft. x 4 ft.	5	1 hr.	Two	—	1 shovel. Sand-bags.	Shingle in sand-bags, one loophole. If wall below and round window is not bullet-proof allow extra time as required. Three men fill and carry, 2 men lay, sandbags.
17	Gas proofing cellars.	1	5 hrs.	Each entrance.	—	1 saw. 1 hammer. Nails. 2 blankets. Bleach.	See Protection against Gas and Air Raids, Pamphlet No. 3.
18	Standard double apron fence.	1 N.C.O. and 10 men.	Day:— 30 mins. Night:— 45 - 60 mins.	50 yds.	—	1 pair of pliers. 10 windlass sticks. Gloves, if desired.	Stores for 50 yds. double apron fence:— 20 long pickets. 40 short pickets. 9 (65 yds.) coils of barbed wire. 2 (130 yds.) coils of barbed wire (for diagonals).

19	Wire tree-entanglement in thick undergrowth.	8	20 mins.	50 yds.	—	2 billhooks, hand-axes or matchets. 2 pairs of pliers. 5 65-yd. coils of barbed wire.	
20	Knife rest.	3	1 hr.	One	—	1 pair of pliers. 4 5-ft. pickets. 1 12-ft. pole. Plain wire (200 yds.). 1 130-yd. coil of barbed wire.	Knife rest 10 ft. long.
21	Standard triple barbed wire concertina fence, with screw pickets.	1 N.C.O. and 7 men.	17 mins.	50 yds.	—	1 pair wire cutters. 7 windlassing sticks. Gloves, if available.	i. For method of making the obstacle. ii. Stores for 50 yds. obstacle:— 9 barbed wire concertinas. 26 long screw pickets. 1 130 yds. coil barbed wire.
22	Standard triple barbed wire concertina fence, with angle iron pickets.	1 N.C.O. and 10 men.	30 mins.	50 yds.	—	As for 21 but for 11 men.	As for 21. Angle iron pickets and 2 sledge hammers required.

Item No. (1)	Nature of work (2)	No. of workers (3)	Time (4)	Quantity (5)	Task per man per hour (6)	Tools for party (7)	Remarks (8)
23	Laying and fuzing A.Tk. mines. i. Close spacing, e.g. road block. ii. Open spacing (10 rows) i.e. minefield 1,000 yds. long by 90 yds. deep.	3 50	10 mins. 1 hour	20 mines 1,000 mines.	40 20	— —	i. Assume that M.T. available for distributing the mines. ii. If mines are to be concealed or partially buried the tasks will take up to 2 or 3 times as long depending upon the circumstances, and the necessary tools must be provided. iii. The arming of Mk. 1 mines is not allowed for in these figures. One man can arm 8 mines (1 box) in 15 mins.

PART II.—TIME AND LABOUR FOR DEFENCES.

1. An infantry platoon, not in contact with the enemy, with a working strength of 30 men should be able to carry out the following work :—

1st 4-hour task .. Dig weapon pits (18), erect 450 yards wire obstacle by day (300 yards at night) if stores are dumped at 100 yards interval, and do some clearing of the field of fire.

2nd .. Dig 18 alternative weapon pits and 60 yards of crawl trench.

3rd .. Dig 150 yards of crawl trench.

4th .. Dig 150 yards of crawl trench.

Each subsequent 4-hour task—Deepen to 3 ft. depth 90 yards of crawl trench.

2. Digging tasks per man in average ground.

4-hour tasks :—

Weapon pit .. 6 ft. by 3ft. 6 ins. by 3ft. deep One.

Crawl trench.. 3 ft. 6 ins. by 1 ft. 6 ins. deep at centre 5 yards.

Trench .. 3 ft. 6 ins. by 3 ft. deep .. 2 ..

Trench .. 3 ft. 6 ins. by 3 ft. deep developed from crawl trench .. 3 ..

APPENDIX II
Table of Tools Carried by Certain Units in the Field
 (Excluding those allowed for machine gun or vehicle equipment.)

Designation.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	Remarks.
Weight complete in lb.		6	18		34	34	8	28	40	7	20	32	40		38	38	38	36	1	12	8		
Axes, felling	..	2 1/2	4		24	24	1	16	24	12	16	16	24		38	38	38	36	1	12	8		
" " hand	..	4	10		100	100	8	100	140	32	100	96	40		38	38	38	36	1	12	8		
" " pick..	..	20			24	24	1	26	38		100	96	40		38	38	38	36	1	12	8		
Crowbars	30													38	38	38	36	1	12	8		
Cutters, wire	..	200													38	38	38	36	1	12	8		
Hooks, bill..	..	1	18												38	38	38	36	1	12	8		
Machets	24	59												38	38	38	36	1	12	8		
Sandbags	24													38	38	38	36	1	12	8		
Saws, crosscut	..	33													38	38	38	36	1	12	8		
" " folding	..	1	15												38	38	38	36	1	12	8		
Shovels, G.S.	..	33	30												38	38	38	36	1	12	8		
" " hand	..	1													38	38	38	36	1	12	8		
Shovels, R.E.	..	33	30												38	38	38	36	1	12	8		
Spades	6													38	38	38	36	1	12	8		

*To be issued later.

