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# FIELD ENGINEERING (ALL ARMS)

MILITARY TRAINING PAMPHLET

No. 30

PART V : PROTECTIVE WORKS

1944

(This pamphlet supersedes the 1941 edition)

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*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, 1944

## CHAPTER 1.—INTRODUCTION

## 1. OBJECT OF PAMPHLET

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

## 2. CLASSIFICATION OF FIELD ENGINEERING

1. Engineers should be employed on work for which they alone have the necessary training and equipment. They should NOT be employed on work that lies within the capacity of other arms, unless in the opinion of the commander such a course is necessary because of the urgency of the operations.

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

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.

2. Protective works for the construction of which all arms are responsible include :—

- (a) Works necessary for fighting : siting, construction, and concealment of fire positions for the various weapons ; clearing the field of fire.

(Obstacles are dealt with in MTP 30, Part III (1943). Minefields are dealt with in MTP 40 (1943), which is being issued in four parts).

- (b) Works for the protection of personnel : slits, shelters.

- (c) Improvements to communications : crawl trenches, tracks.

In all these works the importance of concealment cannot be too strongly emphasized. MTP 46—Camouflage—Parts 1, 2, and 6 (1941). should be studied in conjunction with this pamphlet. Concealment is dealt with in MTP 57 (1943).



### 3. DEVELOPMENT OF FIELD DEFENCES

1. The development of defence works will depend on the time for which it is expected to hold the position.

2. When the position is occupied hastily, the work will generally develop as follows :—

- (a) Protective minefields (*see* note to Sec 2, 2(a) above).
- (b) Weapon slits and emplacements for Infantry A tk guns, MMGs, etc.
- (c) Obstacles (*see* note to Sec 2, 2 (a) above).
- (d) Improvement of observation and field of fire.
- (e) Emplacements for field and medium guns and observation posts.
- (f) Emplacements for other infantry weapons.
- (g) Emplacements for light anti-aircraft guns.
- (h) Command posts.
- (j) Headquarters and offices.
- (k) Aid posts and advanced dressing stations.

3. If the position is likely to be held for some time, subsequent development will include :—

Revetting of weapon slits.  
Crawl trenches connecting weapon slits and section posts  
Strengthening of obstacles.  
Alternative fire positions.  
Dummy fire positions, crawl trenches, and tracks.  
Shelters.

4. Concealment will still be of the utmost importance, and for this reason the digging of crawl trenches should be kept to a minimum.

Where it is impossible to conceal the general defensive layout, the detailed disposition of the defenders must be concealed by the construction of dummy defence works.

## CHAPTER 2.—FACTORS GOVERNING THE DESIGN OF PROTECTIVE WORKS

### 4. OBJECTS OF PROTECTIVE WORKS

1. The object of protective works is to enable a commander to employ the minimum number of men in the defence of any area, thereby :—

- (a) Releasing more men for other purposes ; or
- (b) enabling a larger area to be held by a given number of men.

2. To achieve this purpose, attention must be paid to the following points :—

- (a) Concealment.
- (b) Use of weapons.
- (c) All round fire.
- (d) Protection.
- (e) Control (and communications).
- (f) Comfort.

### 5. USE OF WEAPONS—GOVERNING DIMENSIONS

#### 1. The rifle

In the positions stated a man can fire his rifle over the following heights :—

(a)	(b)	Fires over (c)	Distance needed behind (d)	Remarks (e)
1	Lying ...	9 to 12 in	5 ft	Man not covered from view, cannot move about. Badly exposed to plunging fire.
2	Sitting ...	2 ft	2 ft	Man cannot sit under cover, and can only move with difficulty without exposure.
3	Kneeling	3 ft	2 ft	—
4	Standing	4 ft 6 ins	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 :—

- |   |                                |
|---|--------------------------------|
| (a) Light machine-gun and anti-tank rifle | As for rifle.                  |
| (b) 6 pr. anti-tank gun ... ..            | 24 ins                         |
| (c) Field artillery (25 pr) ... ..        | 30 ins                         |
| (d) MMG on tripod mounting ... ..         | 18 ins<br>(in lowest position) |
| (e) PIAT ... ..                           | 8 ins                          |
| (f) 17 pr A tk gun ... ..                 | 24 ins                         |



## 6. PROTECTION REQUIRED AGAINST DIFFERENT TYPES OF FIRE

### 1. Small arms fire

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

The table below shows the safe thickness in inches against armour piercing LMG fire up to 7.92 millimetres (burst of 20 rounds) or splinters from 100 lb bombs bursting not less than 30 ft away.

Serial No (a)	Material (b)	Safe thickness in inches (c)	Remarks (d)
1	Earth or loam as in parapets ... ..	60	Variable
2	Chalk as in parapets ... ..	60	
3	Clay as in parapets ... ..	72	
4	Sand, loose or between boards ... ..	30	
5	Brick rubble confined between boards ... ..	18	Variable
6	Coal between boards ... ..	24	
7	Road metal 1½-2 ins between boards ... ..	14	
8	Sandbags filled with—		
	(a) rubble ... ..	30	
	(b) earth ... ..	30	
	(c) road metal ... ..	20	
	(d) shingle ... ..	20	
	(e) sand ... ..	30	
9	Brickwork in lime mortar ... ..	18	
10	Concrete unreinforced ... ..	12	
11	Mild steel plate ... ..	1½	Variable
12	Timber ... ..	60	

### 2. HE 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 fly 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.

### 3. HE 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 those 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 slits.

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.

### 4. Dive-bomber attack

The best protection is given by narrow weapon slits.

## CHAPTER 3.—DETAILS OF PROTECTIVE WORKS

### 7. SITING OF FIRE POSITIONS

#### 1. General

The defended area will be organised in depth in a series of defended localities, within which platoon posts are sited. These posts and localities must provide for all round defence.

#### 2. Siting of weapon slits

(a) Siting is governed by :—

- The fire tasks to be carried out.
- The concealment and protection obtainable from folds in the ground, trees, hedges, etc.

(b) The following points must be remembered in siting weapon slits :—

- The field of fire must always be checked from the level at which the weapon will be fired. A minimum field of fire of 100 to 150 yds in all directions and without intervening dead ground, is desirable.
- The posts must not obstruct the fire of neighbouring posts. The fire of A tk weapons close over the heads of the defenders must be accepted.
- Weapon slits must be mutually supporting and sufficiently close to each other to enable section commanders to exercise control by voice. The only limiting factor is that they should not be so concentrated as to render them all vulnerable to a single shell burst.
- Low ground, where water may collect, should be avoided if possible.



## 8. IMPROVEMENT OF OBSERVATION AND FIELD OF FIRE

### 1. General

(a) Some clearance around defence works is usually necessary. The objects are:—

- (i) To increase the field of fire of the weapons.
- (ii) To facilitate observation of enemy movement.

(b) Clearance, unless very sparingly and carefully carried out, will give away fire positions however well the positions themselves are concealed. Clearance should, therefore, be reduced to a minimum.

(c) Clearance work should generally be undertaken early in the preparation of a defensive position.

(d) Range marks, natural or artificial (if screened from the enemy) should be left to assist in fire control.

### 2. Detailed considerations

(a) *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.

(b) *Hedges, etc.*—Hedges and patches of bush may often, if left standing, help to screen the fire positions from the enemy's observers and may be of value as obstacles, especially if wire is laid in them. Partial clearance of the lower part will usually allow adequate vision without sacrifice of concealment.

(c) *Bush.*—In areas thickly covered with bushes, clearings or lanes should be made, and the edges of the parts left uncleared should be filled with obstacles.

(d) *Buildings and walls.*—It may sometimes be necessary to demolish small buildings and walls. Debris from demolished buildings may, however, give good cover to the enemy, so that it is often advisable to leave them standing. In this case, their use by the enemy must be hampered by means of barbed wire and booby traps.

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

## 9. WEAPON SLITS

### 1. General

The standard form of fire position for infantry weapons is the weapon slit for two or three men. The construction may be hasty or deliberate.

### 2. Hasty construction

When positions have to be constructed hastily in face of the enemy, they will normally be dug in stages as shown in Fig. 1.

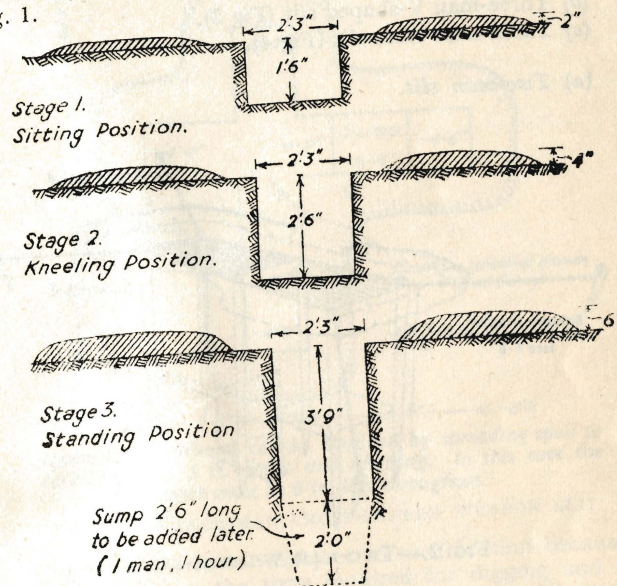


FIG. 1.—WEAPON SLIT HASTILY CONSTRUCTED BY STAGES

Stage 1 may have to be dug with entrenching tools, but deepening beyond this stage should, if possible, be done with picks and shovels. The surface of the ground is used as an elbow rest. Concealment must be achieved by careful siting as the spoil cannot be removed or turfed over. In hasty construction, one man should dig 6 ft 6 in length of slit in the following times, according to ground conditions:—

Stage 1	...	...	$\frac{1}{2}$ to 1 hour, using pick and shovel.
			or
			2 to 3 hours, using the entrenching tool.
Stages 1 and 2	...	$1\frac{1}{2}$ to 4 hours, using pick and shovel, from the commencement of the slit.	
Stages 1, 2 and 3	...	3 to 8 hours, using pick and shovel, from the commencement of the slit.	



### 3. Deliberate construction

The following are the standard types of weapon slit :—

- (a) Two-man slit (Fig 2).
- (b) Three-man V-shaped slit (Fig 3).
- (c) Three-man cross-slit (Fig 4).

#### (a) Two-man slit

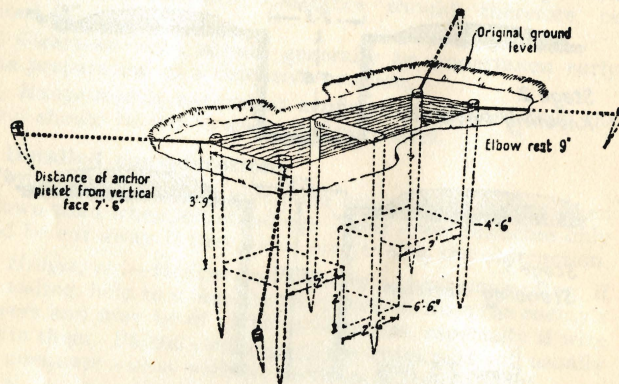


FIG 2.—TWO-MAN WEAPON SLIT

#### (b) Three-man V-shaped slit

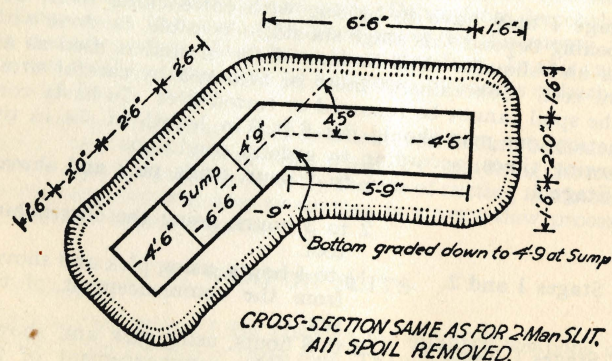
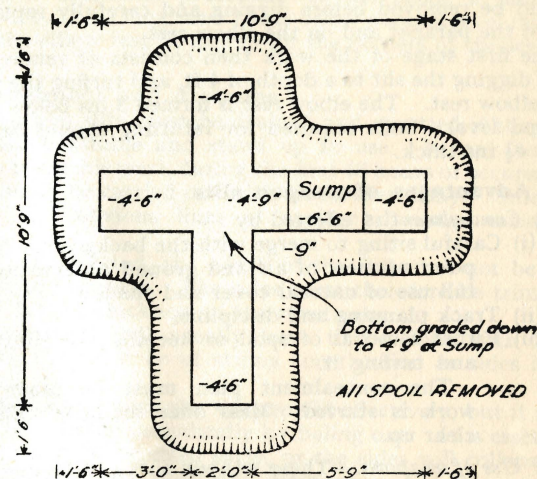


FIG 3.—THREE-MAN V-SHAPED WEAPON SLIT

#### (c) Three-man cross-shaped slit



About 6 in. command can be obtained by spreading spoil to form parapets 5 ft. thick and re-turfing. In this case the depth must be 6 in. less throughout.

