

**DEEP GALLERY SHELTERS.****DOCUMENTS CONSULTED.**

Instructions of December 21, 1915, on Fieldworks for the Use of Troops of All Arms.

Manual for Commanders of the Infantry Platoons (General Headquarters, Third Bureau, 1916).

School of Mines.

Various Army Notes on Deep Shelters.

Note on Deep Shelters by Col. Cernesson (Engineer Instruction Center of the Army Group of the Center).

Lecture on Shelters by Lieut. Col. Cazalas (Engineer Instruction Center of the Army Group of the Center).

Extract from the secret note of general headquarters, dated April 5, 1916, in regard to the information to be drawn from the Battle of Verdun.

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## NOTE ON THE CONSTRUCTION OF DEEP GALLERY SHELTERS.

### I. OBJECT.

With the increasing intensity of bombardments, the question of shelters has become one of capital importance in the organization of sectors both from the offensive and defensive points of view.

As bombardments are executed exclusively with artillery of medium and large caliber, it is necessary that the shelters be able to resist the systematic and regular fire of medium-caliber artillery or of single rounds from the large-caliber gun most frequently used, for example, the 21-centimeter mortar. In other words, the shelters in question should belong to the class of works defined as bombproof shelters by the Instructions of December 21, 1915, on field works for the use of troops of all arms. (See Instructions of Dec. 21, 1915, No. 89, p. 43.)

Experience has shown, on one hand, that the type of sunken shelters (see Instructions of Dec. 21, 1915, No. 128, p. 77) covered with a filling of earth containing three layers of round logs was not proof against the projectiles with delay-action fuses of the German 21-centimeter mortars, even with a small charge of explosive (6.3 kilograms to 8 kilograms), and that on the other hand the type of shelter known as "deep shelter" (see Instructions of Dec. 21, 1915, No. 128, p. 77) was able to resist projectiles of large caliber if the untouched soil above it was of the proper thickness, which again depends on the nature of the terrain and the kind of projectiles used against it.

Consequently, among the sunken shelters described by the Instructions of December 21, 1915, under No. 128, only those constructed underground, at a suitable depth, are bombproof in the sense given to this term in the above-mentioned instructions.

It therefore follows that this shelter, generally known as a deep-gallery shelter, should be adopted to the exclusion of every other type, except in cases where a water-bearing stratum is encountered near the surface.

It appears from the above that the Engineer troops, to whom the construction of such shelters is intrusted, should be thoroughly acquainted with all details concerning the construction of these shelters. The Engineer troop depots of the interior must therefore lay great stress on that part of the instruction of sappers which deals with the construction of this type of shelters.

The object of the present note is only to facilitate the task of the officers of the above-mentioned depots by placing at their disposal a résumé of the principles and details of construction now used by the armies in constructing "deep gallery shelters."

## II. DEFINITION.

By deep gallery shelters are understood shelters executed by subterranean, as distinguished from open-cut, excavation, the roof and walls of which are given a plank lining constructed according to the principles laid down by the School of Mines for the construction of mine galleries. (See School of Mines edition published Apr. 30, 1909.) The prescriptions of the School of Mines must be strictly followed, and, in particular, the precautions therein mentioned as regards strengthening the galleries must always be taken.

The casing is generally of wood. (Note: Some type of frames of reinforced cement, studied by the Technical Section of the Engineers, are now on trial.) In this case, according to the resources at hand, the frames may be either of the ordinary standard type or makeshift frames of roughly squared logs (see plate 5).

If on good terrain large frames of thick planks may be used for lining the entrance descents to the galleries (see plates 2 and 5).

## III. ADVANTAGES.

Besides providing shelter against single round of the 21 centimeter gun with the means at hand in the field, the deep gallery shelter has the advantage of being easy to construct, and the enemy will suspect nothing if care is taken either to conceal the spoil or to unload it far enough away.

The one fault generally found with this type of shelter is that it is slow to construct. This is compensated, in a certain measure, by the fact that work may be carried on continuously as soon as the descents have attained a length of a few meters.

These descents then constitute shelters in themselves and are far superior to niches or temporary shelters.

#### IV. SUMMARY DESCRIPTION.

Deep gallery shelters are of two types—single and double. The former are especially appropriate for troops guarding the first-line trenches.

Generally speaking, the single shelters are the most used.

The type of shelter to be adopted depends on local tactical circumstances, but its choice is also subordinate to the nature of the subsoil and the contours of the terrain.

As to the nature of the subsoil and the situation of the emplacement, experience has shown that it is best to make a careful examination of the terrain before giving up the construction of deep shelters through fear of their being invaded by water. Simple operations may often be found after close study. For instance, in certain places where only shelters of no great depth had been undertaken the existence was discovered, at a varying depth, but fairly near the surface, of a layer of thick clay, compact, without fissures, and consequently waterproof. Deep gallery shelters were dug there, after the pervious upper layer had been previously drained and isolated within a certain radius by means of ditches dug deep into the clay strata, which insured the draining of the water.

##### SINGLE SHELTER.

The single shelter generally consists of a horizontal gallery dug underground to a depth depending on the nature of the terrain, and chosen in consequence, according to the indications given in Paragraph V hereafter.

Access is obtained by *at least* two distinct descents, at sufficient distance from each other to prevent their being subject to the action of the same projectile.

The descents should be made as steep as possible, in order to diminish their length, in order, on the one hand, to reduce the amount of work required to construct them, and on the other to make them less vulnerable. Each descent generally debouches at one extremity of the main part of the shelter. The entrances to the descents constitute the most delicate part of deep shelters, as it is not possible with the means usually available to give them adequate protection. They open on a trench or on a portion of an open or covered *boyau*.

The protection of the entrances may be improved by keeping their sills at a fairly low level, by deepening the entrance boyau, and by reinforcing the covering of the armored portion of this boyau with layers of logs placed side by side and solidly joined together with wire or cramp irons. (See variation of sketch No. 6.) However, every precaution should be taken to prevent the entrance of water.

To enable the garrison of a shelter to leave it, even if the trench has fallen into the hands of the enemy, it is wise whenever the necessary time and personnel is available to provide an additional outlet easy of egress, debouching in the open country in rear or in front of the trench. This outlet should consist of a gallery with gentle slope so as to permit of rapid evacuation. To deceive the enemy, it would be well for the relative position of this third outlet not to be uniform with reference to the two others. Moreover, the exit should be concealed as well as possible. If there is no natural or artificial depression within convenient distance around the shelter, the exit gallery may be made to end in a sloping sap, debouching in a shell crater, real or simulated, if the terrain is already torn up. In this case, care should be taken to disguise this sap to prevent its appearing on the aerial photographs. An easy and simple method consists in stretching a metal grating between the ends of the sap and covering it with a thin layer of grass, straw, raffia, or branches. It may also be covered with ordinary canvas or awning properly adjusted.

This supplementary exit on the open country is especially needed in shelters for troops guarding the first-line trenches.

It is also advisable to provide shelters of the latter class (shelters for first-line trenches) with *underground communication* connecting them *in front with the combat posts for machine guns or automatic riflemen, with the observing stations and listening posts.* In the first positions, where it is hardly possible to transport matériel and armor, these stations, also well disguised, are equipped with shields (of a light type that can be transported in the galleries) proof against perforating bullets and projectiles of small-caliber guns (37-47 millimeters). In the second position these posts or observing stations, also disguised, may be covered with cement and equipped with armored roofs.

On account of the many and various solutions which may be devised, the dimensions and arrangements of detail of the shel-

ters can not be strictly regulated. The types shown in the sketches attached to the present note are only given as an indication.

It should be noted, however, that each shelter should be constructed with a view to receiving a unit consisting of *at least* one-half a platoon, as a rule. A smaller unit should not be considered, for owing to the amount of work required by the construction of the descents to the deep shelters (which work is independent of the capacity of the shelters), the construction of shelters for a unit of less than one-half a platoon would require an amount of work out of all proportion to the object to be attained.

The capacity of the shelters is determined by the commanding officer in the orders relating to the organization of the sector.

As for the arrangement of details and the preparation of the interior of the shelters, it will be sufficient to call attention to the following points:

1. In each shelter there should be camp beds with two, and sometimes in exceptional cases, three berths above each other (made of boards or wire trellis work with wooden frame), for a fraction of the unit in occupation, and a certain number of seats, the proportion of each to be determined by the commanding officer.

Room for the camp beds may be obtained by giving to the horizontal gallery the profile of the grand gallery,<sup>1</sup> or else by opening on a transversal service passage (in the main gallery or in the great gallery) cells of varying length of the dimensions required for the installation of camp beds.<sup>2</sup> These cells are generally constructed in the grand gallery. The width to be obtained by this arrangement is, per tier of berths, either three places side by side,<sup>3</sup> or two places separated by a passage; the latter installation should be reserved for cases when the cell must contain several rows of beds in depth.<sup>4</sup>

Two rows of beds of three tiers each are sometimes installed in the grand gallery, which with equal capacity gives more free space.

The cell system is often praised because it can be constructed progressively. It can be utilized as soon as the transversal gal-

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<sup>1</sup> See sketches 1 and 3.