APPENDIX III

Organization of Tracing Parties

1. The organization of a tracing party given below applies to taping fire trenches, but may be modified for other purposes. The party should be divided into groups as follows:—

- Fire bays.**—An officer and 1 N.C.O., with extra men as carriers. The officer traces out the fire bays, driving in pegs at the end of each; the shape of the ground must, of course, be borne in mind in selecting the fire bays.
- Traverses.**—An experienced N.C.O. and 2 men, with extra carriers if necessary. The N.C.O. pegs out the traverses.
- Clearing.**—A number of men, varying with the nature of the ground, to clear crops, bushes, etc., from the line of the tape.
- Taping.**—One N.C.O. with carriers for tape, running out the tape and fixing it to the pegs.

2. The duties of the various groups are tabulated below:—

Group	Composition	Tools and stores	Duties
(1)	(2)	(3)	(4)
No. 1 Group	1 officer, 2 or 3 men.	1 mallet and bundles of pegs.	Peg out fire bays.
No. 2 Group	1 N.C.O., 2 to 4 men.	1 mallet and bundles of pegs.	Peg out traverses.
No. 3 Group	Reaping, as required by nature of ground.	Reaping hooks, billhooks, etc.	Clear line for tape.
No. 4 Group	N.C.O. and 2 or 3 men.	Tape.*	Fixing tape to pegs.

* Tracing tapes are generally supplied in 50-yd. lengths.

APPENDIX IV Load Tables, Ordnance and Engineer Stores

Articles	One Man Load		Vehicles				Remarks
	No.	Weight		15-cwt.	30-cwt.	3-ton	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
"A" frames (small):	1	30		30	60	120	
Army wire track (4½ cwt. rolls)	—	—		1	4	8	
Axes, pick, 4½ lb. complete	4	18		200	420	840	
Bags, sand, common (in bales of 250)	100	38		3,000	7,500	15,500	
Board, trench 6 feet long	1	35		34	52	120-15	
Blankets (in bales of 25)	—	—		250	625	1,050	
" (in bundles of 10)	—	—		250	500	1,000	
Bleaching powder, 28 lb. drums	—	—		48	90	160	
Canvas, Hessian, roll 3 feet wide, 50 yds. in roll	33 yds.	34		30	60	120	
" Rot-proof, roll 5 feet wide, 120 yds. in roll	30 yds.	32		8	18	40	
Cement, bag 112 lb.	—	—		12	26	52	
" cask 400 lb.	—	—		3	6	14	
Cloth, union, anti-gas (bales)	—	—		5	10	21	
Clothing, anti-gas—							*Packed in cartons each containing
Capes	10	36		—	—	—	10
Gloves	40	32		—	—	—	40
Hoods	40	20		—	—	—	40
Jackets, heavy	6	35		—	—	—	6
" light	10	22		—	—	—	10
Overboots, No. 2	10	28		—	—	—	10
Trousers, heavy	10	32		—	—	—	10
" light	20	26		—	—	—	20
Light sets, comprising jacket, trousers, overboots, gloves	—	—		220	440	880	
Earth, in sandbags, ½ filled ½ sandbag	—	—		65	135	270	
Felt, roll 3 feet wide, 25 yds. in roll	10 yds.	31		15	33	66	

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Great coats (each 8 lb.)	4	32		200	400	800	
Iron, corrugated, 6-foot sheets Width, 2 feet 2 inches	2	32		—	175	350	
" " 7-foot sheets " "	2	37		—	150	300	
" " 9-foot sheets " "	1	28		—	—	200	
Joists, steel, rolled (9 feet by 6 inches by 3 inches) 108 lb.	—	—		—	—	52	
Metal, expanded, sheets (6 feet 6 inches by 3 feet)							
In cases of 20 sheets	3 sheets	27		—	100	200	
*Nails			See foot-note				
Pickets, angle, long 6 feet long	2	28		100	200	400	
" " medium 3 feet 6 inches long	4	36		175	350	700	
" " short 2 feet long	8	36		325	650	1,300	
Pickets, brushwood, long 5 feet long, 3½ to 4 inches diam.	4	36		150	300	600	
" " short 2 feet 6 inches long	8	24		450	900	1,800	
2½ to 3 inches diam.	4	34		150	300	600	
Posts, screw, wire entanglement, Type "A," long	12	33		400	800	1,600	
" " Type "B," short	—	—		—	—	75	
Prop, pit, 9 feet long 6 inches in diam.	—	—		—	—	36	
" " 9 feet long 9 inches in diam.	—	—		—	—	—	
Rifles, loose	—	—		160	325	650	
Road-making materials:—							
Sand	—	—		15	30	60	
Shingle	—	—		17	34	69	
Clay	—	—		14	28	57	
Chalk	—	—		12	25	51	(a)
Earth	—	—		24	48	96	(a) Figures are in cubic feet.
Granite	—	—		10	20	40	
Limestone	—	—		10	21	43	
Sheets, ground (in bundles of 5)	—	—		475	950	1,920	
Shelter, steel, corrugated, large	—	—		—	—	1	
" small	—	—		—	—	5	
Shovels, G.S.	7	37		250	700	1,500	
" R.E.	5	35		100	450	1,050	
†Staples, No. 8 S.W.G.			See footnote				