FIG. 4.—THREE-MAN CROSS-SHAPED WEAPON SLIT

(d) *Time and labour.*—Subject to modification because of ground conditions, the time required for digging and concealing weapon slits, but omitting sump and revetment, is as follows :—

Two-man slit. 1 man. 8 to 16 hours.

Three-man V-slit. 2 men. 6 to 12 hours.

If spoil has to be removed to a distance, extra men should be employed.

#### 4. Details

These slits may be made with no parapet, all the spoil being carefully removed and dumped where it will not show up. An elbow rest should be dug out as shown in Fig 2, and turfed. A convenient way of removing spoil is by means of a groundsheet.

The work is done in two stages :—

- (a) Digging slit to a depth of 4 ft 6 ins and removing and concealing spoil, forming and re-turfing elbow rest.
- (b) Digging sump and revetting slit.

Alternatively, the spoil, if spread out round the pit, makes a parapet 6 ins high and about 5 ft wide. The turf from the



whole area to be covered by the excavation and the spoil should be removed before digging and carefully replaced on top of the parapet and on the elbow rest.

The first stage of the work then consists of removing the turf, digging the slit to a depth of 4 ft, and turfing the parapet and elbow rest. The elbow rest is formed 3 ins below original ground level. Sods required for returfing should be cut at least  $4\frac{1}{2}$  ins thick.

### 5. Advantages of weapon slits

(a) *Concealment* is effected by:—

- (i) Careful siting to merge with the background from the point of view of air and ground observation, with full use of natural cover and shadow.
- (ii) Track planning and discipline.
- (iii) Either removal of spoil or keeping the parapet low and turfing it.

The concealment plan must be made before work is started. Mess once made is difficult to clear up.

(b) *Use of weapons*.—These weapon slits can be used for all small arms. Modifications for light machine guns and 2 in mortars are given in paras 6 and 7. The three-man cross slit is specially suitable for grenade throwing and for AA fire from the Bren gun. It is also a convenient form for platoon headquarters.

All round fire is obtained by making the parapet, if any, the same height all round.

(c) *Protection*.—A 5-ft parapet gives protection against small arms fire. The narrowness of the trench gives the greatest possible protection against shell fire and bombing, while a tank can pass over the top without injury to the occupants. Revetment gives further protection against shells bursting near by.

(d) *Control* is obtained by siting the slits comprising a section post sufficiently near to one another to be under verbal control. Control will be improved as the development of crawl trenches proceeds.

(e) *Comfort*.—The sump provides for drainage and enables the occupants of the weapon slit to use the firestep as a seat.

### 6. Light machine guns

Light machine guns can be fired over the parapet of a weapon slit, holes being made as necessary, to take the bipod, or tripod, for firing on fixed lines.

### 7. 2-in mortars

2-in mortars can be fired from the elbow rest at all ranges (100 to 500 yards) high angle fire only.

To give additional protection to the firers, a platform 15 ins wide, 18 ins long, and 12 ins below parapet level may be cut in the elbow rest at any or all the corners of the weapon slit.

### 8. Revetment and drainage

(a) Weapon slits must be drained and revetted if they are to remain habitable and stand up to use. It may not be possible to do this work during the first 48 hours of occupancy, but it should be carried out without further delay. Siting in hollows and obvious lines of surface drainage must be avoided.

(b) When revetted, the width of the slit must not be less than 2 ft in the clear. The sides must therefore be trimmed to allow for the thickness of the revetment.

(c) Revetment will usually have to be done with local materials, but must be of strong construction as sides have no batter.

(d) The sump drains the weapon slit effectively, but it may have to be emptied periodically by baling out. It is essential that the sump be revetted early, or the sides will collapse.

For details of revetment and drainage see Sec 13.

## 10. MORTAR EMPLACEMENTS

### 1. 3-in mortar

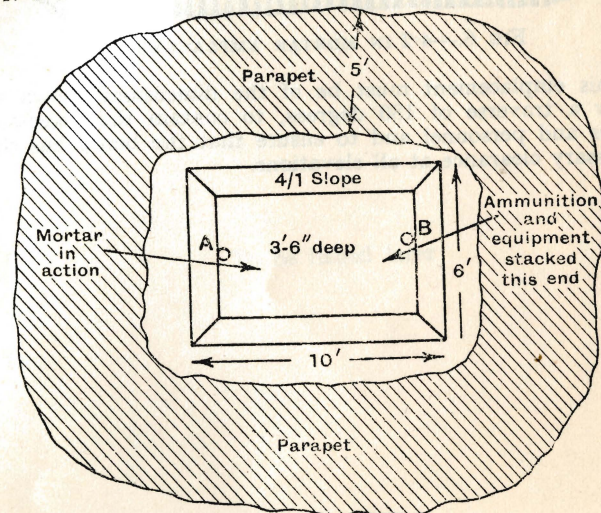


FIG 5.—3-IN MORTAR EMPLACEMENT



## 2. 4.2-in mortar

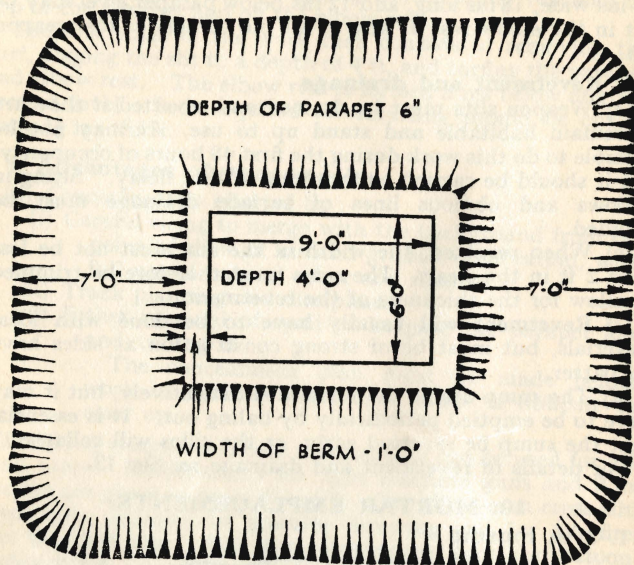


FIG 6.—4.2 IN MORTAR EMPLACEMENT

This emplacement must be of the dimensions shown to allow a traverse of 180 degrees, to contain the necessary stores and personnel and to ensure that the bomb has the necessary clearance at all elevations.

## 11. ANTI-TANK GUN EMPLACEMENTS

## 1. 6-pr anti-tank gun. See Fig 7 (a).

To be issued later

FIG 7 (a).—6-PR A TK GUN EMPLACEMENT

## 2. 17-pr anti-tank gun. See Fig 7 (b).

To be issued later

FIG 7 (b).—17-PR A TK GUN EMPLACEMENT



## 12. MMG EMBLEMENTS

1. The dimensions of the Vickers gun mounted in the normal position are given in figures below. The front to rear 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.

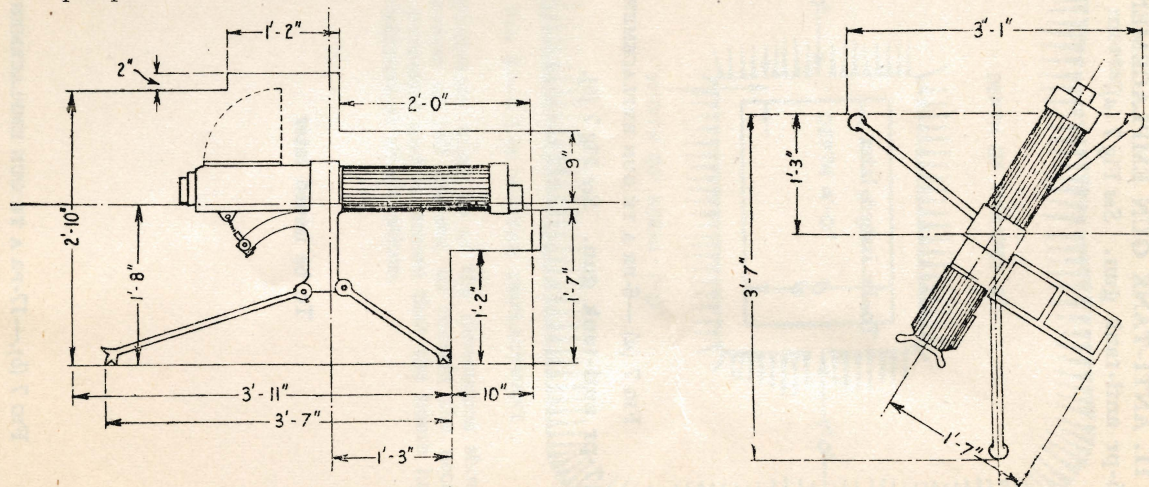
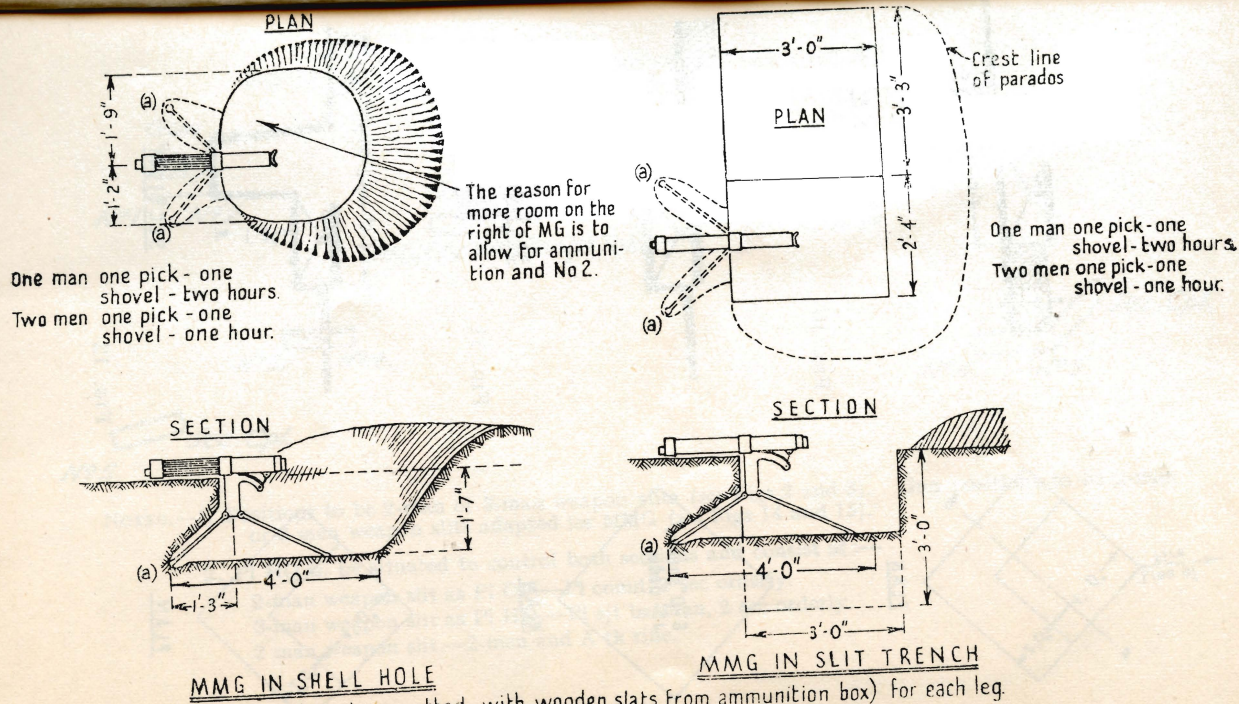


FIG. 8.—MINIMUM DIMENSIONS OF MMG EMBLEMENT

2. Types of hastily constructed emplacements are given in Figs 9 to 15 below.



MMG IN SHELL HOLE  
(a) Slight undercut (can be revetted with wooden slats from ammunition box) for each leg.