<sup>2</sup> See sketches 6, 7, 8, and 9.

<sup>3</sup> See sketches 7 and 8.

<sup>4</sup> See sketches 6 and 10.

## DEEP GALLERY SHELTERS.

Material required for the construction of some of the various types of shelters, etc.—Continued.

## III. SINGLE SHELTER FOR ONE-HALF PLATOON, ETC.—Continued.

Name of parts of shelter.	Logs.				Rafters.			Strips, 0.03 by 0.01 meter.	Batten, 0.018 meter.	Wire nails.	
	Diameter of 0.10 meter and length of—		Diameter of 0.15 meter and length of—		0.04 by 0.08 meter.	0.08 by 0.08 meter.	0.06 to 0.10 meter.			0.15 to 0.18 meter.	
	3 meters.	4 meters.	3.5 meters.	2.1 meters.							
1. Shelter proper.....	22	2	.....	.....	Meters 26	Meters .....	Meters .....	Meters 18	Kilograms 8	Kilograms 4	
2. Entrances and descents.....	.....	8	80	.....	7	.....	.....	.....	2	1.75	
3. Periscope room and lantern.....	4	.....	4	4	.....	.....	.....	.....	1	.....	
4. Niches (grenades, etc.).....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.25	
5. Interior arrangements:	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
(a) Bunks for 12 men and officer.....	.....	.....	.....	.....	.....	28	.....	.....	3	.....	
(b) Benches for 10 men.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	
(c) Shelves.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	
6. Closing panels (4 alike).....	.....	.....	.....	.....	.....	.....	20	.....	.....	.25	
Total.....	26	10	80	4	37	28	20	18	17.50	5.75	

<sup>1</sup> Sheet-iron pipe 0.15 in diameter, for periscope room, 7.5 meters.

## IV. GROUP OF DOUBLE SHELTERS, PORTION FOR ONE PLATOON.

Name of parts of shelter.	Main gallery frame.	Great gallery frame.	Special frame, 1.33 by 1.90 meters.	Half gallery frame.	Special frame, 0.80 by 1.64 meters.	Planks (roof), length.		
						1 to 1.10 meters.	1.20 to 1.30 meters.	1.50 meters.
1. Shelter proper:	.....	.....	.....	.....	.....	.....	.....	.....
(a) First story.....	5	.....	19	5	7	100	41	5
(b) Second story.....	16	8	.....	.....	6	62	120	36
2. Entrance and descent.....	.....	9	3	23	.....	126	6	12
3. Interior arrangements:	.....	.....	.....	.....	.....	.....	.....	.....
(a) Camp beds for 12 men and officer.....	.....	.....	.....	.....	.....	.....	.....	.....
(b) Benches for 10 men.....	.....	.....	.....	.....	.....	.....	.....	.....
(c) Shelves.....	.....	.....	.....	.....	.....	.....	.....	.....
4. Closing panels (4 alike).....	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	21	17	22	28	13	338	167	53



DEEP GALLERY SHELTERS.

Material required for the construction of some of the various types of shelters, etc.—Continued.

IV. GROUP OF DOUBLE SHELTERS, ETC.—Continued.

Name of parts of shelter.	Planks, casing.			Mine bat- tens.	Logs.			
	Length.				Diameter of 0.10 meter and length of—		Diameter of 0.15 meter and length of—	
	to 1.10 meters.	1.20 to 1.30 meters.	1.50 meters.		3.50 meters.	4 meters.	3.50 meters.	2.10 meters.
1. Shelter proper:				Meters.				
(a) First story.....	196	202	54	20	4			
(b) Second story.....	228	330		112	5			
2. Entrance and descent	340	20	58	25	43	41	2	
3. Interior arrange- ments:								
(a) Camp beds for 36 men and offi- cer.....								
(b) Benches for 10 men.....								
(c) Shelves.....								
4. Closing panels (2 alike).....								
Total.....	762	552	112	450	81	50	2	

Name of parts of shelter.	Inter- vening up- rights for great gallery frame, 0.1 by 0.7 by 1.10 meters.	Woo- l stakes, 0.1 by 0.10 meter; length, 1.50 meters.	Planks, 0.027 meter; length, 2.10 meters.	Rafters.			Square meters.
				0.04 by 0.08 meter.	0.08 by 0.08 meter.	Straps, 0.03 by 0.01 meter.	
1. Shelter proper:				Meters.	Meters.	Meters.	Square meters.
(a) First story.....	2			16			5
(b) Second story.....	10			17.5			
2. Entrance and descent.....		33	4	40.0			
3. Interior arrange- ments:							
(a) Camp beds for 36 men and offi- cer.....				180	12.5		
(b) Benches for 10 men.....				7			
(c) Shelves.....				6			
4. Closing panels (4 alike).....				8			12
Total.....	12	33	4	201	73.5	12.5	12

## DEEP GALLERY SHELTERS.

Material required for the construction of some of the various types of shelters, etc.—Continued.

## IV. GROUP OF DOUBLE SHELTERS, ETC.—Continued.

Name of parts of shelter.	Wire nails.		Planks, 0.22 by 0.08 meter.	Canvas.
	0.04 to 0.10 meter.	0.15 to 0.18 meter.		
	<i>Kilo-grams.</i>	<i>Kilo-grams.</i>	<i>Meters.</i>	<i>Meters.</i>
1. Shelter proper:				
(a) First story.....	4	2		
(b) Second story.....	3	1		
2. Entrance and descent.....	5	3	30	
3. Interior arrangements:				
(a) Camp beds for 36 men and cover.....	6			
(b) Benches for 30 men.....	0.50			
(c) Shelves.....	0.15			
4. Closing panels (2 alike).....	0.35			1.50 by 1.80
Total.....	19	6	30	2 (1.50 by 0.90)

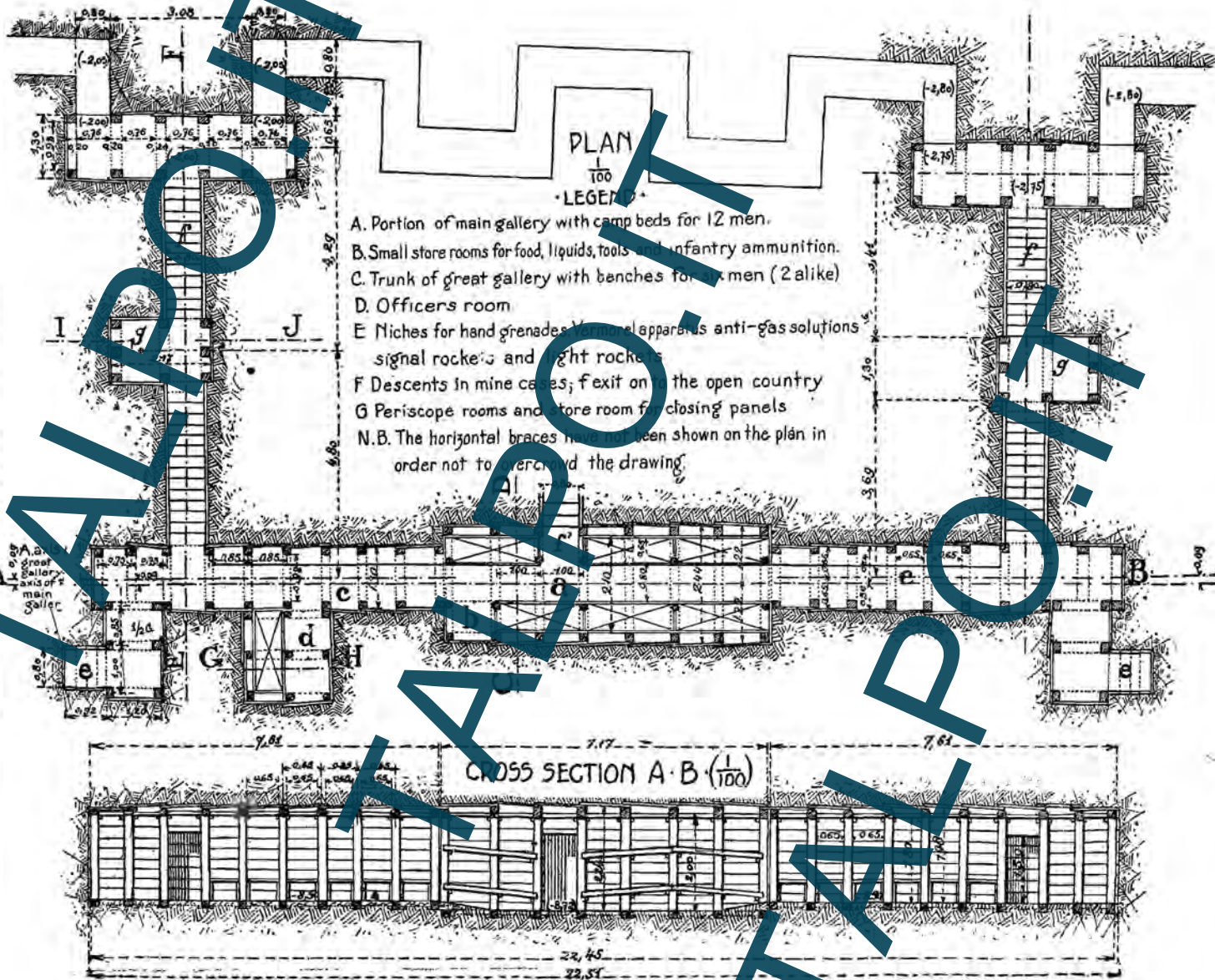
NOTE.—The following must also be provided: Wedges, slope templates, and wooden lining for the construction of the galleries; 6 camp irons with points in the same direction; 24 bolts 24 centimeters long, 18 bolts 18 centimeters long, and 21 bolts 12 centimeters long for the entrance to the shelter, and also the wire to bind together the roof for the cover of this entrance.