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Articles	One Man Load		Vehicles				Remarks
	No.	Weight		15-cwt.	30-cwt.	3-ton	
	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Tapes, tracing... .. in 50-yd. rolls	12	—					
Timber, 4 inches by 2 inches 2½ lb. each ft. run		—		500	1,100	2,250	ft. run
Timber, 9 inches by 3 inches 9 lb. each ft. run	—	—		90	250	600	ft. run
Wire, barbed, coils 1	28			50	100	200	
Wire, concertinas 1	50			20	40	80	
Wire, galvanized, iron, coil No. 14 S.W.G.	½ coil	28		25	50	100	
Wire, netting, roll 3 feet wide, 50 yds. in roll	20 yds.	32		16	35	70	

* Nails, 1 inch = 800 to 1 lb.; 2 inch = 122 to 1 lb.; 3 inch = 52 to 1 lb.; 4 inch = 30 to 1 lb.; 5 inch = 20 to 1 lb.; 6 inch = 14 to 1 lb.

† Staples, No. 8 S.W.G., 50 to 1 lb.

NOTES. 1. Figures for the 3-ton lorry are based on loading trials. Figures for 30-cwt. and 15-cwt. are not based on actual trials, but are sufficiently accurate for general calculations. A blank indicates that the vehicle cannot carry that particular load.

2. Wiring stores carefully packed can be loaded in correct proportion in a 3-ton lorry as follows:—

	D.A.F.	Barbed Wire Concertina.	
		Triple	Double.
Wire and screw pickets ..	800 yds.	400	600
Wire and angle iron pickets ..	500 yds.	—	—

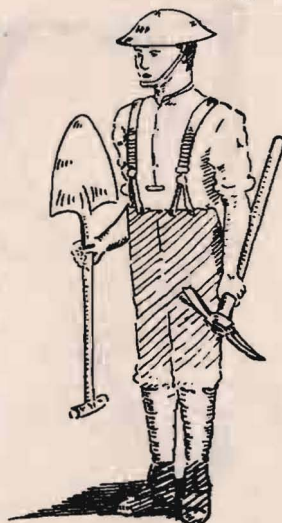
If packed hastily or with used wire these figures should be halved.