FIG. 9



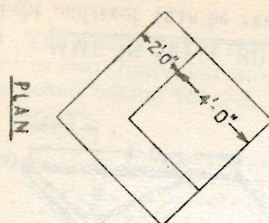


Fig. 12

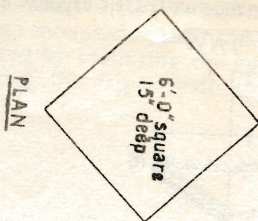
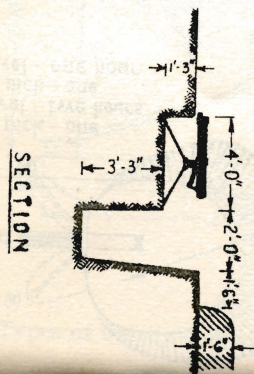


Fig. 11

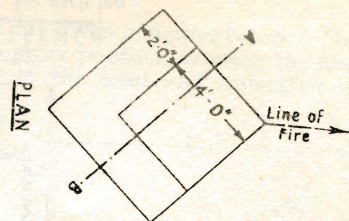
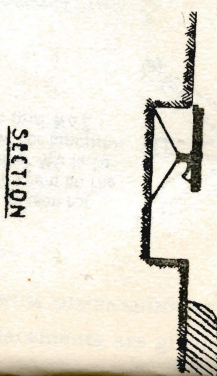


Fig. 10

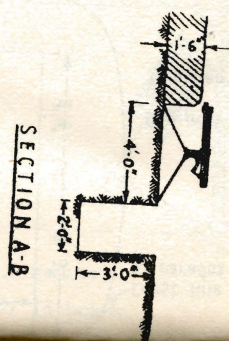
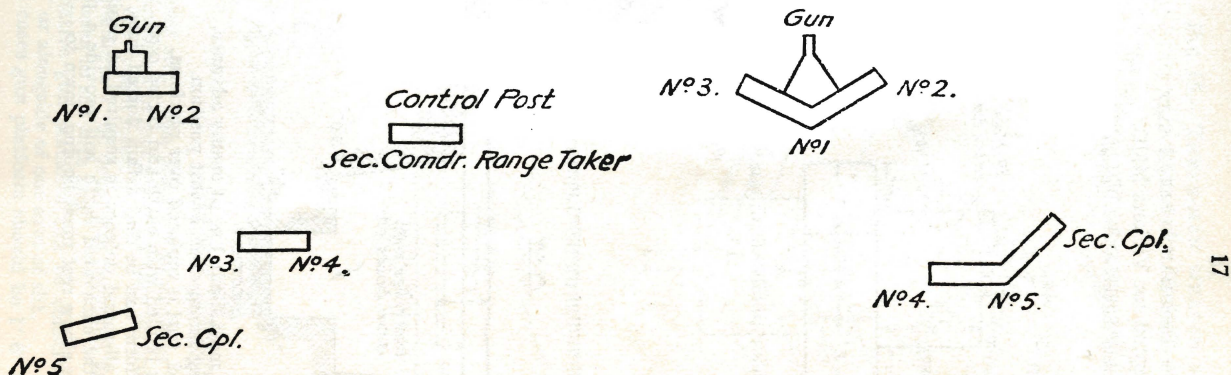


FIG 13.—DIAGRAMMATIC LAYOUT OF WEAPON SLITS FOR MMG SECTION

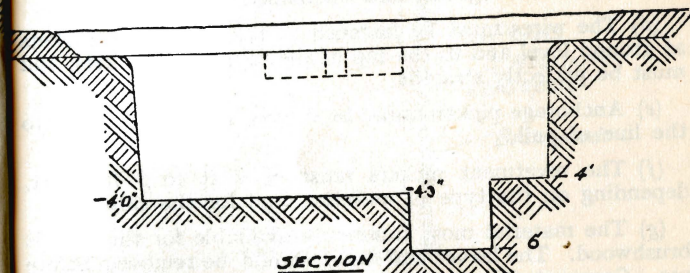
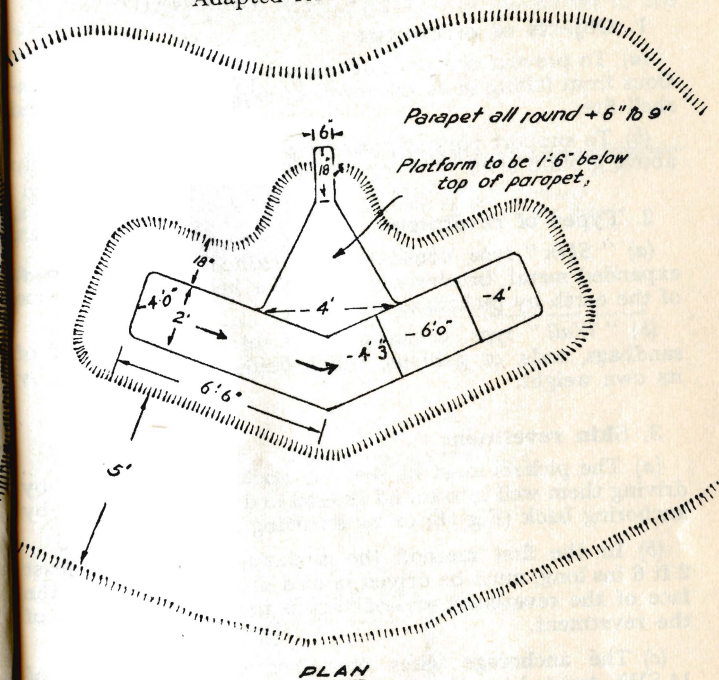


NOTES.—1. Positions to be 2-man or 3-man weapon slits (see Figs 2 and 3). Gun positions to be 2-man or 3-man weapon slits adapted for MMG (see Figs 14 and 15).

2. Pl HQ to be situated to control both sections and consist of :—
  - 2-man weapon slit as Pl OP.—Pl comd, 1 sec orderly.
  - 3-man weapon slit as Pl HQ.—Pl sgt batman, 2 sec orderly.
  - 2 man weapon slit.—2-men and A tk rifle.



FIG 15.—THREE-MAN WEAPON SLIT, V-SHAPE  
Adapted for Vickers MMG



V-shaped slit. Gun platform on angle of "V".  
Measurements of gun platform vary according to angle at which  
arms of the trench meet.  
Gun platform 1' 6" deep, gun mounted and platform returned.  
Three men in slit with gun.  
Alternative gun platform can be constructed at opposite side  
of "V" or alongside of one arm of slit.  
In all cases gun platform should be 1' 6" below top of parapet.



#### 4. Sandbag revetment

(a) Sandbag revetments are used principally for repairing damaged parapets, or when silent work is essential. They are expensive in material and labour and rot quickly.

(b) Sandbags must be filled not more than three quarters full, and the neck tied round with the string provided. 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.

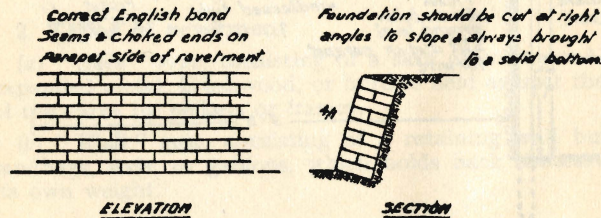


FIG 18.—SANDBAG REVETMENT

(c) When laid, the sandbags should be carefully beaten into the correct shape, the finished dimensions being 20 ins by 10 ins by 5 ins.

Sandbags laid with their long side at right angles to the wall are called "headers," and the others "stretchers." The bottom course and the top course of a sandbag wall must always consist of headers.

The face of the wall should have a slope of 4/1.

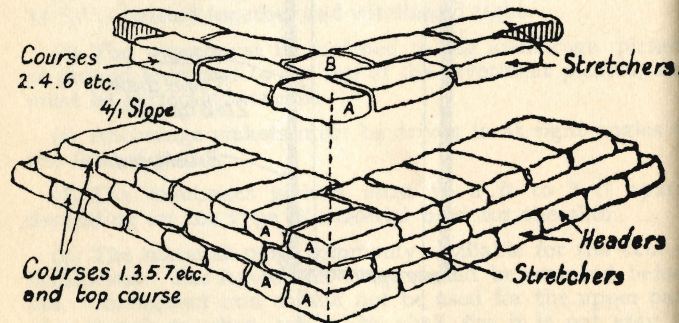


FIG 19.—SANDBAG WALL—RIGHT ANGLED CORNER

(d) Fig 19 shows how a right angled corner may be built, so as to maintain the bond.

The bags marked "A" must be three quarters of the normal length, i.e., 15 ins.

The bags marked "B" must be half of the normal length, i.e., 10 ins.

(e) 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 60 bags in an hour.

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

5. Sods should be laid in the same way as sandbags, with 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.

6. Gabions are open-ended boxes usually made of XPM. They are made by bending a sheet of XPM round a stout rectangular frame 3 ft high with four 18 in faces. The joint where the ends overlap is laced with wire. They must be braced internally with wire to preserve their shape. Gabions are built up into a revetment at a batter of 4/1 and filled with earth. The foundation must be sloped as for a sandbag wall.

Empty oil drums, tins, and other receptacles can be used in a similar way.

#### 7. Drainage

(a) In weapon slits, the only means of drainage is the sump, which must be revetted as early as possible. If in impermeable soil, the sump must be baled out as necessary.

(b) In trenches, shelters, etc., the bottom should be graded towards one end, and drainage provided to a separate sump or preferably to lower ground.

(c) The sides of an open drainage trench should be sloped at 1 in 1, unless revetted.

(d) Excavation of drains should start from the lower end. Care must be taken to avoid forming pockets that would retain water.



## 14. BREASTWORKS

### 1. Use

Breastworks are made when it is impossible to obtain sufficient cover by digging; for instance, in rocky country where there is little depth of earth, or in marshy country where the water lies on or close to the surface. Breastworks may also be required for blast walls to protect gun emplacements, entrances to buildings, etc.

### 2. Construction

(a) A breastwork consists of a parapet or wall of earth built up above ground level and held up by revetment.

(b) The revetment may be of the skin type (pickets and brushwood, etc.) or of the wall type (sandbags or gabions).

(c) When pickets and sheeting are used, the revetment is erected first, and the sheeting must be wired or otherwise secured to the pickets. Earth is then dug from a borrow pit and thrown against the revetment. Where the height of the breastwork exceeds 3 or 4 ft, the upper part is usually best built up with sandbags.

(d) Sandbag breastworks are much more vulnerable to artillery fire than those constructed with other types of revetment, but may have to be used when silent work is essential or when other materials are not available. The sandbag walls are built as described in Sec 13, the earth being filled in behind each course of sandbags as it is laid.

(e) A berm of 3 ft should be left between the foot of the breastwork and the edge of the borrow pit.

(f) The height and thickness of the breastwork depend on the degree of protection required. For example, a shallow weapon slit will require sufficient height of parapet to give the normal 4 ft 6 ins over which to fire. The thickness at the top should be 5 ft for protection against SAA.

### 3. Concealment

Breastworks are difficult to conceal and require a great deal of time, labour, and material.

Some degree of concealment can be achieved by siting the breastwork against a suitable background, making the exposed faces tone with the surroundings, leaving the tops of parapets irregular and by the use of dummies.

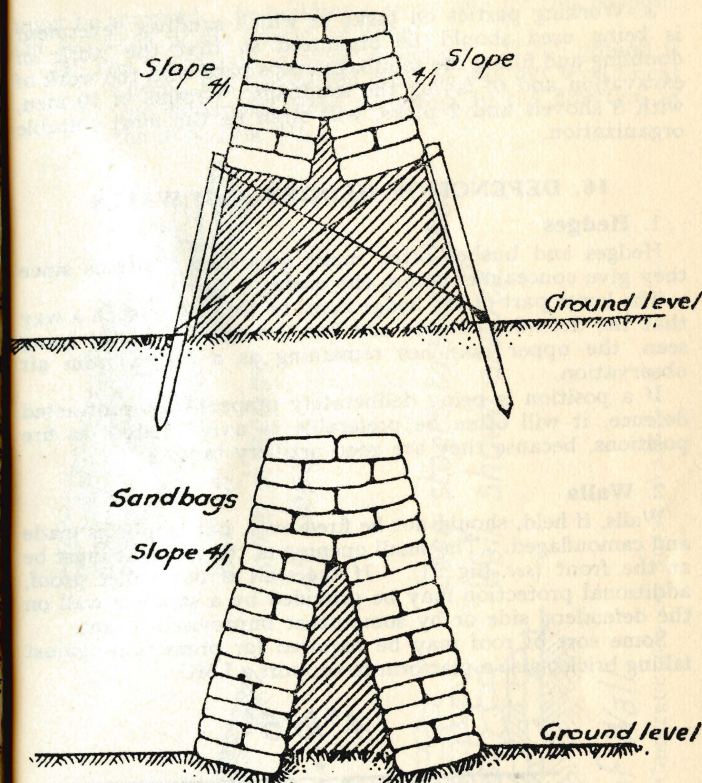


FIG 20.—BREASTWORKS

## 15. CONSTRUCTION OF DEFENCES IN SAND

1. Defences should not be sited in deep loose sand where this can be avoided, because of the laborious methods of construction involved. Where they must be so sited, defences must approximate in final dimensions to those of normal weapon slits, though the labour of construction may sometimes be so great as to justify a decision to build a fire position which is half trench and half breastwork.

2. Owing to the fluidity of sand, it is necessary to dig the initial excavation much wider than the width aimed at, particularly when sandbags must be used for revetment. Sandbags so used must be doubled, *i.e.*, one sandbag inside another.