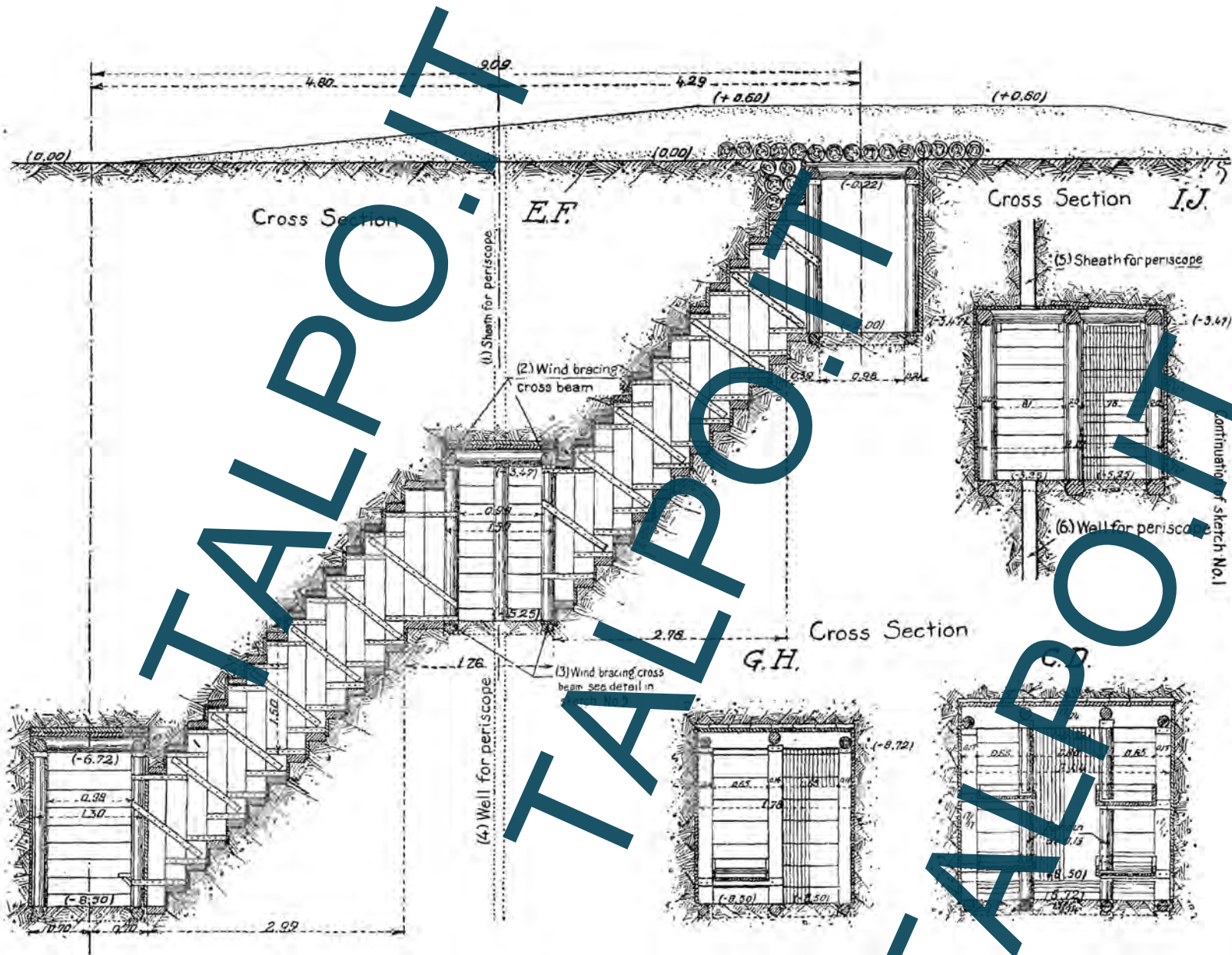
The material for the third exit and for the defense of this shelter is also not included in the above estimates.

Sketch No. 1 attached to note  
of January 21st, 1917.

# TYPE OF SINGLE SHELTER FOR 1/2 PLATOON

SHELTER WITH CENTRAL BODY WITH MAIN GALLERY FRAME





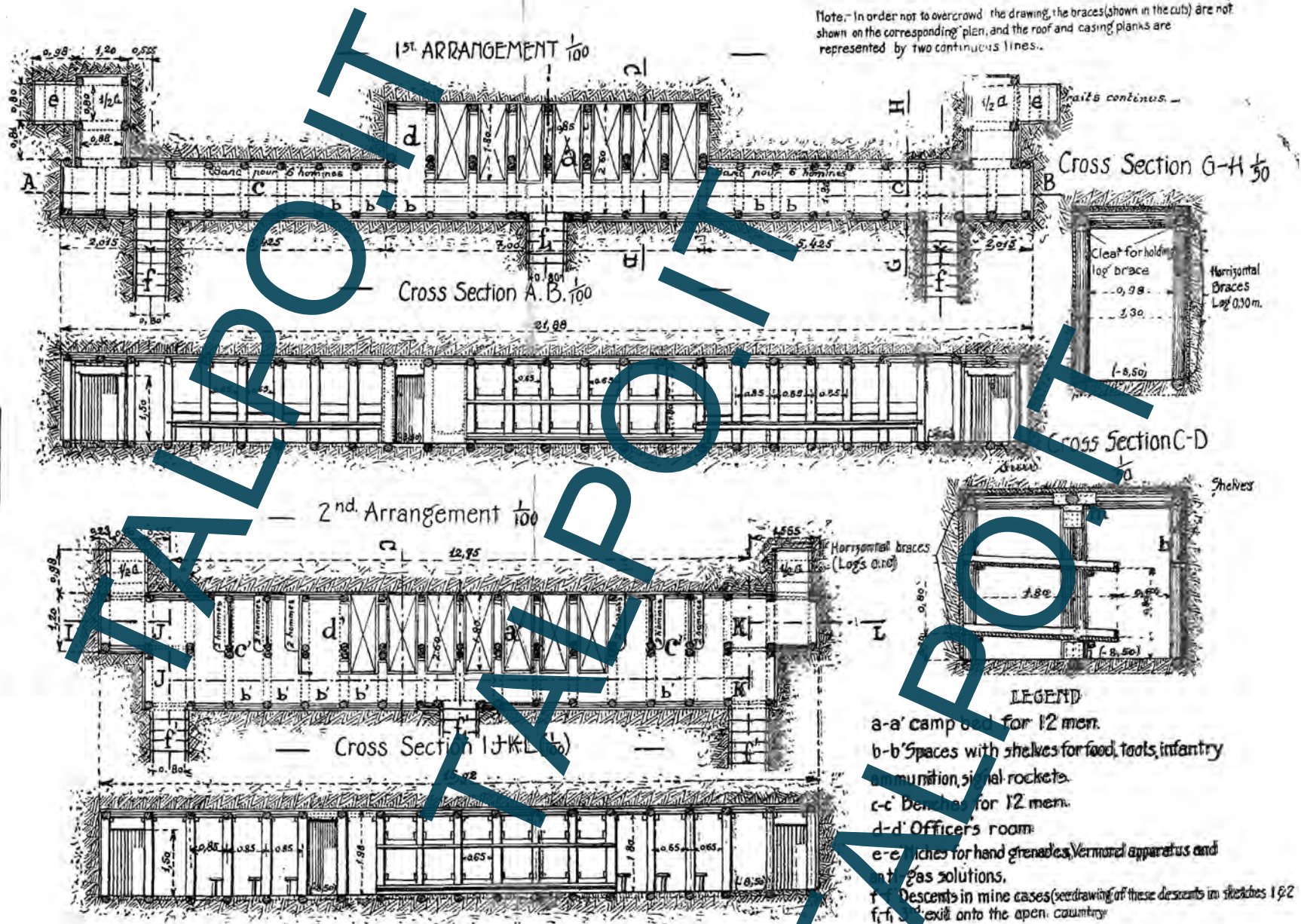
TYPE OF SINGLE SHELTER ]  
 FOR 1/2 PLATOON  
 SHELTER WITH CENTRAL BODY WITH MAIN GALLERY FRAME

Sketch No. 2 attached to note of  
 January 21<sup>st</sup> 1917.

Sketch No. 3 attached to  
note of January 21<sup>st</sup> 1917.