PICK AND SHOVEL DRILL

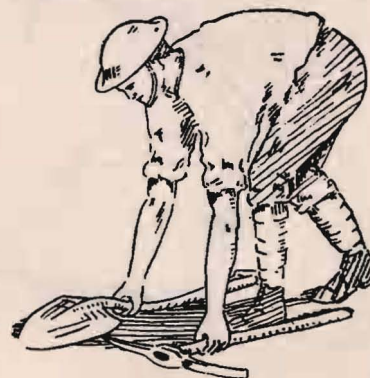
BRACES SHOULD BE REMOVED WHEN DIGGING



Falling-in with Tools



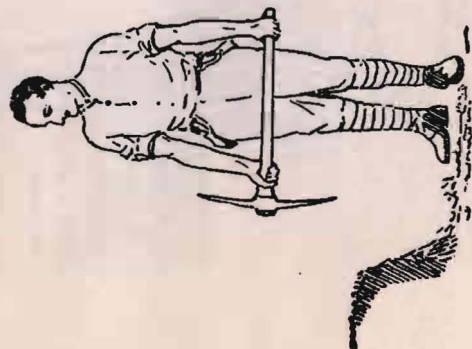
Turning with Tools



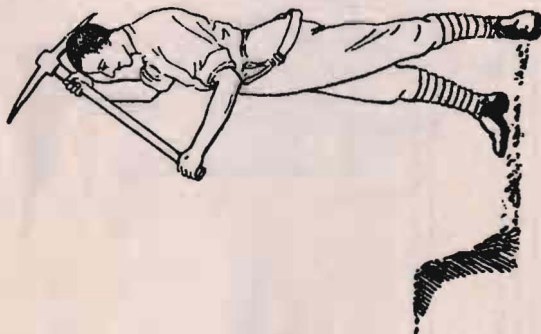
Ground Tools

See Sec. 5, 8, 9

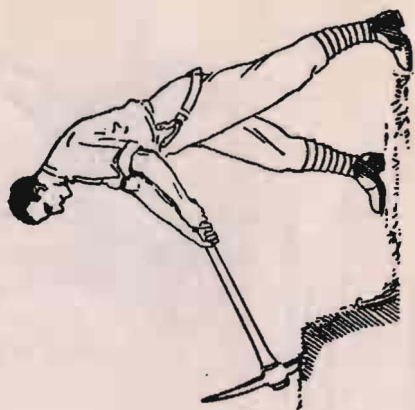
USE OF PICK



Ready



Raise

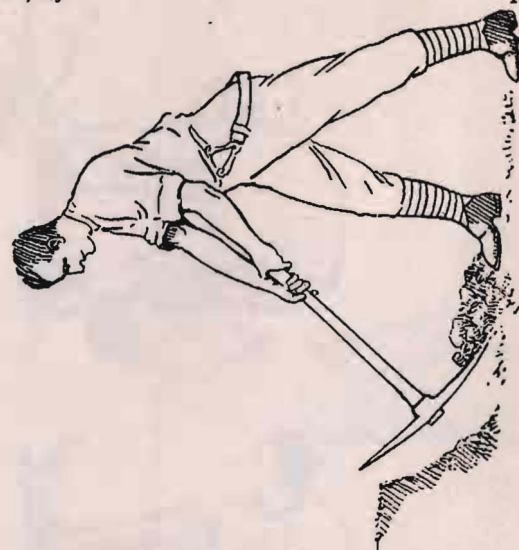


Strike

USE OF PICK



Break



Rake

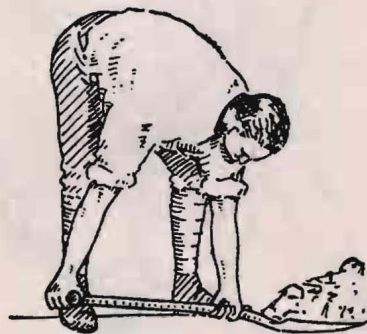
USE OF SHOVEL



Ready



Swing



Fill

and

See Sec. 5, 4.

USE OF SHOVEL

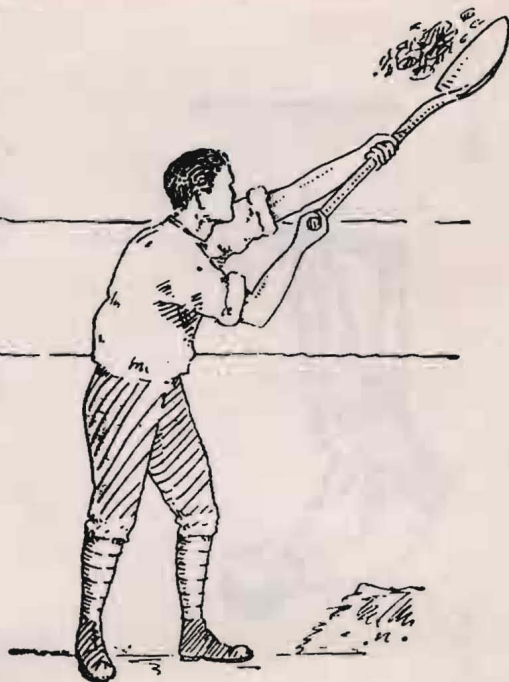
See Sec. 5, 4.

P a r a p e t



Swing

and



Throw

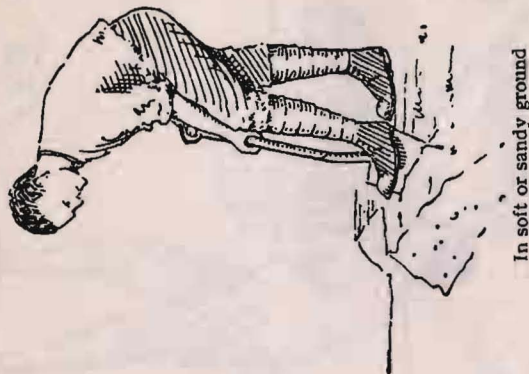
PLATE 5.

NOTE.—During this movement the helve should be allowed to slide through the left hand.

PLATE 6.

[See Sec. 5, 4.]

USE OF SHOVEL



In soft or sandy ground



In rocky ground

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PART VII.—PROTECTIVE WORKS

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