3. Working parties on tasks in which sandbag revetment is being used should be organized so that the work of doubling and filling the sandbags keeps pace with the work of excavation and of laying the sandbags. Groups of 10 men with 8 shovels and 2 picks, will often be the most suitable organization.

## 16. DEFENCE OF HEDGES AND WALLS

### 1. Hedges

Hedges and bushes often make good fire positions since they give concealment from the enemy's view.

The lower part of the hedge must be thinned in such a way that the defender can see and fire through it without being seen, the upper branches remaining as a screen from air observation.

If a position is being deliberately prepared for protracted defence, it will often be preferable to avoid hedges as fire positions, because they are good artillery targets.

### 2. Walls

Walls, if held, should not be fired over, but loopholes made and camouflaged. The small opening of the loophole must be at the front (see Fig 21). If the wall is not bullet proof, additional protection may be provided by a sandbag wall on the defenders' side or by some other improvised means.

Some sort of roof may be required for protection against falling bricks, also a platform to support a LMG.

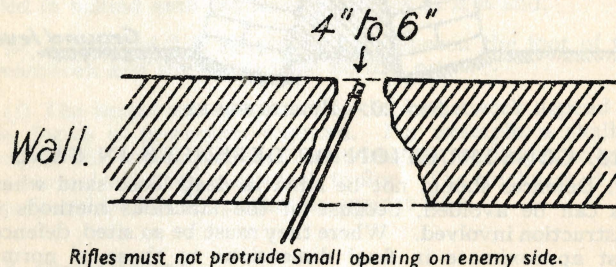


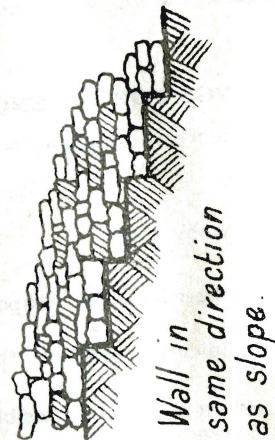
FIG 21.—LOophOLE IN WALL

### 3. Stone walls

In rocky country where the ground is too hard for weapon slits to be dug to the full depth, stone walls make a good form of defence. The danger of flying splinters when under fire

must be accepted. In building a stone wall for this purpose, the following points should be noted :—

- (a) The foundation is most important. If the ground is sloping, the foundation must be dug out level or cut into horizontal steps according to the direction of the slope (Fig 22).



Long stones to strengthen Wall shown shaded.

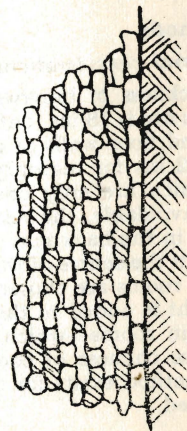
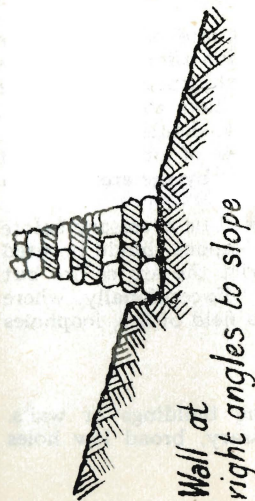


FIG 22.—CONSTRUCTION OF STONE WALLS



- (b) Only the largest stones that can be comfortably man-handled should be used. They should be built as far as possible in courses, breaking joint with each other. Any specially long stones should be used as "bond stones" to tie the wall together.
- (c) Walls should be 2 ft 6 ins thick at the top, with a slope on each face of 4/1.

## 17. PREPARATION OF BUILDINGS FOR DEFENCE

### 1. Preparation of buildings for defence will include :—

- (a) Preparation of fire positions.
- (b) Clearing fields of fire.
- (c) Construction of obstacles and booby traps.
- (d) Shoring up of ceilings.
- (e) Construction of alternative fire positions, *e.g.* weapon slits outside the building.
- (f) Improvement of inter-communication within the building.

Concealment is usually best effected by duplicating visible signs of occupation of neighbouring houses.

### 2. Methods

#### (a) General considerations

The thickness of brickwork for adequate protection from small arms fire is 18 ins, but the protection afforded by houses with ground floor walls of a minimum thickness of 14 ins for brick or 12 ins for masonry will often have to be accepted. Houses which are only one room thick should be avoided. Where unavoidable, the resultant danger of silhouette or of being shot in the back may be minimized by the erection of a screen down the centre of the room.

If upper rooms are chosen, shoring will be necessary before extra weight is added to the floor. Weapons should be sited well back in rooms—which may restrict the arc of fire but will increase chances of concealment. Exceptionally, where no other method exists for obtaining a field of fire, loopholes may be used.

#### (b) Clearance of field of fire

May include demolition of outlying buildings or walls. Complete demolition may be unnecessary, broad low holes being sufficient.



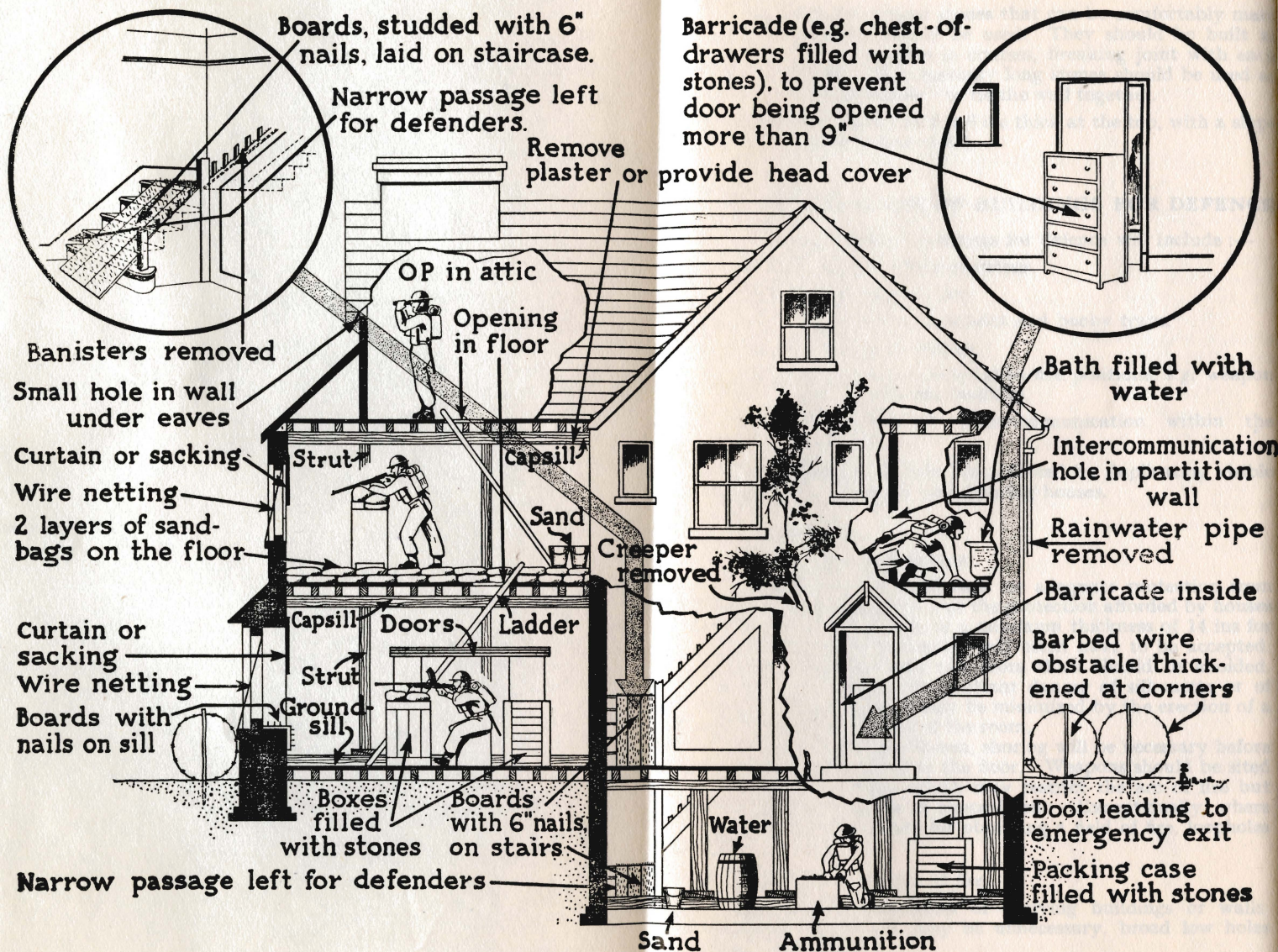


FIG 23.—PREPARATION OF A BUILDING FOR DEFENCE



*(c) Obstacles*

A protective obstacle should be provided outside the range of grenades. Another should be provided close to the house, thickened at the corners in order to force the enemy into the field of fire of the defenders. This obstacle should be fixed either to the house or the ground. A concertina obstacle is ideal, fixed to the ground with pickets. Natural obstacles, if they exist, should be strengthened. New ones should be concealed or made to conform with ground pattern.

*(d) Fire positions*

Additional protection for the firers may be afforded by furniture or boxes filled with stones or rubble, or by sandbag walls. For details see para 3.

*(e) Alternative fire positions*

Weapon slits should be dug in the garden. These may be used in addition during enemy bombardment or dive-bombing.

*(f) Intercommunication*

Must be provided both inside and outside the building. It may be achieved by making holes in walls and floors, care being taken not to weaken the main structure by so doing.

**3. Aids to defence**

(a) Rip all plaster off ceilings and walls. If this precaution is not taken the defenders will be blinded and choked by dust as soon as enemy fire begins.

(b) Shore up ceilings remembering that :—

- (i) It is no use putting extra weight in upper rooms unless the floor has first been shored up from below.
- (ii) Shoring should be started on solid material, a cement or stone flag floor being best.
- (iii) All material required may be obtained from joists and timber procured from nearby buildings.
- (iv) Examples of shoring are shown in Fig 23. A capsill should be placed at right angles to the floor joists that are to be shored up. This should be supported by uprights which are tightened up by driving in wedges.



(c) If it is not considered necessary to occupy upper roof (when shoring becomes unnecessary) improvised protection may be produced against debris by placing suitably-braced tables over the weapon and firer, possibly resting on two chests-of-drawers.

(d) Fig 24 shows a design for a framed cover made from floor joists and boarding, the only tools required being hammer and a handsaw. The joints in the frames are made by nailing cover plates to the outside of the main members. One pioneer and one assistant should be able to collect the materials and construct the cover in about six hours, and no assistance is not necessary. The dimensions and timber size can be varied to suit local conditions. The roof may be made of two layers of corrugated iron instead of planking.

(e) Glass should be removed from all windows. This presents a uniform view to the attacker and reduces the danger to the defenders from flying glass.

(f) Unused windows should be blocked up and made bullet proof. This can best be done by nailing planks or corrugated iron on both sides and filling the intervening space with stone or rubble (minimum thickness 18 ins).

(g) Curtains or sandbags should be draped inside window to block the upper half. If possible they should be hung well back from the window so as not to be conspicuous. Thus sufficient light will be left inside the rooms for the defenders to be able to fire out, but chances of any accurate observation by an attacker will be reduced.

(h) Rabbit wire netting should be placed over all windows on the ground floor. This prevents the enemy from throwing grenades into the room. The wire should be fixed inside the window frame at the top and outside at the bottom. Certain windows in the upper storey should be left free so that it is possible for the defenders to throw grenades, etc out of them.

(i) Boards with nails driven through them upwards should be fixed inside on ground-floor window-sills. If put outside they would cradle grenades. These boards will hamper enemy attempts to jump through the windows.