TYPE OF SINGLE SHELTER  
FOR ½ PLATOON

Body of shelter with great gallery frame

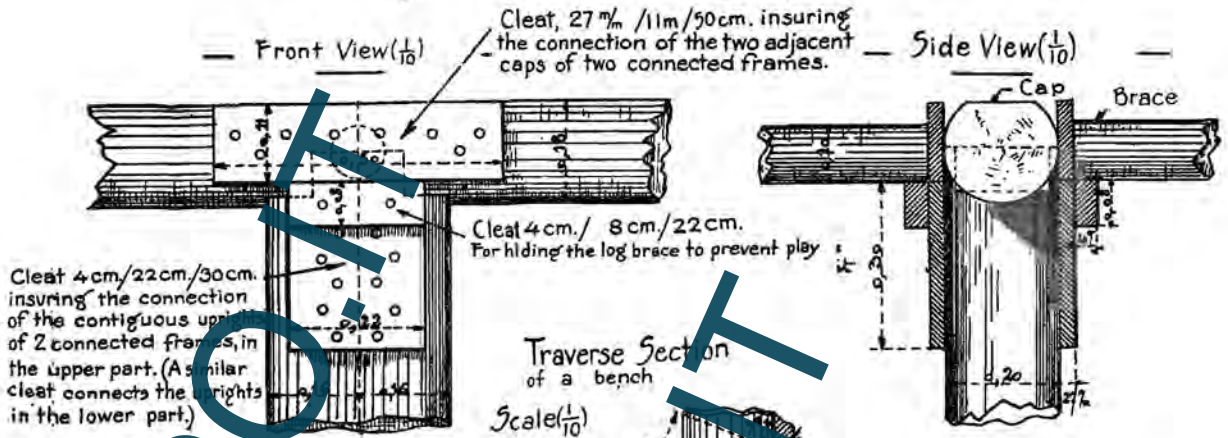


# TYPE OF SINGLE SHELTER FOR 1/2 PLATOON

Details of the type having body with great gallery frame

Sketch No. 4 attached to  
note of January 21<sup>st</sup>,  
1917

Detail of the junction M of the  
uprights and the caps  
(See Sketch No. 3 Cut following CD)

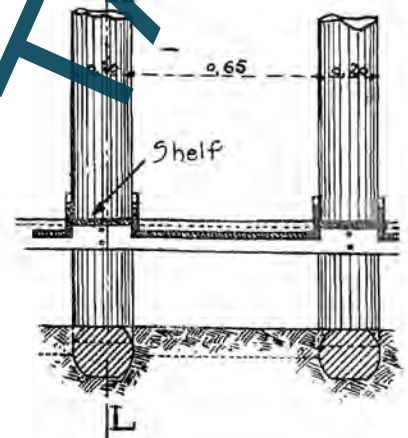
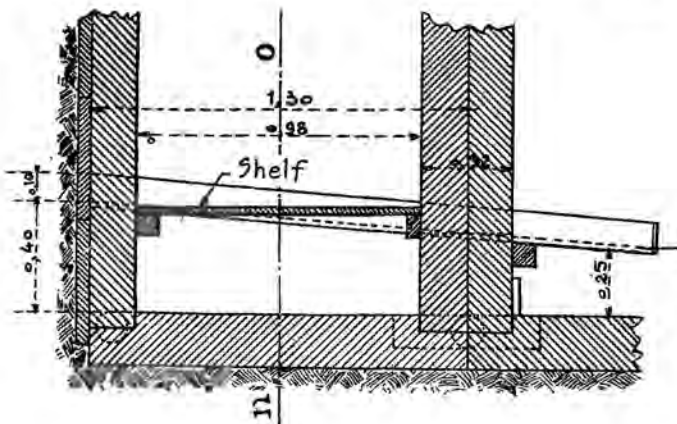


Traverse Section  
of a bench  
Scale (1/10)

DETAIL OF A BED

- Cross Section K-L - Scale 1/10

- Cross Section M-O -



# TYPE OF SINGLE SHELTER FOR 1/2 PLATOON

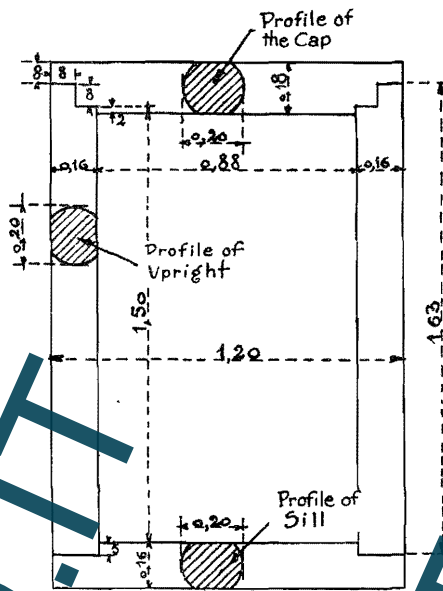
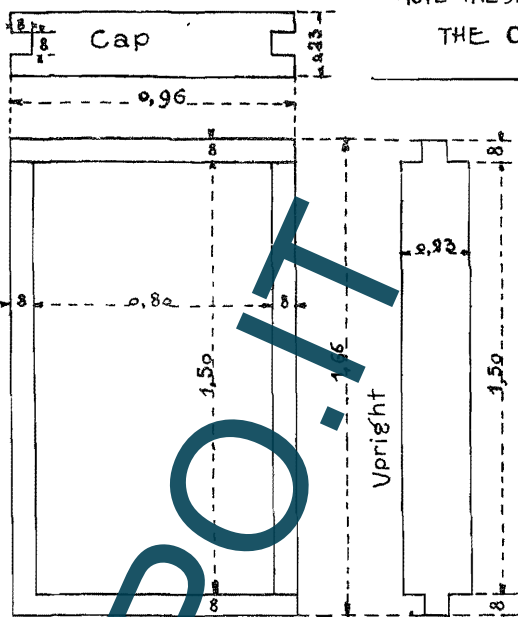
Sketch No. 5 attached  
to note of January  
21<sup>st</sup>. 1917

DETAILS OF THE FRAMEWORK USED IN THE TYPES SHOWN IN SKETCHES 1, 2, 3, 4

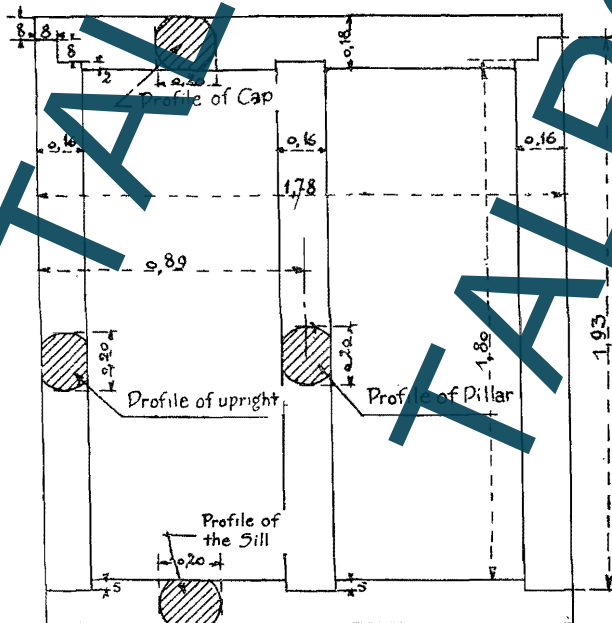
MINE CASES FOR DESCENTS

SCALE 1/20

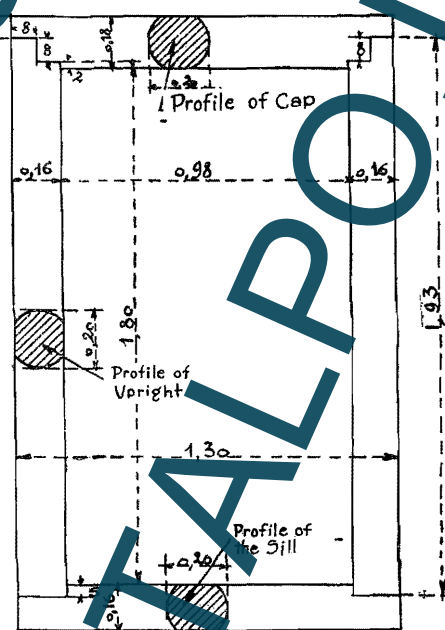
FRAME OF HALF  
GALLERY



FRAME WORK FOR OFFICERS ROOM



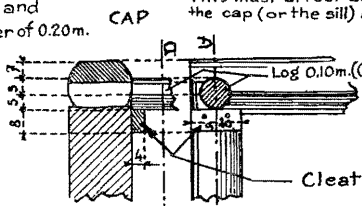
frame work of great gallery



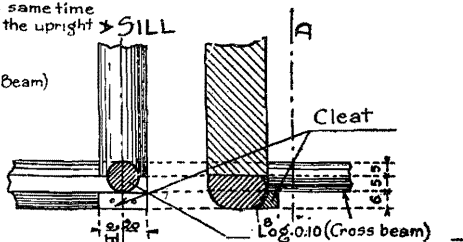
Note: The logs in the special frame work are roughly squared and have a minimum diameter of 0.20m. The framework of the main gallery which is simply the regulation frame work has therefore not been shown on the present sketch.