(j) All doors should be barricaded so that they will only open the minimum amount necessary for entry. This precaution will reduce an attacker's chance of rushing the

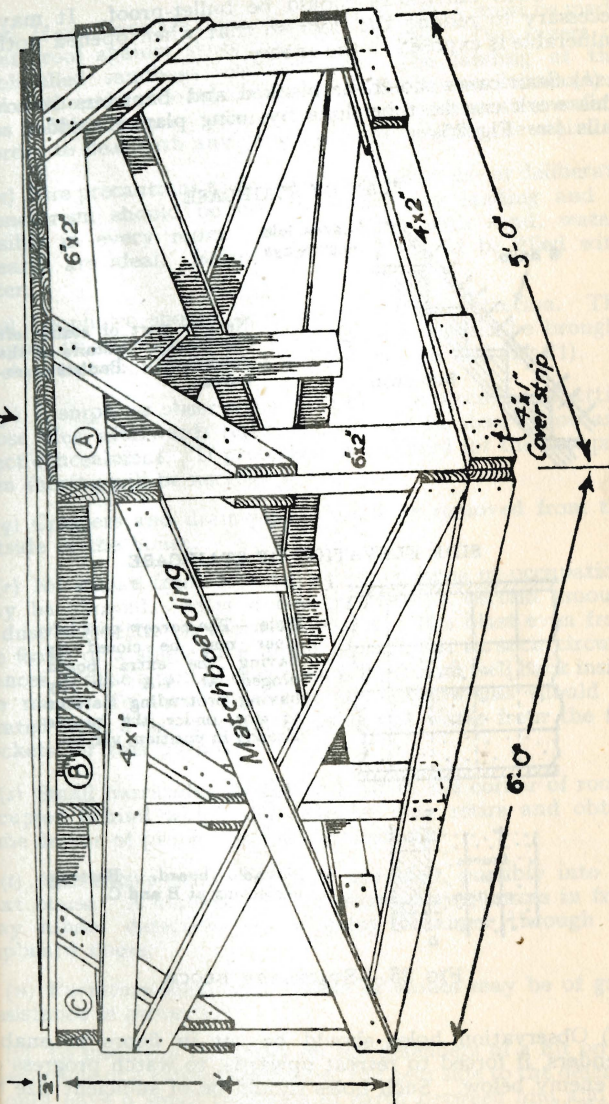
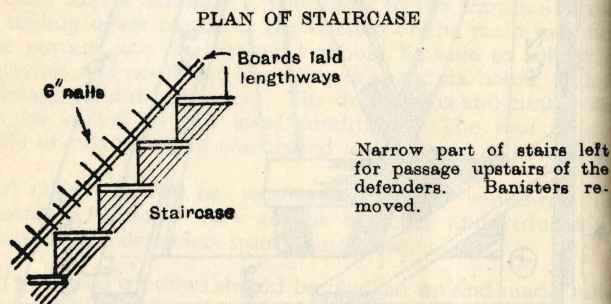


FIG 24.—OVERHEAD COVER FOR LMG AND CREW IN A DEFENDED BUILDING

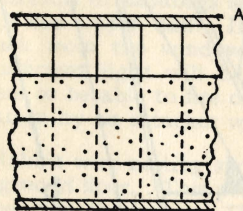


door. Such barricades should be bullet-proof. It may be necessary to rehang the door so that when opened nothing vulnerable is exposed to the enemy.

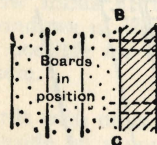
(k) Stair-cases should be blocked and banisters removed. This work can best be done by using planks studded with nails (see Fig 25).



**SIDE ELEVATION OF STAIRCASE**



**Note.**—The narrow part left clear may be closed by having the extra board hinged at A-A or by having protruding battens to slot under the boards already in position, viz.:—



Movable board. Battens projecting at B and C.

**FIG 25.—STAIRCASE BLOCK**

(l) Observation holes should be cut in floors to enable defenders, if forced to retreat upwards, to watch progress of the enemy below. Such holes should be of sufficient size to permit the passage of a grenade.

(m) If positions are built on upper floors they must be made bullet-proof against shots fired from below. Two layers of rubble-filled sandbags are sufficient. The landing at the head of the stairs should always be treated in a similar manner. Thus a defender may take up position in comparative safety in order to deal with any attacker as he mounts the stairs.

(n) Fire precautions to deal with accidental fire or deliberate incendiaryism should be provided on every landing and if possible in every room. Buckets filled with sand, water, or earth are ideal. Basins and baths should be filled with water.

(o) Loopholes should be small to escape detection. The weapon, in order to obtain a field of fire, should be brought up close but should not protrude (see Sec 16 and Fig 21).

(p) A sniper or observation post may be placed in an attic. Loose tiles, afterwards replaced, may aid in observation and effect concealment. If protection is required for the occupier then shoring will be necessary.

(q) Creepers and drain-pipes should be removed from the outside of the house.

(r) No smoke from cooking, or other signs of occupation, may be allowed. After a bombardment a certain amount of dust will settle on the window-sills. The blast even from the firing of a single rifle bullet is sufficient in such circumstances to raise a puff of dust even if fired from well back inside the room. To settle this dust the window-sills should be treated with a damp sandbag using the water from the fire buckets for this purpose.

(s) Small barricades should be built in the corner of rooms occupied behind which the defender may retire and obtain some degree of protection from grenades.

(t) Alternative exits should be provided, possibly into the next house. A cupboard or wardrobe drawn across in front may hinder detection, entry being obtained through the cupboard doors.

(u) Furniture filled with rubble or stones may be of great assistance in protection.

(v) To minimize the effect on the defenders of a hit on the enemy side of a rubble protection, the near side to the defender should have a small thickness of earth between him and the rubble. This precaution also prevents injury from splinters.



#### 4. Responsibility for work

The preparation of a building for defence is an all round responsibility, all the technical work described above being within the capabilities of infantry pioneers.

RE advice and assistance may be required for :—

Strengthening of cellars for use as command posts, signal centres, or regimental aid posts.

Making holes in walls and ceilings to improve intercommunication.

### 18. SHELTERS

#### 1. Weatherproof shelter

Fig 26 shows a design of weatherproof shelter which can be constructed adjoining a weapon-slit. The shelter is easy to construct and conceal. It is made on the "cut and cover" principle, that is, the site is excavated, the sides revetted, and the roof put on and covered. Surplus soil must be removed and concealed.

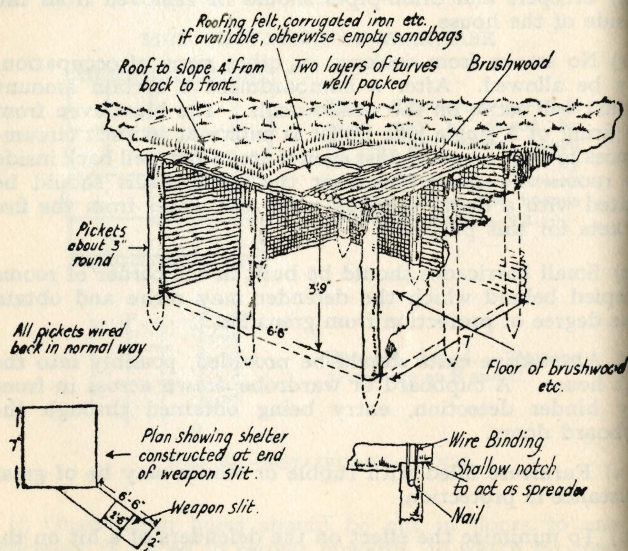


FIG 26.—WEATHERPROOF SHELTER

#### 2. Light splinterproof shelter

Fig 27 shows a stronger type of shelter designed for a maximum covering of 2 ft 6 ins of earth, which will give protection against splinters and machine gun bullets from the air. It is impossible to make this type of shelter proof against a direct hit by a shell or bomb, and any additional thickness of cover will merely overload the roof and make rescue more difficult in case of collapse.

The side frames, A and B, can be constructed at some convenient place under cover, and transported or carried to the site and dropped into the excavation. The erection is then completed and the covering put on and turfed.

The structure of this shelter is braced in every direction to withstand the concussion of shells bursting a few yards away.

Sides are prevented from collapsing inwards by being strutted apart top and bottom by spreaders.

Distortion is prevented by diagonal bracing on the sides and ends.

Groundsills under the uprights supporting the roof prevent them from sinking into the ground.

#### 3. Miscellaneous hints

(a) No roof, whatever its resistance to penetration, is of any value unless it is strong enough to carry the weight of the covering and supported on properly designed supports.

(b) The roof should be sloped to throw off water. When corrugated iron is used, nails should be driven through the ridges and not through the valleys of the corrugated iron.

(c) Water must be prevented from draining into the shelter; a sump near the entrance will usually be effective.

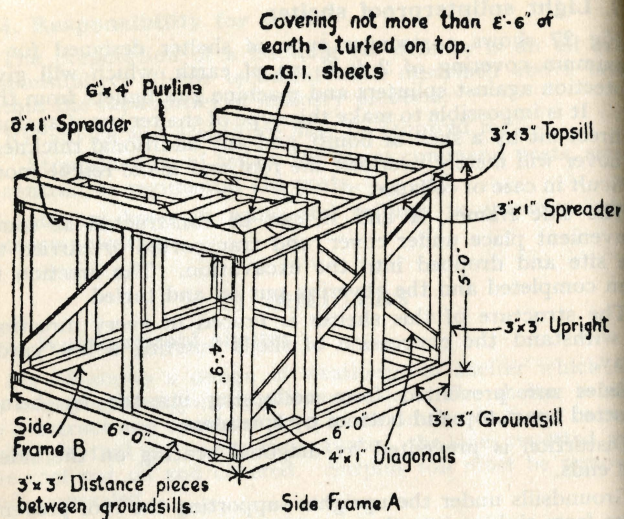
(d) The shelter must be concealed, usually as a low natural mound.

#### 4. Hints on the use of timber for framework of shelters

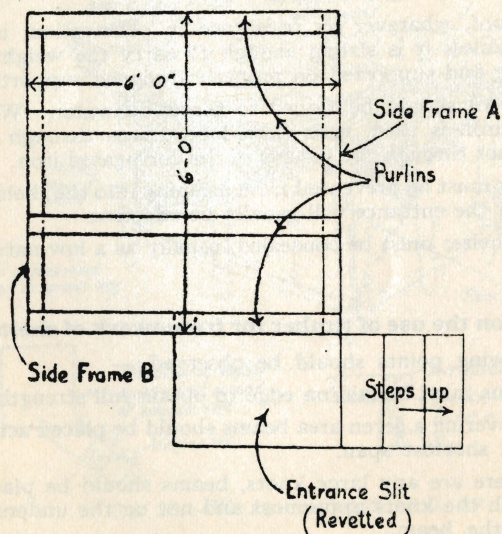
The following points should be observed :—

- Beams must be laid on edge to obtain full strength.
- In covering a given area beams should be placed across the shortest span.
- If there are any large knots, beams should be placed with the knots uppermost and not on the underside of the beam.





FRAMEWORK OF SHELTER.



PLAN WITH COVERING REMOVED.

FIG 27.—LIGHT SPLINTERPROOF SHELTER

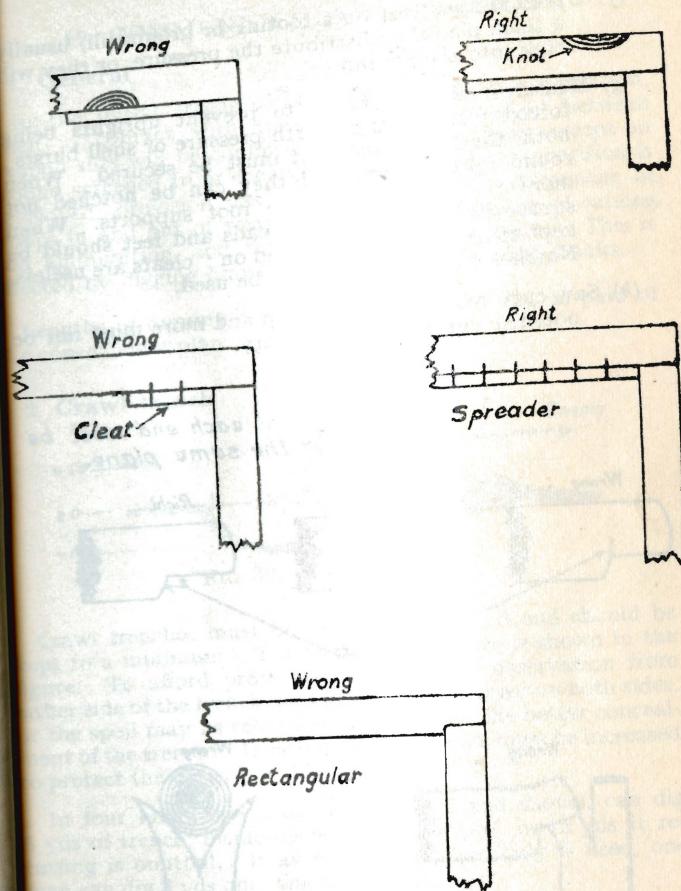


FIG 28.—SQUARED TIMBER CONSTRUCTION (COMMON FAULTS)

- (d) Heavy weights must not be taken by nails or on an unsuitable support such as sandbags.
- (e) The best upright is the natural pit prop. When round timber is not used, uprights should be as nearly square as possible in section.



- (f) Uprights must rest on a footing or ground sill, usually a thick plank, to distribute the pressure, or they will sink into the ground.
- (g) Measures must be taken to prevent uprights being forced in sideways by earth pressure or shell bursts. When round uprights are used they can be notched no more than  $1\frac{1}{2}$  ins into the roof supports. When square timber is used the heads and feet should be kept apart by spreaders nailed on; cleats are useless. Notches must on no account be used.
- (h) Saw cuts must not be too deep and more must not be notched out than is necessary.

*The flats at each end must be in the same plane.*

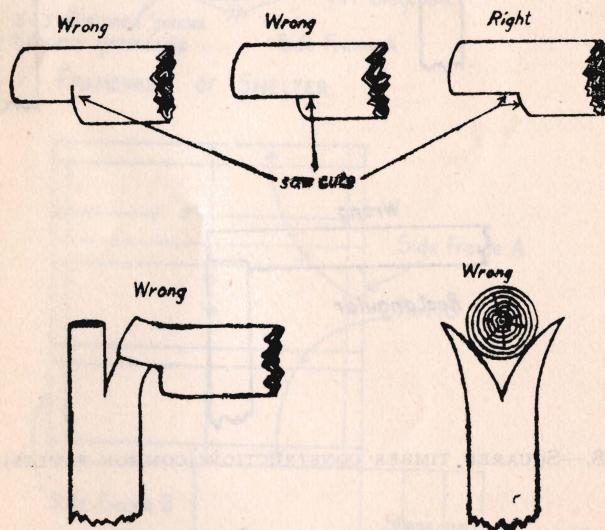


FIG 29.—ROUND TIMBER CONSTRUCTION (COMMON FAULTS)

## 19. COMMUNICATIONS AND TRACKS

### 1. General

In the initial stages of constructing a defensive position, when in contact with the enemy, all movement between weapon slits will be confined to hours of darkness, except on ground screened from enemy observation. As the position is developed, provision has to be made for the movement of troops in and out of weapon slits, the carrying up of rations and ammunition, and the evacuation of casualties. This is effected by digging crawl trenches and by forming tracks.

Lengths of dummy crawl trench should be dug as part of the concealment plan.

### 2. Crawl trench

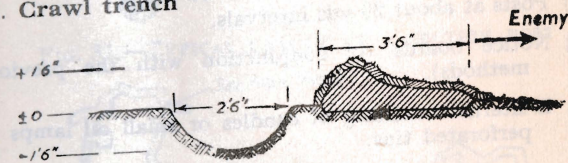


FIG 30.—CRAWL TRENCH

Crawl trenches must be carefully concealed and should be kept to a minimum. The usual cross-section is shown in the figure. To afford protection from enemy observation from either side of the trench, parapets may be formed on both sides, or the spoil may be removed altogether for the better concealment of the trench. In either case, the depth must be increased to protect the users.

In four hours one man, using a pick and shovel, can dig 5 yds of trench, including returfing the spoil, or 12 yds if returfing is omitted. If an entrenching tool only is used, one man can dig 3 yds omitting returfing.

### 3. Tracks

(a) *Concealment.*—As tracks are conspicuous from the air, even when almost invisible on the ground, attention must be paid to track discipline.

For example, a track should follow the hedge round two sides of a field and not go diagonally across in the open. When a track in the open is unavoidable, for example one



leading to a weapon slit, it should be continued to the other side of the field or to a dummy position. Troops must be made to use the dummy track regularly so as to deceive the enemy.

This problem is dealt with fully in MTP 46, Part II, 1944, Chapter I.

(b) *Siting*.—In addition to the requirements of concealment, tracks should be sited to avoid likely shell traps and ground liable to become waterlogged after heavy rain.

(c) *Marking*.—Tracks can be marked by :—

- (i) Blazing trees.
- (ii) Tracing tapes (a temporary expedient, as they are soon obliterated by mud).
- (iii) Posts at about 20 yds intervals.
- (iv) Notice boards (in conjunction with the previous methods).
- (v) Lanterns consisting of candles or small oil lamps in perforated tins.

(d) *Other work on tracks*

- (i) *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.
- (ii) *Wiring*.—Places where men are liable to take short cuts and so upset the concealment plan should be wired across.
- (iii) *Trenchboards* make an excellent track. They should be laid on transoms (about 3 ins by 2 ins) bedded in the ground. In swampy ground they should be laid on trestles, consisting of a transom supported on two pickets driven into the ground. XPM nailed to the trenchboards makes this type of track more durable.
- (iv) *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.

## 20. DEVELOPED DEFENSIVE POSITION

Defensive positions in the Middle East developed over a period of weeks took the following form :—

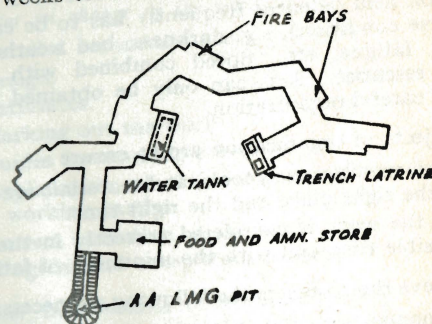


FIG. 31.—TYPICAL LAYOUT OF A SECTION POST

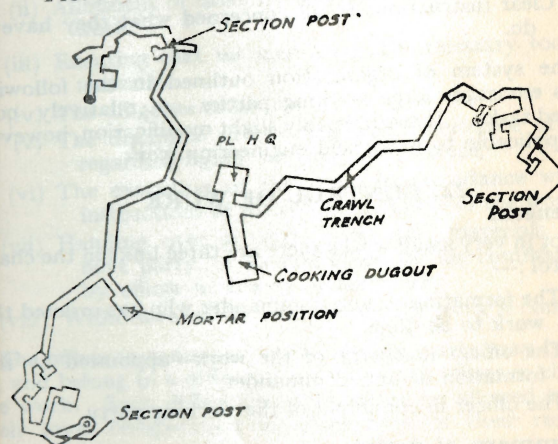


FIG. 32.—TYPICAL LAYOUT OF A PLATOON POST

### NOTES

1. Slit trenches without fire steps, parapets, paradors, or revetting. Dimensions 2 ft 6 ins wide at top, 1 ft 6 ins at bottom. Depth 4 ft 6 ins. Above adjusted to suit individuals.
2. Fire bays were notched into side of trenches—maximum length 6 ft, minimum interval between bays 7 ft. Notches were 1 ft 6 ins wide and the same depth as rest of slit (4 ft 6 ins).
3. Light head cover was provided for concealment.



## CHAPTER 4.—ORGANIZATION OF WORK

### 21. GENERAL CONSIDERATIONS

1. Work on field defences frequently has to be carried out under adverse conditions, *e.g.* darkness, bad weather, enemy interference, fatigue, etc. Speed combined with efficiency is therefore essential. This can only be obtained by sound training and careful organization.

2. The objects of organization are to ensure :—

- (a) That men, transport, tools, and materials are available at the right place and the right time.
- (b) That the work is completed correctly in the shortest possible time and with the minimum of fatigue.

3. To achieve these objects the following are necessary :—

- (a) Reconnaissance and planning before the work begun.
- (b) Clear instructions to all concerned what they have to do.

4. The system of organization outlined in the following sections envisages large working parties on relatively concentrated tasks. It requires only slight modification, however, to be applicable to most field engineering work.

### 22. CONTROL OF WORK

#### 1. General

Except in very small works there are three links in the chain of control :—

- (a) The formation or unit commander who has ordered the work to be done.
- (b) The officer in charge of the work—appointed by the formation or unit commander.
- (c) 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 :—

- (a) *Formation or unit commander ordering the work to be done*
  - (i) Reconnaissance.
  - (ii) Priority of work.
  - (iii) Instructions to officer in charge of work.
  - (iv) Arrangements for provision of men, tools, materials and transport.

- (v) Arrangements for control and continuity of work.
- (vi) Provision of covering party if necessary.

(b) *Officer in charge of the work*

- (i) Detailed reconnaissance.
- (ii) Design.
- (iii) Estimates.
- (iv) Marking out the work.
- (v) Guides for working parties.
- (vi) Explanation of the work to officers in charge of working parties.
- (vii) Correct execution of the work.
- (viii) Progress and completion reports.

(c) *Officer in command of working party*

- (i) Explanation of the work to his subordinates.
- (ii) Allotment of tasks to, and disposal of, his men on the work.
- (iii) Ensuring that his men have the necessary tools and materials.
- (iv) The diligence of his men.
- (v) The discipline of his men and observance of orders regarding lights, smoking, and silence.
- (vi) The execution of the work in accordance with the instructions of the officer in charge of the work.
- (vii) 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.
- (viii) 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. Such differences 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 regarding its urgency.



## 23. RECONNAISSANCE

1. A preliminary reconnaissance will be carried out by officer ordering the work to be done, accompanied, if possible, by the officer in charge of the work. As a result, instructions will be given to the latter on the following points :—

- (a) Approximate siting and nature of the work.
- (b) Approximate resources in time, labour, and material available.
- (c) Outline of organization for the execution of the work.
- (d) Provisional priority of the work.
- (e) Covering parties, if required.

2. The officer in charge of the work will then make a detailed reconnaissance of his task. Time may be saved if the work is marked out as the reconnaissance proceeds.

## 24. PRELIMINARY ARRANGEMENTS

### 1. Estimates

As a result of his detailed reconnaissance, the officer in charge of the work will prepare an estimate including :—

- |  |   |
|--|---|
| (a) Time.  | } These are obviously interdependent factors. |
| (b) Labour.  |   |
| (c) Tools.   |   |
| (d) Materials.   |   |
| (e) Transport.   |   |
| (f) Carrying parties.  |   |
| (g) Other requirements (e.g. guides, covering parties, etc.) |   |

The calculation of labour for a field engineering task is simplified by making a work table, an example of which is given in Appendix F.

In preparing this, the following tables will be useful :—

Appendix C —Men, time, and tools.

„ D —Tools carried in the field.

„ E —Load tables.

These tables are also included in FSPB, Part I, Pamphlet No. 7, 1944.

## 2. Demands

The officer in charge of work will then submit his demand for labour, etc., to the authority laid down by the officer ordering the work. The demand will show for each task :—

Date.

Number of working men.

Rendezvous.

Time.

Guides.

Tools to be provided.

Short description of task (stating whether task or time work and probable duration ; if duty is carrying stores, number of journeys).

Name of officer in charge of work.

Remarks.

The actual number of men required will be stated on the demand, but the formation or unit supplying the working party will make up the number by detailing complete units, companies, platoons, sections, etc., in accordance with the actual strength of units at the time. Better work is obtained when the normal military organization is adhered to and the men are working under their own officers and NCOs.

The officer in charge of the work will also submit a demand for transport. He will also make any necessary arrangements for marking out the work (if not already done) and for providing guides for transport and working parties. To avoid delay the marking out must be done before the working party arrives.

## 25. ORGANIZATION OF WORKING PARTIES

1. Work may be allotted either as task work or as time work.

2. **Task work.**—The advantage of task work over time work lies in the moral effect in that the working party knows :—

(a) What has to be done.

(b) That it will be dismissed as soon as task is completed.



Tasks should, if practicable, be allotted to small parties such as sections, rather than to individuals.

Tasks must be set fairly. They should be so calculated that the average man or party can complete them just inside the period of time for which the men are expected to work. A task once set should not be increased because the work is being completed sooner than expected.

3. **Time work** should not be used unless task work is impracticable on account of difficulty in estimating the time required. The approximate 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.

4. **Carrying 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 to collect them. At the end of the journey the loads must be put down so as to form an orderly dump, or distributed at the points on the work where they are needed.

When various types of stores are being carried, it is advisable to distribute the stores of any one kind amongst different individuals or parties. In the event of casualties there is thus less likelihood of the work being held up on account of the loss of the party carrying one particular type of store.

5. **Arms and equipment.**—During work, arms and equipment should normally be laid out close at hand for immediate use in emergency. Care must be taken that they do not get buried during digging.

If there is danger of a sudden attack the commander of the party may decide to work with arms slung, which however greatly hinders the work. Carrying parties will carry their arms slung when working in close proximity to the enemy.

6. **Reliefs.**—When working with reliefs on task work, a short interval of time should be allowed between the estimated completion of the task of one relief and the arrival of the next.

When working in darkness, each relief should bring with it all the tools required and take them away on conclusion. Otherwise the tools used by one relief must be dumped in one place for collection by the next relief.

## TOOLS AND MATERIALS

### 1. Tools

(a)	Type of tool (b)	Purpose (c)	Remarks (d)
1	(a) <i>Digging tools</i> Pickaxe ...	Loosening soil ...	Head, 4½ lb. Helve, 1½ lb (2½ lb if iron ferruled). Length, 3 ft.
2	Shovel ...	Clearing away soil loosened by pick.	Weight (GS pattern), 3½ lb. Length, 2 ft 8 ins.
3	Spade ...	Cutting sods, trimming slopes, digging in stiff soil, e.g. clay.	Weight, 6 lb. Length, 2 ft 9 ins.
4	Entrenching tool.	Initial digging in face of enemy.	
5	Crowbar ...	Making holes in walls, moving large stones, levering weights, etc.	Lengths :— 3 ft 6 ins. 4 ft. 1 in. 5 ft. 6 ins.
6	(b) <i>Cutting tools</i> Felling axe	Felling trees and cutting large timber.	
7	Cross-cut saw		
8	Folding saw		
9	Hand saw ...	Cutting small timber.	
10	Hand axe	Cutting brushwood, clearing and trimming hedges and bushes.	
11	Bill-hook		
12	Matchet		
13	Reaping hook...	Cutting corn, grass, etc.	
14	(c) <i>Miscellaneous tools</i> Maul ...	Driving wooden pickets.	Weight, 14 lb.
15	Sledge hammer	Driving iron pickets and wedges.	Weight, 7 and 14 lb.
16	Auger ...	Making holes in timber.	