## LONGITUDINAL WIND BRACING

This must affect at the same time the cap (or the sill) and the upright



Cut A.B. Elevation C.D.



Elevation C.D. Cut A.B.

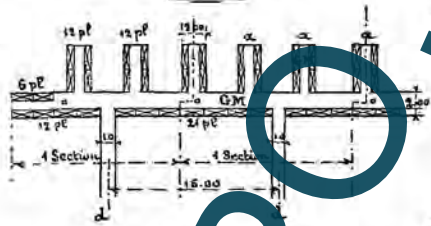
# DIAGRAMS OF TYPES OF SINGLE SHELTERS WITH CELLS

Scale of  $\frac{1}{500}$

Sketch No. 6 attached to note of January 21st 1917

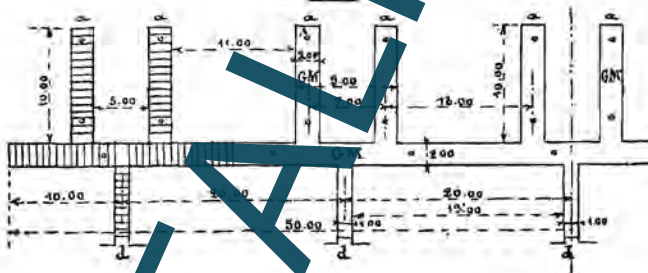
Sketch No. 1  
Shelter with short cells.

This type is generally substituted for type of double shelter shown in sketches 7 and 8

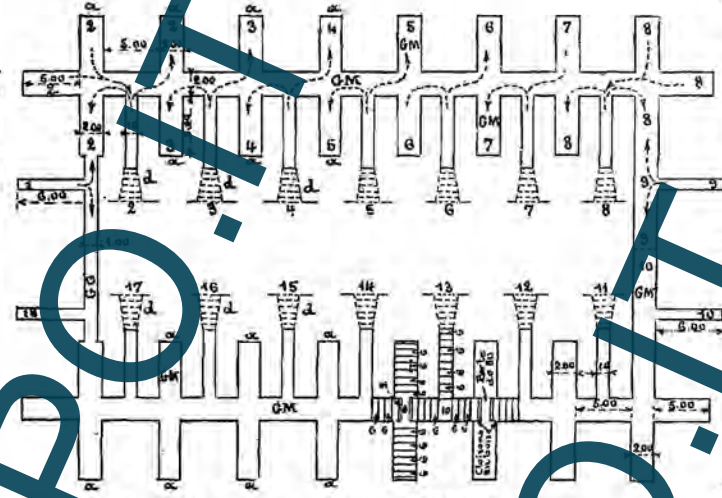


By using three story beds and arranging them in the manner shown by the sketch the capacity of a shelter for a company will be 231 places. The necessary room can therefore be reserved for officers for a small office-store room, and for an electric plant.

SKETCH NO. 2  
Shelter 100 meters long with large cells



SKETCH NO. 4  
Army Corps Command Post.

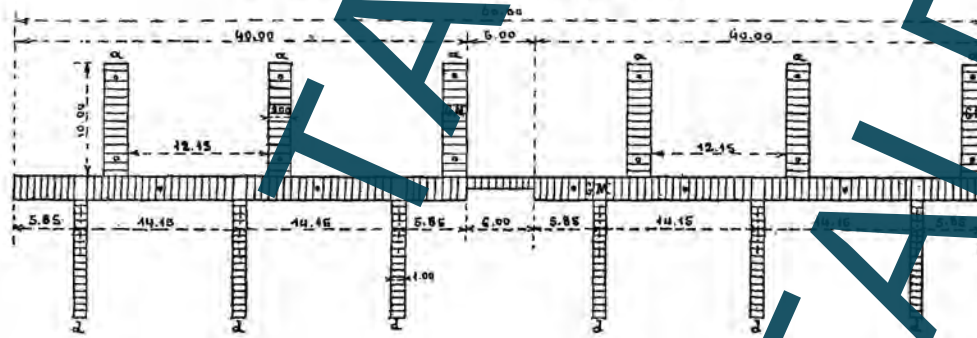


Distribution of the work of excavation among the 18 elevators

Distribution of the frame work  
2 means 0.60m from axis to axis.  
2 means 0.20m from axis to axis.  
8 means 0.80m from axis to axis.  
10 means 1m from axis to axis.

The sketch shows the arrangements adopted by a unit of a battalion MD in the construction of this command post

SKETCH NO. 3  
Group of two shelters with large cells

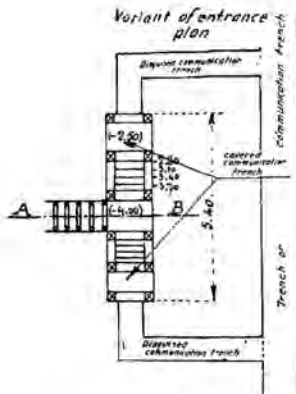


- LEGEND
- A-Cells
  - D-Descents
  - GM-Main gallery
  - GG-Great gallery
  - o-Ventilation shaft



# GROUP OF DOUBLE SHELTERS \* PORTION - FOR ONE PLATOON

Sketch No 7 attached to note of January 21<sup>st</sup> 1917



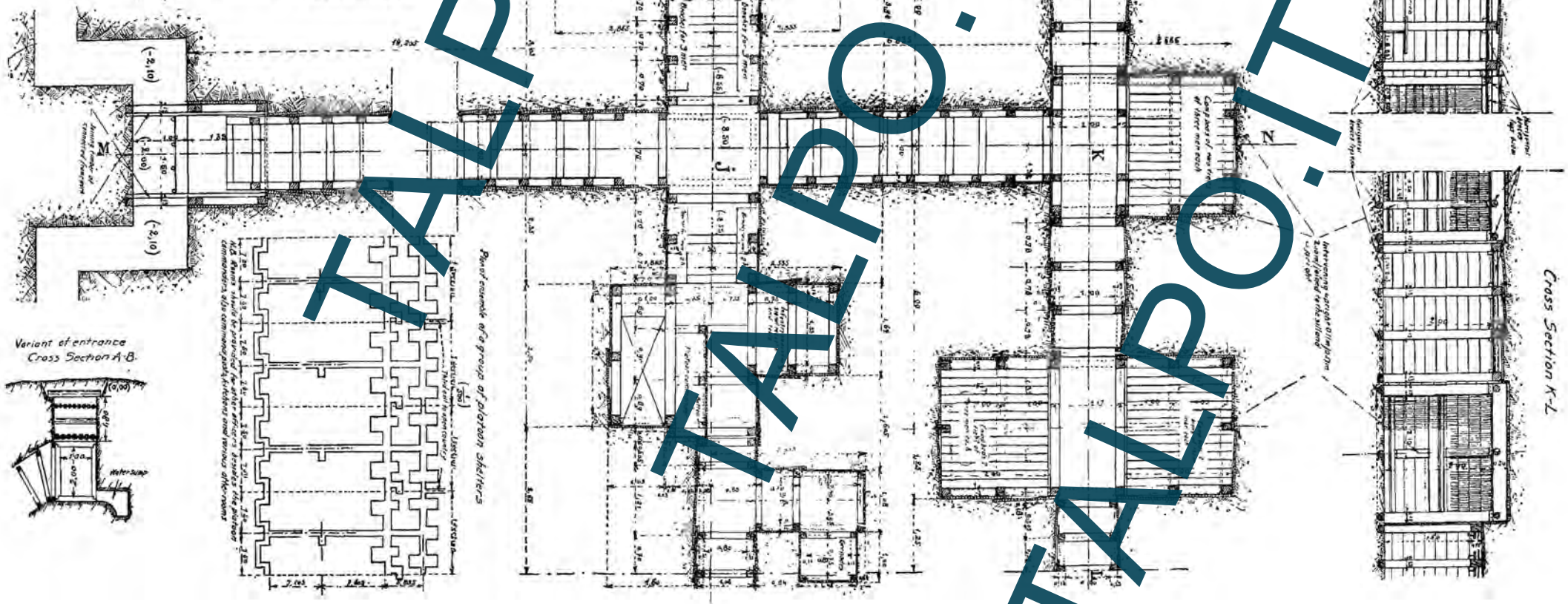
N.B. On the plan A-B-C-D-E-F the horizontal braces of both stories of the bed of the shelter are represented by a dotted line. The various braces of the descent are not shown on this plan in order not to overcrowd the drawing.