### NOTES

1. Tools must always be kept sharp and clean. Grindstones, saw sets, files and honing stones must be provided to keep the cutting tools sharp.

2. The felling-axe can only be used effectively by a man trained to use it.



3. The cross-cut saw is safe and easy to use in the hands of unskilled men. It is worked by two men who pull the saw in turn across the timber. It must not be pushed. When felling trees, wedges are required to prevent the saw from jamming.

4. When using the maul or sledge hammer, 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.

5. When using an auger, great care must be taken that the small point at the end is not broken. The auger should be screwed in, whenever possible, at right-angles to the face of the timber.

## 2. 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 lbs per cubic 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 4).

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 concealing excavated earth, and for revetting. They should be cut approximately to 18 ins by 9 ins by 4½ ins thick.

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

(a) Scantlings, or squared timber of various sizes.

(b) Round timber pickets, 2 ins to 5 ins diameter, used in revetment work and for wiring; pit props, 6 ins to 9 ins diameter, used for shoring of buildings and construction of shelters.

6. **Brushwood** consists of thin straight branches of bushes with the leaves and twigs removed. It is used for revetting and for making hurdles and fascines.

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

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 cubic 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 ins long by 3 ft wide. Weight, 11 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 ins wide, and weighing, respectively, 16, 18, and 28 lb.

12. **Plain wire**.—Mainly used for binding purposes and in anchorages. 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 50 yds long, 33 ins wide, weighing 36 lb. Other widths are also available.

14. **Hurdles**.—These are used for revetments. They are usually made 6 ft long and 3 ft wide. Six strong rods are



driven into the ground about 10 ins 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 nailed to a timber framework.

15. **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 ins. 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.

16. **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.

17. **Tracing tapes** are used for tracing trenches, marking tracks, lines of wire obstacles, etc.

They are 50 yds long.

## APPENDIX B

### TOOL AND DIGGING DRILL

#### 1. General

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

(b) 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.

(c) 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, and to carry them quietly.

(d) 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

Tools are issued from stores as follows :—

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.

#### 3. Tool drill

(a) *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.

(b) *Grounding and taking up tools*

(i) "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 ins in front of the left toe. Then return to the position of attention.

(ii) "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.

(iii) *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.

(c) *Marching with tools*.—As in war much 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 and explained to the men :—

(i) "Right turn."—Drop the head of the pick and raise the blade of the shovel (Plate 1), 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.

(ii) "Left turn."—As above, except that the turn is to the left.



- (iii) "*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 (a) above).

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

#### 4. Digging drill

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

(b) *Picking*.—Right hand forward; right foot forward.

- (i) "*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 ins from pickhead. Left hand at small end of helve.
- (ii) "*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.
- (iii) "*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.
- (iv) "*Break.*"—Force small end of helve upwards and move forward hand towards pickhead.
- (v) "*Rake.*"—Rake the loosened earth towards feet by pulling pick back with both hands. Weight of body on rear foot.
- (vi) "*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.
- (vii) 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.

(c) *Picking*.—Left hand forward; left foot forward; the position of feet and hands and the action are reversed.

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

(e) *Shovelling*.—Right-handed. For throwing to left and front.

- (i) "*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.
- (ii) "*Swing and fill.*"—Swing shovel back with weight of body on rear foot; left arm straight and left hand near right knee. Right arm to 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.
- (iii) "*Handle low.*"—Depress "T" piece of helve to free shovel load from pile of earth.
- (vi) "*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.
- (v) *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.

(vi) 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.

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



(g) *Digging in with the entrenching tool.*—Men must be taught to use the tool lying down facing the enemy, and to dig from rear to front. Hard ground is more easily broken up by this method and a hollow for the disengaged arm is quickly provided which gives more cover for the digger.

### 5. Points for instructors

(a) 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 task 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.

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

(c) 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 point, 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 ins 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 many times.

(d) 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, duplicating his work.

(e) All men 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 action. 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.

(f) 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 slit or pit.

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

(g) In a narrow slit 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.

(h) 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 cubic ft
In the second hour	25 "
In the third hour	15 "
In the fourth hour	10 "
Total in 4 hours	80 cubic ft

(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 cubic ft. For general estimating, however, it is safer only to assume 60 cubic ft by day and 50 cubic ft by night.

(i) *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 work may be done as a drill. Each man digs as fast as possible for 2 minutes, the other two men lying behind the work. At the end of 2 minutes the NCO i/c blows a whistle. The next man (No. 2) jumps into the work and carries on with the task 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.



See Appx B (3)

PLATE 1

### PICK AND SHOVEL DRILL



Falling-in with tools



Turning with tools



Ground tools

56

See Appx B (4)

PLATE 2

### USE OF PICK



Ready



Raise



Strike

57



See Appx B (4)

### USE OF PICK



PLATE 3

See Appx B (4)

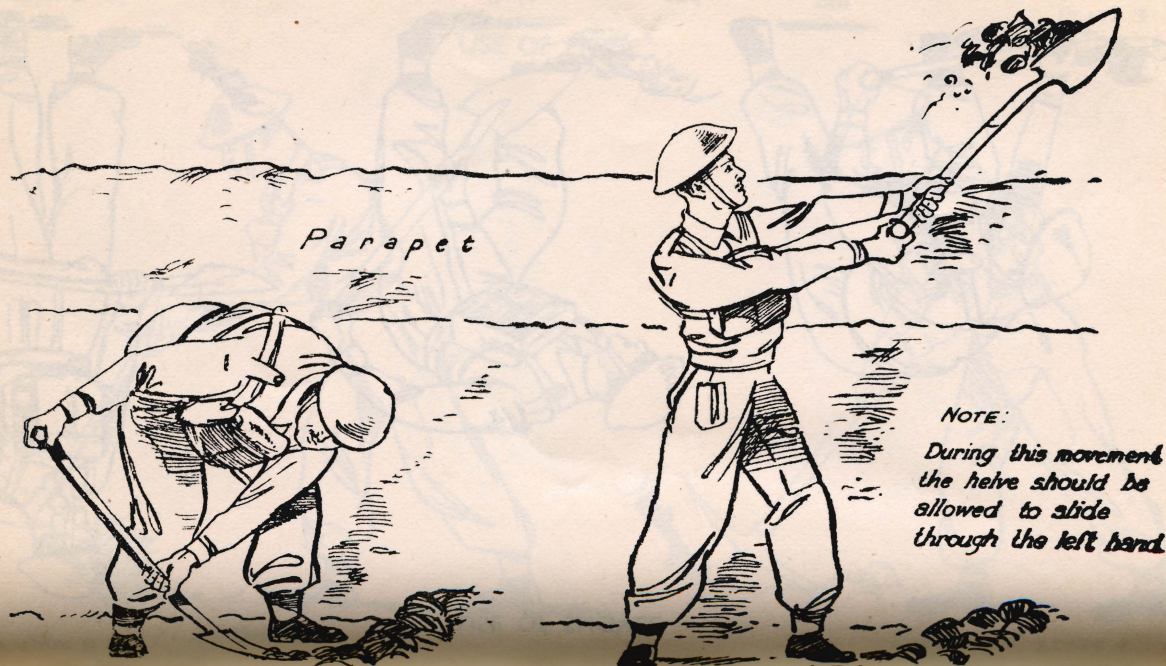
### USE OF SHOVEL



PLATE 4



# USE OF SHOVEL



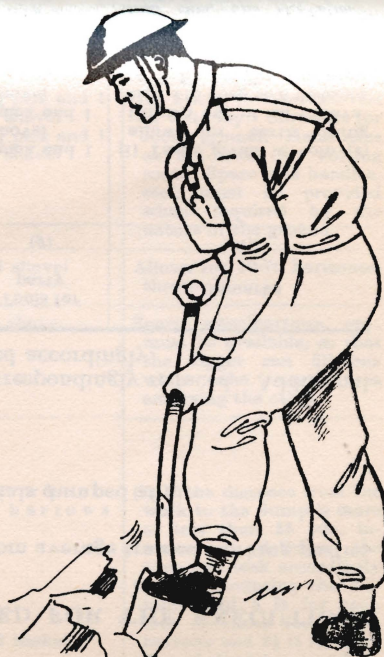
See Appx B (5)

## USE OF SHOVEL

PLATE 6



In rocky ground



In soft or sandy ground



# **CALCULATIONS OF MEN, TIME AND TOOLS REQUIRED FOR THE EXECUTION OF CERTAIN FIELD WORKS**

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

All tracing and marking out done beforehand, and materials dumped at site.

Work carried out by day, or on a moonlight night.

It is not raining.

March to work does not exceed  $1\frac{1}{2}$  hours.

In conditions less favourable tasks columns (e) and (f) must be correspondingly reduced. Additional time must be allowed for concealing work, or the task must be reduced accordingly.

Item No.	Nature of work	No. of workers	Time	Quantity	Task per man per hour	Tools for party	Remarks
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
	<b>Earthwork :—</b>			cubic ft	cubic ft		
1	Excavation of trenches— In soft, sandy ground	1	1 hr	30	30	1 pick and 1 shovel	(i) Tasks given in coln (e) allow for earth being thrown out of an excavation 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	—	1 pick and 1 shovel	
2	In medium ground, i.e. ground of average consistency for digging, or soft ground with stones or small roots	1	1 hr	20	20	1 pick and 1 shovel	(ii) When depth of excavation is more than 4 ft, one shoveller should be added for every two diggers, to clear berms and make up parapet to correct shape
		1	4 hrs	60	—	1 pick and 1 shovel	
3	In hard ground or medium soil with stones and roots	1	1 hr	15	15	1 pick and 1 shovel	(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	40	—	1 pick and 1 shovel	
4	Shovelling earth already excavated	1	1 hr	40	40	1 shovel	Allows for 10-ft horizontal throw
		1	4 hrs	120	—	—	
5	Excavating earth and loading into wheelbarrows, stretchers, or baskets	1	—	As under items 1-4 above			Spare wheelbarrows, etc., must be available, so that the digger can fill one while the carrier is emptying the other
6	Moving earth 25 yds; depositing and returning :— In wheelbarrows	1	2 mins	1	30	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 (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
		1	2 mins	$\frac{1}{2}$	10	2 baskets	
7	In baskets	1	2 mins	$\frac{1}{2}$	10	2 baskets	



## APPENDIX C—contd.

Item No. (a)	Nature of work (b)	No. of workers (c)	Time (d)	Quantity (e)	Task per man per hour (f)	Tools for party (g)	Remarks (h)
8	In sandbags (see below)	1	4 hrs	40	10	2 sandbags	(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
9	<i>Digging hasty type weapon slits:—</i> 1 ft 6 ins deep	1	½ to 1 hr	6 ft 6 ins run of slit	—	1 pick and 1 shovel	If using entrenching tool only, allow 2 to 3 hrs From beginning at ground level and using pick and shovel throughout From beginning at ground level and using pick and shovel throughout
10	2 ft 6 ins deep	1	1½ to 4 hrs	6 ft 6 ins run of slit	—	1 pick and 1 shovel	
11	3 ft 9 ins deep	1	3 to 8 hrs	6 ft 6 ins run of slit	—	1 pick and 1 shovel	
12	<i>Digging and concealing standard type weapon slits:—</i> 2-man slit without sump	1	8 to 16 hrs	Slit 6 ft 6 ins × 2 ft × 4 ft 6 ins	—	1 pick and 1 shovel	
13	V-shaped 3-man slit without sump	2	6 to 12 hrs	One 3-man slit	—	2 picks and 2 shovels	
14	Sump	1	1 hr	1 sump 2 ft 6 ins × 2 ft × 2 ft	1 sump	1 pick and 1 shovel	
15	<i>Digging crawl trench</i> 2 ft 6 ins wide × 1 ft 6 ins deep:— Without returfing spoil	1	4 hrs	12 yds run of trench	—	1 pick and 1 shovel	In average soil If using entrenching tool, only 3 yds run will be dug in 4 hrs
16	Including returfing spoil	1	4 hrs	5 yds run of trench	—	1 pick and 1 shovel	In average soil
17	<i>Sandbag revetments:—</i> Filling sandbags	3	1 min	1 bag	20 bags	1 shovel	(i) Two men holding and tying: one man shovelling (ii) Sandbags to be three-quarters filled (holding ¼ cubic ft) (iii) In calculating tasks for carrying bags, calculate distance as for carrying baskets in notes (i) and (ii) to items 6–8 above (iv) Builders work in pairs when possible (v) 1 square ft of revetment means 1 square ft measured on the outer face of the sandbag wall. For example: A revetment 10 ft long and 4 ft high = 4 × 10 = 40 square ft, and would take 1 pair of builders. 2 × 40 = 80 mins and would require 120 sandbags
18	Carrying sandbags 25 yds; dumping and returning	1	2 mins	1 bag holding ½ cubic ft of earth	30 bags	—	(vi) A beater may be either a special wooden beater, a bill-hook or shovel
19	Building sandbag revetment	2	2 mins	1 square ft of revetment, i.e. 3 filled bags	15 square ft = 45 bags	1 beater	



APPENDIX C—*contd.*

Item No. (a)	Nature of work (b)	No. of workers (c)	Time (d)	Quantity (e)	Task per man per hour (f)	Tools for party (g)	Remarks (h)
20	<i>Sod revetment : Cutting sods</i>	3	3 mins	5 sods	33 sods	3 sharp spades	(i) Size of sod $18 \times 9 \times 4\frac{1}{2}$ ins. 1 sod to be taken as $\frac{1}{2}$ cubic ft. (ii) Allow 5 sods each $18 \times 9 \times 4\frac{1}{2}$ ins for each square ft of surface revetted 18 ins thick
21	Building sods	2	3 mins	1 square ft of revetment	—	1 shovel or spade 1 hand-axe	
22	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 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
23	Making brushwood hurdles	3	20 mins	1 hurdle	—	2 billhooks, hand-axes or matchets 1 pair of pliers	75 lb of brushwood
24	Making fascines	4	1 hr	1 fascine	—	3 billhooks, hand-axes or matchets 1 hand-saw 2 knives 1 pair of pliers 1 maul 1 fascine choker	(i) The fascine is described in Appendix A, 2. 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 (ii) The frame on which fascine is made is assumed to have been prepared (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 ins long and 3 ins in diameter, are required
25	Making loopholes in brick walls up to 18 ins thick	1	30 mins	1 loophole	2 loopholes	1 pick or 1 crowbar	(i) Add 50 per cent to the time if in cement mortar (ii) A mason's hammer and chisel are the best for this work
26	Bullet-proofing doorway, 6 ft wide	3	4 hrs	1	—	1 saw 1 hammer Nails	Shingle between boards, to a height of 6 ft 6 ins, with box loophole
27	Bullet-proofing windows, 3 ft $\times$ 4 ft	5	$\frac{3}{4}$ hr	2	—	1 shovel Sandbags	Shingle in sandbags, 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

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, 2 and 3, above.



# APPENDIX D

## TABLE OF TOOLS CARRIED BY CERTAIN UNITS IN THE FIELD (excluding those allowed for vehicle equipment)

	Tools	Armoured Regt	Armoured Car Regt	Tank Bn	Field Bty RA	Medium Bty RA	Anti-Tank Bty RA	LAA Bty RA	Field Sqn/Coy RE	Fd Pk Sqn/Coy RE	A Tps, Coy RE	Infantry Bn	Motor Bn	Recon Regt	Pioneer Coy	Divisional Reserve
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)
1	Crowbars ...	—	4	1	6	4	—	22	12	—	12	10	9	10	—	—
2	Saws, 5-ft crosscut ...	4	—	—	—	—	—	—	12	—	6	9	5	—	—	—
3	„ hand, 26-in ...	1	1	1	8	8	4	4	32	4	67	18	20	30	1	—
4	Axes, felling ...	16	—	—	14	10	12	19	26	38	20	26	16	20	2	—
5	„ hand ...	—	—	—	—	—	—	—	28	38	36	19	33	24	2	—
6	„ pick, 4½-lb head ...	31	22	16	21	36	18	51	64	—	108	134	147	85	12	515*
7	Hooks, bill ...	—	—	—	10	8	—	18	28	—	26	2	—	—	—	—
8	Saws, folding ...	—	24	—	8	8	3	—	—	—	—	12	3	23	—	—
9	Shovels, GS ...	—	—	—	50	25	16	56	—	—	—	221	188	111	24	860*
10	Spades, Mk III ...	—	—	—	17	17	12	38	6	4	16	6	12	12	2	—
11	Hooks, reaping, large ...	—	—	—	4	8	3	—	—	12	6	1	3	3	—	—
12	Matchets, 15-in blade ...	40	37	39	16	17	5	20	19	12	16	75	77	102	1	—
13	Shovels, RE ...	—	—	—	—	—	—	—	56	50	124	10	—	—	—	—
14	Wire cutters, folding ...	—	—	—	8	8	12	2	26	4	42	83	65	123	—	—
15	Sandbags ...	364	452	374	72	76	64	120	376	52	870	582	1370	488	6	—

NOTE.—\* Carried by Fd Pk Coy RE or Fd Pk Sqn RE.



## LOAD TABLES

	ARTICLES	One man load		Vehicles	
		No.	Weight in lb	15-cwt	3-ton
(a)	(b)	(c)	(d)	(e)	(f)
1	Axes, pick, 4½-lb head complete ... ..	4	28	200	840
2	Bags, sand, common (in bales of 200) ... ..	100	42	3,000	15,000
3	Canvas, hessian, roll ... .. 33 ins wide, 50 yds in roll	1 roll	36	30	120
4	„ rot-proof, roll ... .. 5 ft wide, 120 yds in roll	30 yds	32	8	40
5	Cement, bag ... .. 112 lb	—	—	12	52
6	„ cask ... .. 400 lb	—	—	3	14
7	Earth, in sandbags, ½ filled ... ..	1 sandbag	—	65	270
8	Iron, corrugated, 6-ft sheets ... .. Width, 2 ft 2 ins	2	32	—	350
9	„ „ 7-ft sheets ... .. „ „	2	36	—	300
10	„ „ 9-ft sheets ... .. „ „	1	28	—	200
11	Joists, steel, rolled (9 ft by 6 ins by 3 ins) ... .. 108 lbs	—	—	—	52
12	Metal, expanded, sheets (6 ft 6 ins by 3 ft) In cases of 20 sheets	3 sheets	33	—	200
13	*Nails ... ..	—	—	See footnote	
14	Pickets, angle, long ... .. 6 ft long	2	28	100	400
15	„ „ medium ... .. 3 ft 6 ins long	4	36	175	700
16	„ „ short ... .. 2 ft long	8	36	325	1,300
17	„ forestry, long ... .. 5 ft long, 3½ to 4 ins diam	4	36	150	600
18	„ „ short ... .. 2 ft 6 ins long, 2½ to 3 ins diam	8	24	450	1,800
19	„ screw, wire entanglement, long ... ..	4	34	150	600
20	„ „ „ short ... ..	12	33	400	1,630
21	Props, pit, 9 ft long ... .. 6 ins diam	—	—	—	75
22	„ „ 9 ft long ... .. 9 ins diam	—	—	—	36
Road-making materials :—					
23	Sand ... ..	—	—	15	60
24	Shingle ... ..	—	—	17	69
25	Clay ... ..	—	—	14	57
26	Chalk ... ..	—	—	12	51
27	Earth ... ..	—	—	24	96
28	Granite ... ..	—	—	10	40
29	Limestone ... ..	—	—	10	43
30	Shovels, GS ... ..	7	25	250	1,500
31	„ RE ... ..	5	28	100	1,050
32	†Staples, No. 8 SWG ... ..	—	—	See footnote	
33	Tapes, tracing ... .. in 50-yd rolls	12	—	—	—
34	Timber, 4 ins by 2 ins ... .. 2½ lb each ft run	—	—	500	2,250
35	„ 9 ins by 3 ins ... .. 9 lb each ft run	—	—	90	600
36	Wire, barbed, coils ... .. 130 yds in coil	1	28	50	200
37	„ „ concertinas ... ..	1	50	20	80
38	†Wire, galvanized, iron, coil ... .. No. 14 SWG	½ coil	28	25	100
39	„ netting, roll ... .. 3 ft wide, 50 yds in roll	20 yds	32	16	70

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

† Staples, No. 8 SWG, 50 to 1 lb.

‡ Wire, No. 14 SWG, one 56-lb coil=1,093 yds.

NOTES.—1. Figures for the 3-ton lorry are based on loading trials. Figures for 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 :—

	DAF	Triple concertina
Wire and screw pickets ... ..	800 yds	400 yds
Wire and angle iron pickets ... ..	500 yds	—

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



## THE WORK TABLE

1. When estimating the time and labour for field engineering work some form of work table should be compiled. An example is given opposite page 68.

When completed, the table may also be used to guide the officer in charge of the work in organizing the various working parties. It should not, however, be used as a time table to be followed literally.

First write down in column (b) the various sub-divisions or stages of the work in order of priority. Then calculate the numbers of men and time required for each stage. These can be obtained from the tables in Appendices C and E, or estimated from experience.

Decide on the hours of work, considering intervals for meals, or the arrangement of shifts. Show these in the "Allotment of labour" column (d), where the sub-divisions represent working hours. Opposite those tasks which can be started at once, fill in the number of men working in the first shift, or part of it. Check that the total number of men shown as working at any one time does not exceed the number available. If it does, then adjust the first shift and arrange to carry on the uncompleted jobs in the next shift. If the total falls short of the numbers available, look to see whether the spare men can be usefully employed on starting the next task; if so, put them down against it; if not, put them as spare at the bottom of each column.

Go through the remaining tasks in the same way.

Finally, check that no task is scheduled to start before the completion of any other task which must precede it (e.g. revetting cannot begin before the digging is completed) or before the necessary stores reach the site.

The table then gives the estimated time by which the work will be completed. An allowance for contingencies must be added to this, the amount depending upon the degree of accuracy with which it has been possible to estimate the detail.

If the table is to be used to guide the officer or NCO in charge of the work, additional explanatory information (e.g. tools and stores required) can be given in the "remarks" column, or extra columns can be added.

2. (a) The work table given below is an example of the initial stages of the preparation of a company defended locality, showing the organization of the work for the first day and part of the second. It must NOT be taken as a programme applicable in all cases.



(b) The following assumptions are made :—

- (i) Two platoons are available for working parties—48 working numbers in all. The third platoon is employed on protective duties, etc.
- (ii) The men are worked in 4-hour shifts, one shift working while the other has a meal and rests. (This may be necessary during the early stages of the development of a position, but the hourly output of work will be greater if the men are worked for only two 4-hour shifts in the 24 hours.)
- (iii) Work on tank obstacles and anti-tank minefields is being done by other troops.
- (iv) Work is possible by day.
- (v) The soil is easy, and the work allowed for on the weapon slits includes removing turf and returfing or carrying spoil away, but not digging of sumps nor revetting. Each weapon slit is assumed to be an 8-hour task by day, but allowance can be made for slower work at night by using spare men on the following day to complete any unfinished tasks.
- (vi) Only 20 picks and 20 shovels are available.
- (vii) The wiring stores have to be carried half a mile, assuming a rate of 2 mph; one journey takes half an hour.

(c) The number of weapon slits required for a company will depend on the actual strength of the company. In the specimen work table given below it has been assumed that :—

- (i) Each section needs four 2-man (or one 2-man and two 3-man) slits.
  - (ii) Each platoon HQ needs two 3-man slits and one 2-man slit.
  - (iii) Each platoon therefore requires thirteen 2-man and two 3-man slits, or the equivalent, *e.g.*, four 2-man and eight 3-man slits.
  - (iv) **Company HQ** needs cover for 15 men, *i.e.*, five 3-man slits.
- (d) **Spare men** will be employed as required :—
- (i) assisting in the removal of spoil from the weapon slits;
  - (ii) completing any tasks left unfinished by previous shifts;
  - (iii) doing any odd jobs which arise during the course of the work.

When men are digging in pairs and there is a shortage of tools, one pick and one shovel may be shared between two men.

To face page 70]

Serial No.	Task	Quantity	1st relief				
			0700	0800	0900	1000	1100
(a)	(b)	(c)					
1	Digging weapon slits						
	7 Pl locality ... ..	13 2-man slits					
		2 3-man do					
	8 Pl locality ... ..	10 2-man do					
		4 3-man do					
	9 Pl locality ... ..	13 2-man do					
		2 3-man do					
	Coy HQ ... ..	5 3-man do					
2	Clearing field of fire ...						
3	Carrying stores for trip wires	12 man-loads ½ mile carry					
4	Erecting trip wires ... ..						
5	Carrying stores for concertina fence	34 man-loads ½ mile carry					
6	Erecting concertina fence ...	100 yards					
7	Digging sumps in weapon slits	49 sumps					
8	Cutting and carrying pickets and brushwood for revetment						
9	Revetting weapon slits ...	49 slits					
		Spare					
		Totals ... ..					

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