### Cross Section O-D



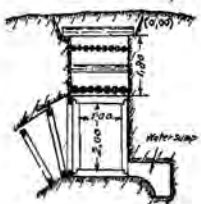
### PLAN FOLLOWING ABCDEFGH

(1/50)



Plan of one of the group of platoon shelters

### Variant of entrance Cross Section A-B



### Cross Section I-J

### Cross Section K-L

TALROIT TALROIT TALROIT

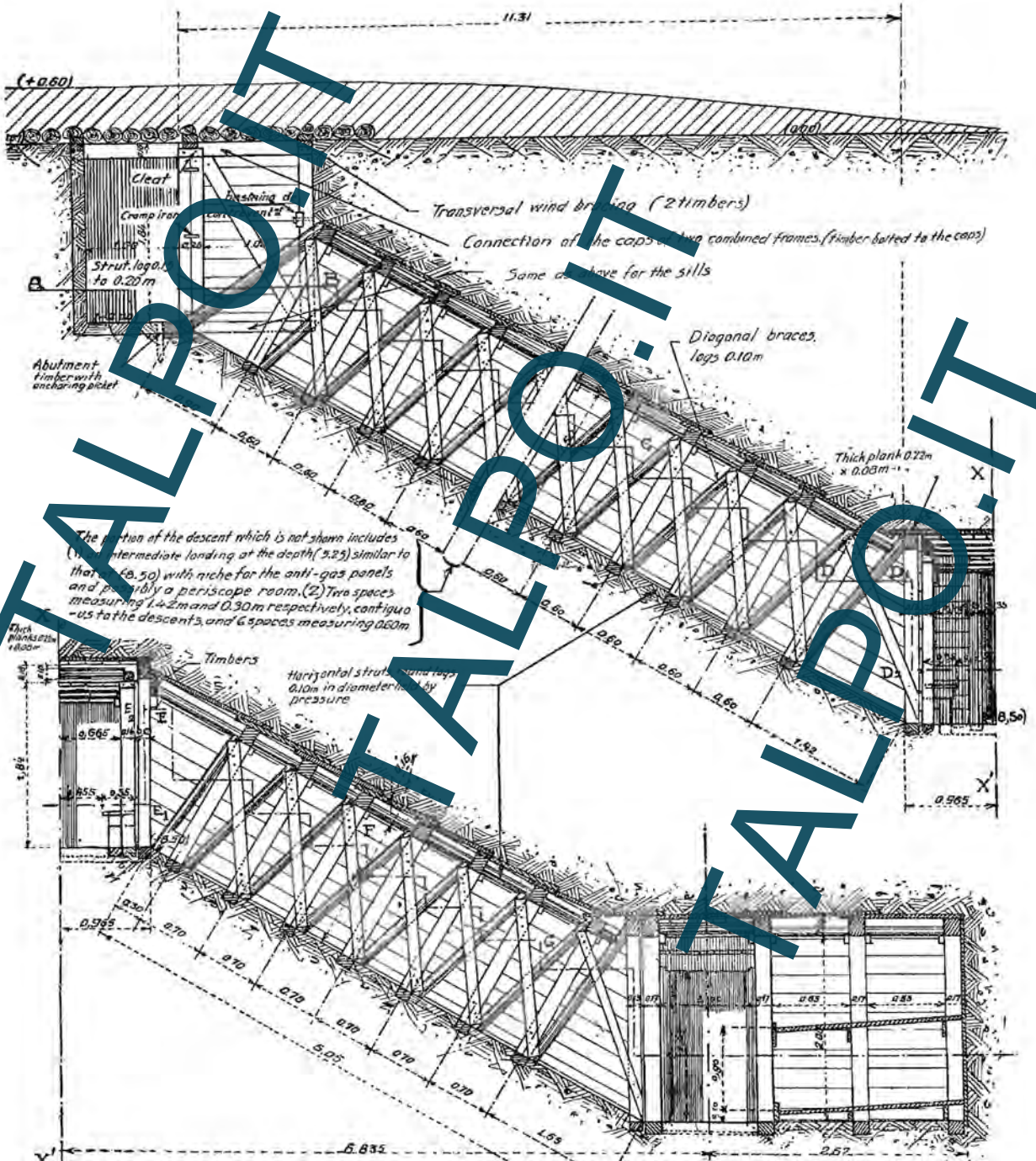
# GROUP OF DOUBLE SHELTERS

Sketch No. 8 attached  
to note of January 21<sup>st</sup> 1917.

TYPE OF PORTION FOR ONE PLATOON

CROSS SECTION M-N

( $\frac{1}{100}$ )



The portion of the descent which is not shown includes (1) an intermediate landing at the depth (3.25) similar to that at 6.50 with niche for the anti-gas panels and possibly a periscope room. (2) Two spaces measuring 1.42m and 0.30m respectively, contiguous to the descent 3, and 6 spaces measuring 0.60m

Note:-- Vertical frame work in the casing of the descents is generally preferred to the arrangement shown above in which the casing requires the frame-work to be placed perpendicular to the axis of the descent it is merely shown above for information

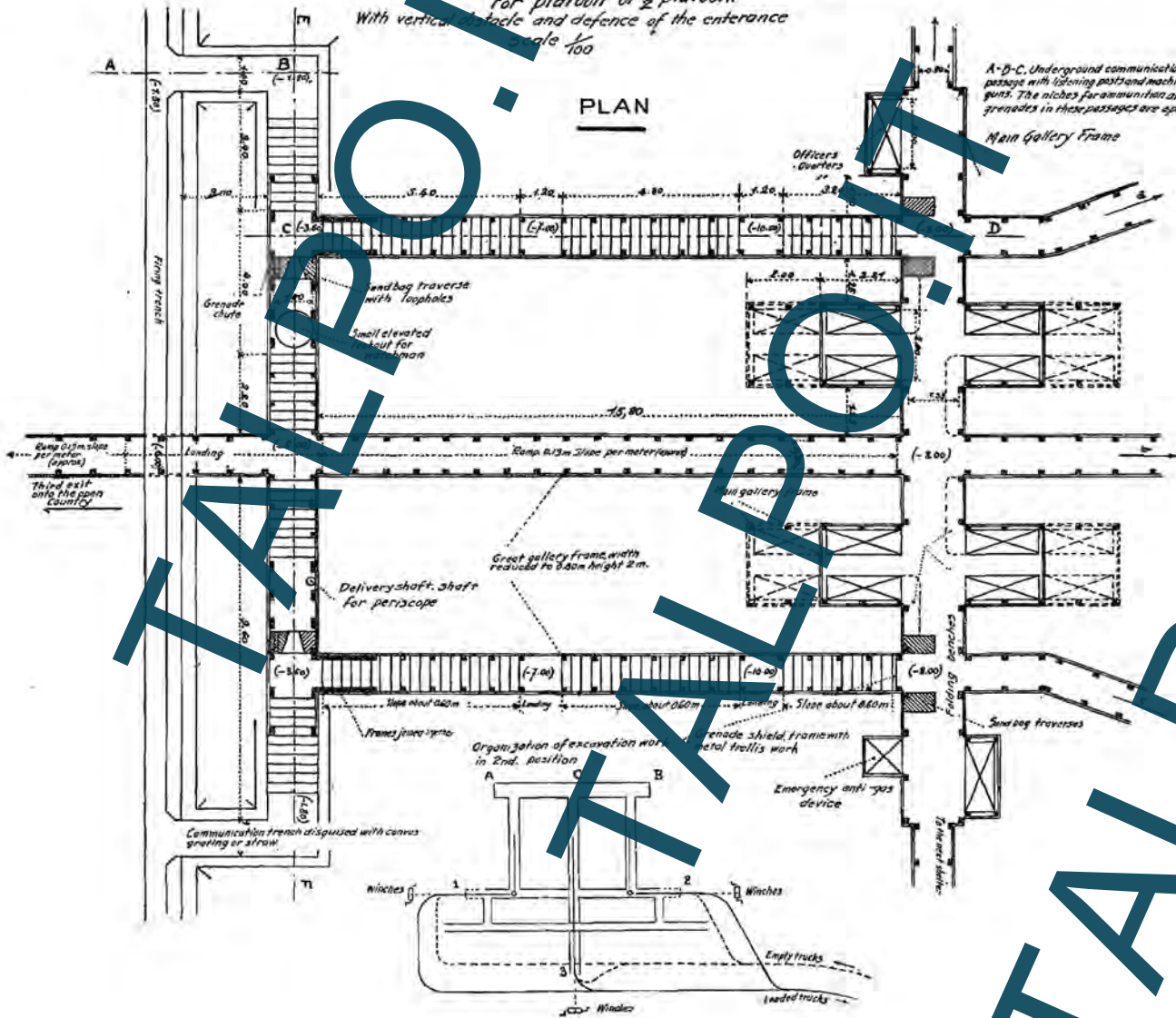
TYPE OF SINGLE SHELTER OF THE ENGINEER INSTRUCTION SCHOOL  
OF THE ARMY GROUP OF THE CENTER

Sketch No. 3 approved version of  
January 21<sup>st</sup> 1917.

For platoon or  $\frac{1}{2}$  platoon.

With vertical  $\frac{1}{100}$  slope and defence of the entrance  
scale  $\frac{1}{100}$

PLAN

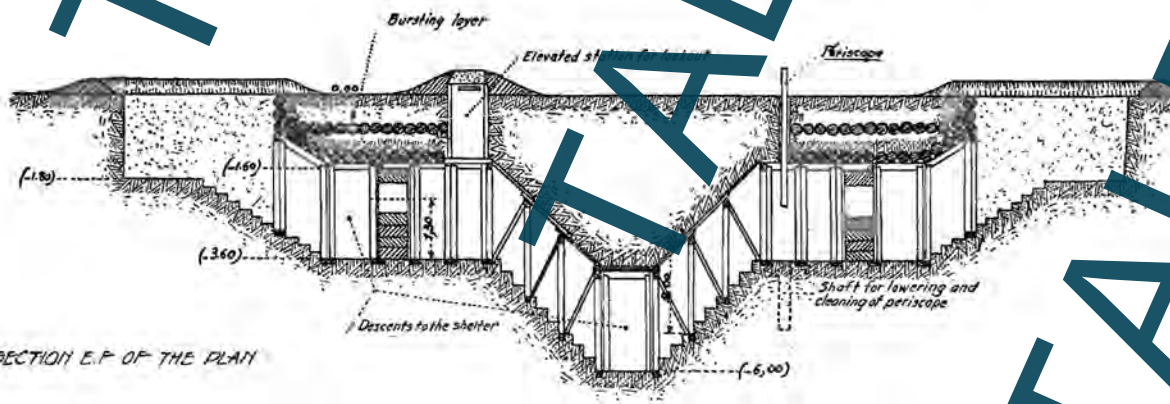
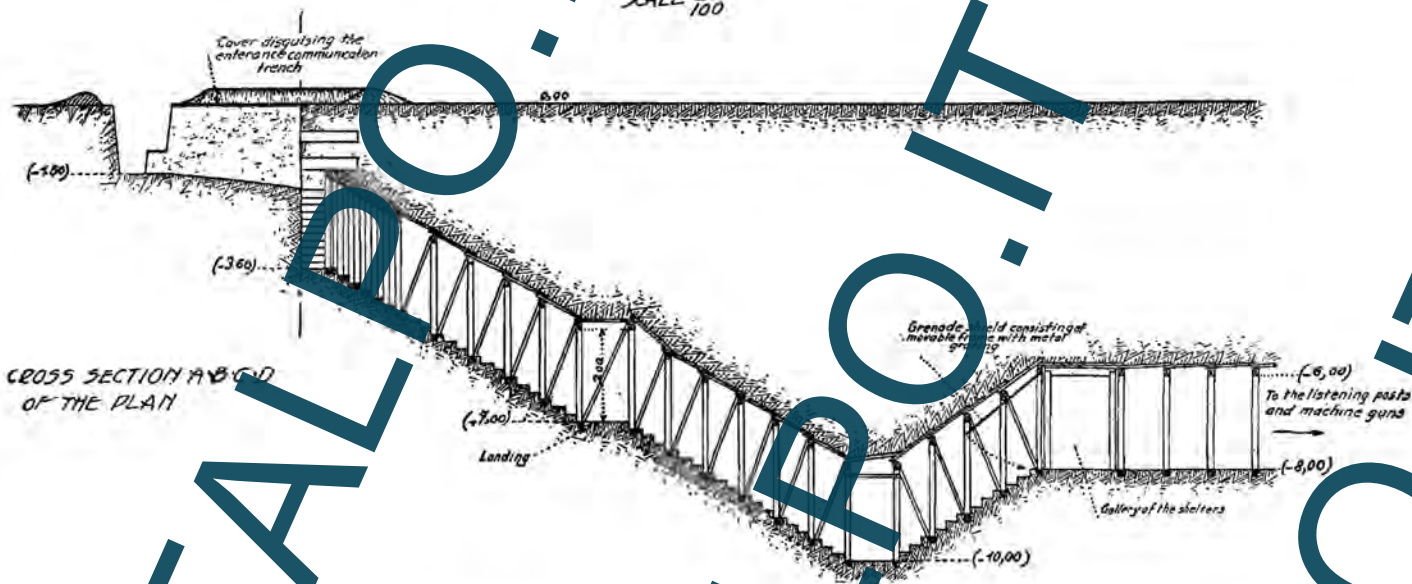


TALPOIT  
TALPOIT  
TALPOIT

TYPE OF SINGLE SHELTER OF THE ENGINEER INSTRUCTION SCHOOL  
 OF THE ARMY GROUP OF THE CENTER  
 For platoon or 1/2 platoon  
 With vertical obstacle and defence of the entrance

Sketch No. 10 attached to  
 note of January 21<sup>st</sup> 1917

SCALE  $\frac{1}{100}$

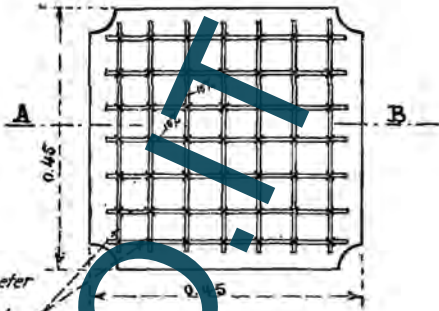


# CEMENT BLOCK FOR BURSTING LAYER

Sketch No. 11 attached to note of January 21<sup>st</sup> 1917

Reinforcement of Bottom

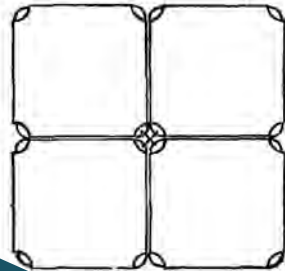
Scale  $\frac{1}{40}$



14 bars diameter 10m. length outstretched 120m

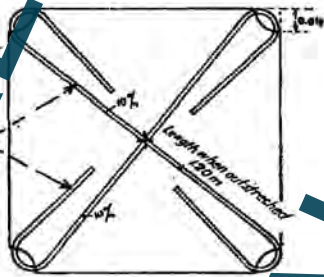
Assemblage of Blocks

Scale  $\frac{1}{20}$



Manner in which Blocks are joined

Reinforcement of Middle

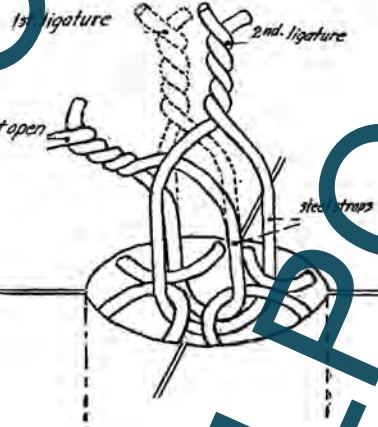
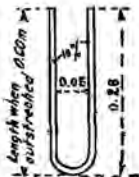


2 bars diameter 10m length outstretched 120m

Cut on A-B



Strap very soft steel



Twisting of strap

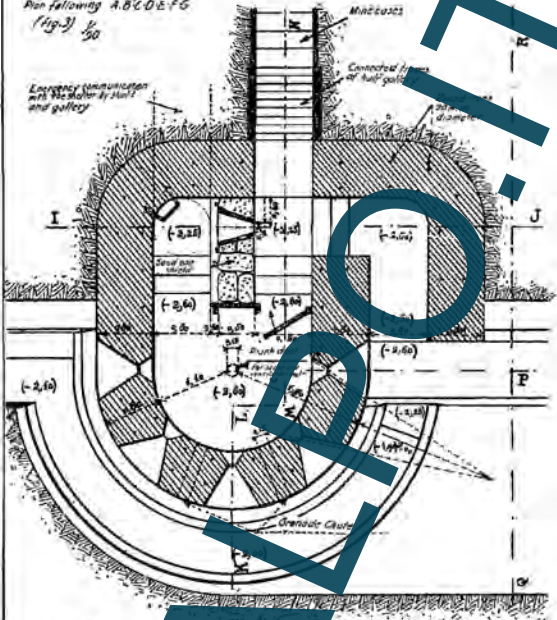
Materials composing a block for bursting layer

CONCRETE { 400 liters of sand + 800 liters of gravel + 400 kilograms of Portland cement: 0.024 m<sup>3</sup>  
Round steel bars 10mm. in diameter, weight: 5 kilograms

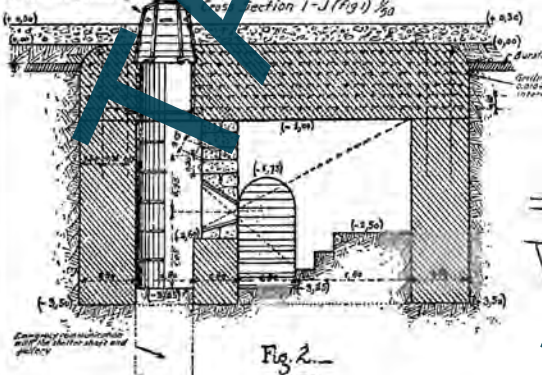
BLOCKHOUSE. TRAVERSE FOR DIMENSION OF THE ENTRANCES

Run following A B C D E F G  
(Fig. 3)  $\frac{1}{50}$

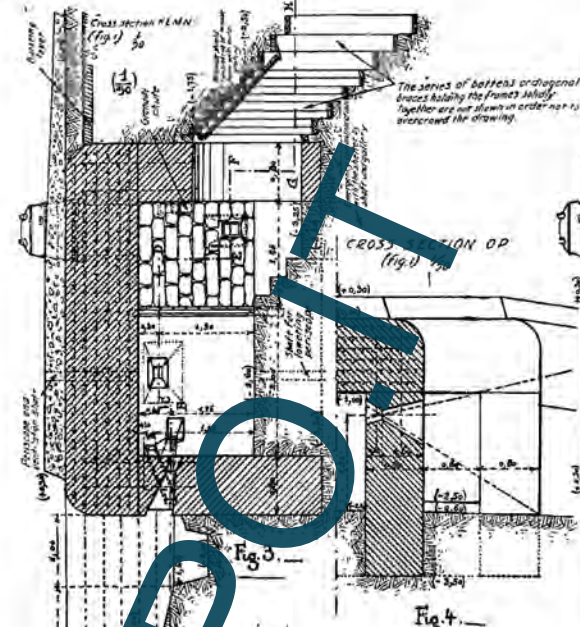
Emergency communication  
with the motor by shaft  
and gallery



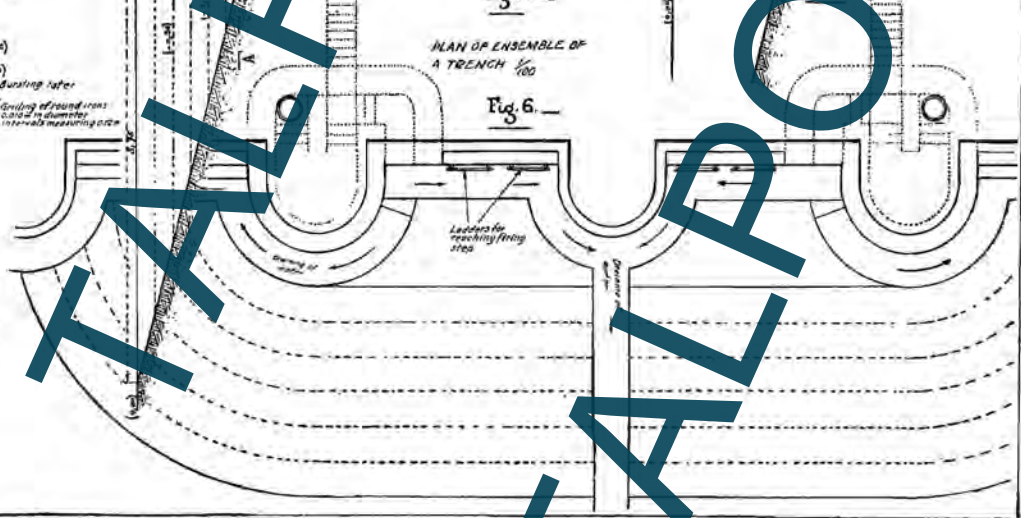
Watchman shelter  
(to be carefully consulted)



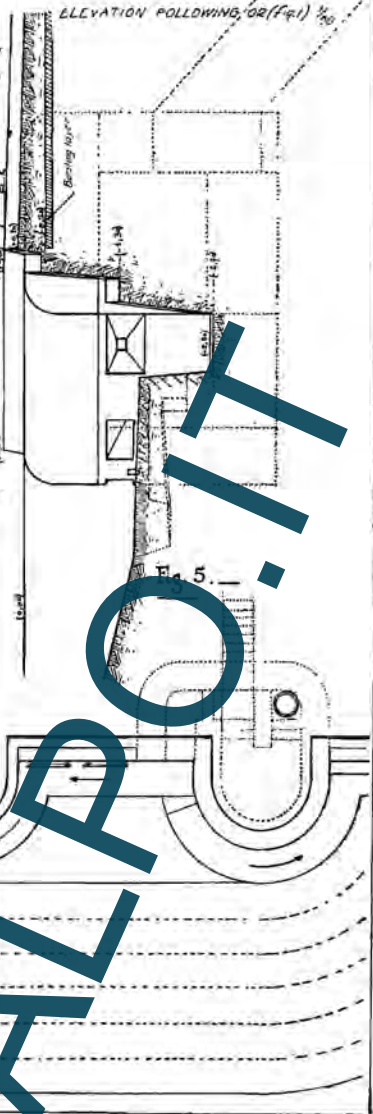
Sketch No 12 attached to note  
of January 21<sup>st</sup> 1917



PLAN OF ENSEMBLE OF  
A TRENCH  $\frac{1}{100}$

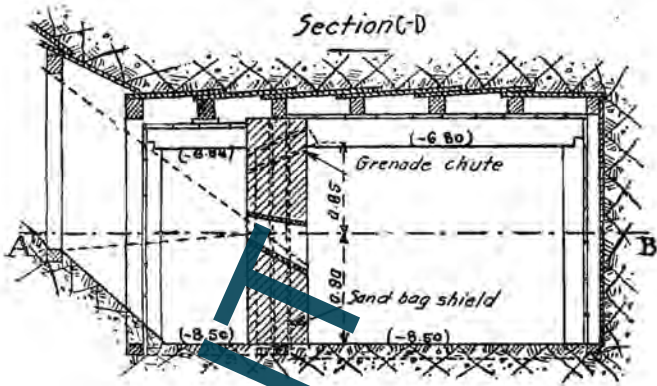


ELEVATION FOLLOWING OR (Fig. 1)  $\frac{1}{50}$

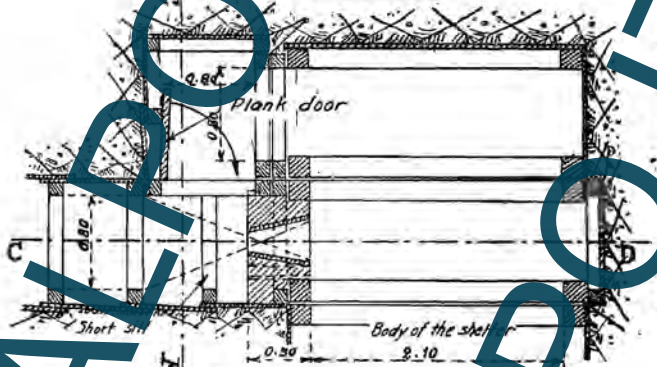


DEFENSE OF DESCENTS AND PROTECTION AGAINST GRENADES  
 Obstacles at bottom of descent 1/50

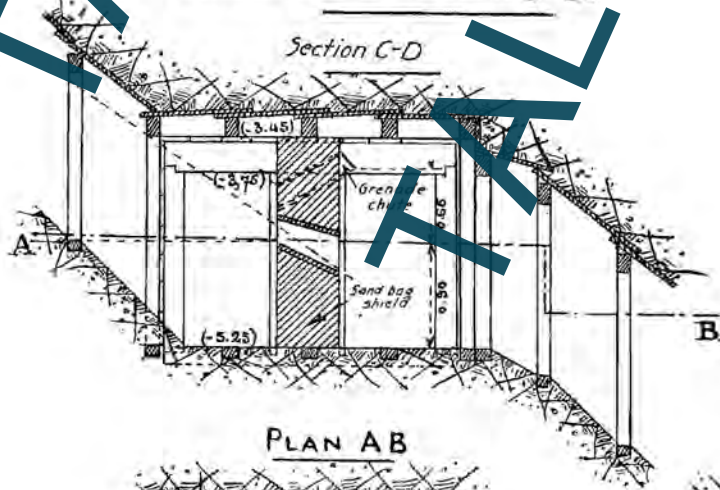
Sketch No. 13 attached to  
 note of January 21<sup>st</sup> 1917



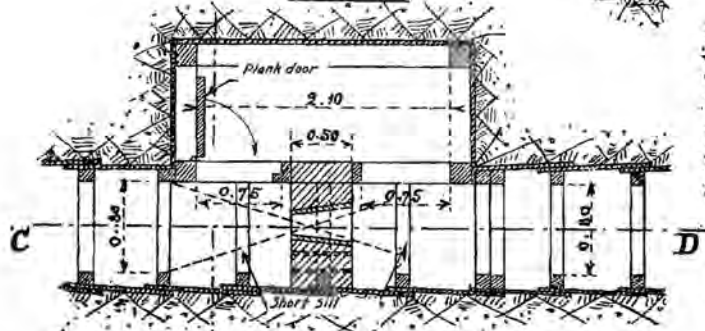
PLAN AB



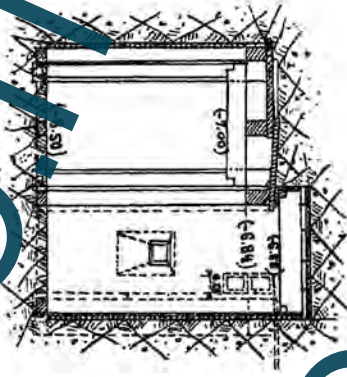
Obstacle on middle landing 1/50



PLAN AB



Section E-F



Note: In drawing these sketches it is supposed that the ground is of medium hardness and that the obstacles are to be built after the shelter is finished. In order not to over-crowd the drawing the mine castings and various wind-bracing struts are not shown.

Section E

