Engineering Notes.

School

Fort Saint Menge

Langres,

France.

Sept. 30, 1918.

3

Sgt. Geo. B. Shipman

Co. B. 1st Engineers.

Mining Section.

Historical Notes.

In the beginning of this war trenches were usually very close together, in cases ten to fifteen yds. apart. Shelters, chiefly of corrugated iron, light timber were for weather protection solely. Entry of hand grenades made it necessary to seek more shelter.

Artillery

When heavy artillery began playing an active part the necessity of more shelter became at once obvious. Mining of a sort was gradually developed starting early in 1915. Artillery at present being very important, dugouts are built for any emergency.

Positions.

At this time the distance between enemy trenches is greater, very little difference between this and other warfare

Lecture Oct. 1. 1918

Lt. Hampton

Overhead Covers and Cut and Cover Shelters.

Necessary

For protection from shrapnel, rifle and machine gun bullets. In winter time are partly quiet and weather protection is a big feature.

Kinds.

1. Cut and Cover
2. Cave Shelters
3. Concrete Shelters

Things to be Considered.

1. Artillery fire to be resisted is of prime importance
2. Character of covering depends on material at hand
3. Arrangement of layers of overhead cover.
4. Construction of shelter.

Some of all orgs are used and it is advisable to make them proof against 210 m.m. shell and overhead cover against 150 m.m.

5. Tactical situation
6. Camouflageing
7. Gas provisions

German Artillery

Piece	Caliber	Maximum Range m.	Weight of Projectile	Undisturbed earth required for Protection 5 Feet,
Light field gun	77 m.m.	10,000	16.2 lbs	
Light field howitzer	105 m.m.	8,400	34.1 "	12 "
Heavy field "	150 m.m.	10,000	91.3 "	17 "
French mortar	170 m.m.	1,160	100. "	20 "
Mortar	210 m.m.	9,400	261.8 "	25 "
Heavy trench mortar	250 m.m.	970	206.8	30 "
Howitzer	305 m.m.	12,800	842.6	30 "
Mortar	420 m.m.	14,200	1749.	48 "

Thickness of virgin ground required in feet.

Caliber	77 m.m.	105 m.m.	150 m.m.	170 m.m.	210 m.m.	250 m.m.	305 m.m.	420 m.m.
Shell-Ploughed-Earth	8	24	30	34	40	52	56	96
Wet Clay or Wet Sand	7	18	23	26	30	39	42	72
Earth, Hard, Dry.	4	12	15	17	20	26	28	48
Chalk or Limestone	3	9	11	13	15	20	21	36
Granite, Sandstone, Quartz	2	6	8	9	10	13	14	24

TABLE

Giving thickness of artificial substitutes equivalent in resisting power to one foot of hard, dry, compact earth.

Material	Equivalent
Loose fresh earth	2.0
Earth, tamped and tight	1.5
Broken stone	0.7
Logs, wired together (not less than 8")	0.4
Solid masonry, brick, stone or unreinforced concrete	0.3
Concrete reinforced, beams or bursters wired together	0.2

A row of I Beams (5" x 3") or 75 lb. rails equal to 5' hard, dry earth.

Surveying

Simple Methods.

1. In a horizontal plane

A. Chain survey.

B. Offset survey.

C. Compass survey.

D. Plane table.

2. In a vertical plane.

A. By means of vertical angles.

B. By differential level. Most accurate.

Blasting.

Hand Steel Drills.

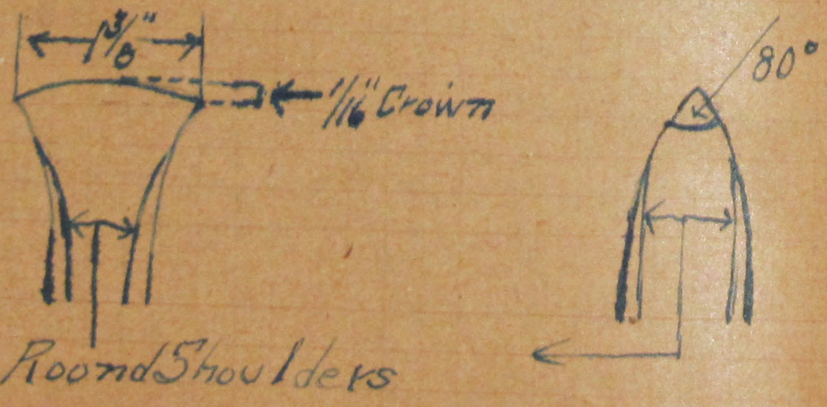
All standard drills for hand drilling are made of 7/8" octagonal steel, Starter bit about one foot long. Succeeding bits are increased one foot.

The starter drill should be 1 3/8" wide at shoulder, decreasing width 1/16" for each increase of a foot in the drill. Arc across cutting edge should be 1/16" high.

Octagonal edges directly under shoulders should be rounded, so as to permit drill to turn freely in hole.

Good striking of drill square on head adds greatly to life of cutting edge.

Side view of drill should project an angle of from 70° to 90°. 80° is a good average. Never less than 70°.



Tempering Steel.

For fairly hard usage. This skill can only be acquired by long experience. The temper to which the drill should be brought is determined by amount of carbon in steel, kind of work to be done with drilled steel plunged when cherry red and then turning to a light and dark straw color will produce good results. Care should be taken to heat steel only about ½" back and not along shank.

Steel rubbed against cyanide will case harden it, that is makes a shell of hard steel with softer core. A very tough steel results.

Oil tempering is another method still requiring quite a degree of skill.

Machine Drilling.

This form of drilling is most desireable where there is a large amount of work to be done. In this work a pick hammer is used, with either a star bit or a rose bit.

15 to 20 feet of drilling can be done in an eight hour day.

Care should be taken of the reciprocating parts of the hammer,

Placing of Holes.

Cave Shelter.

This form of shelter is the most satisfactory for protection.

Entrances.

1. Shelter must have at least two entrances, possibly three.

2. Entrances must be protected as much as possible from shell fire.

3. Effectively concealed from observation.

4. Easy of entrance and exit.

5. Built so as to exclude rain water and ground water.

6. As simple as possible in construction.

The minimum spacing is forty feet, center to center of entrances.

If entrances are connected by trench, there should be at least one traverse.

A straight entrance is essential.

No doors or other obstruction is permitted except gas curtain.

Entrance should be very simple of construction. In case of a direct hit an entrance of elaborate construction would completely block the entrance, while in one of simple construction the debris could be cleared away quickly.

Approaches.

Types.

A. Approach by steps.

B. By deepened trench.

C. Approach by Sap.

D. By special deep trench.

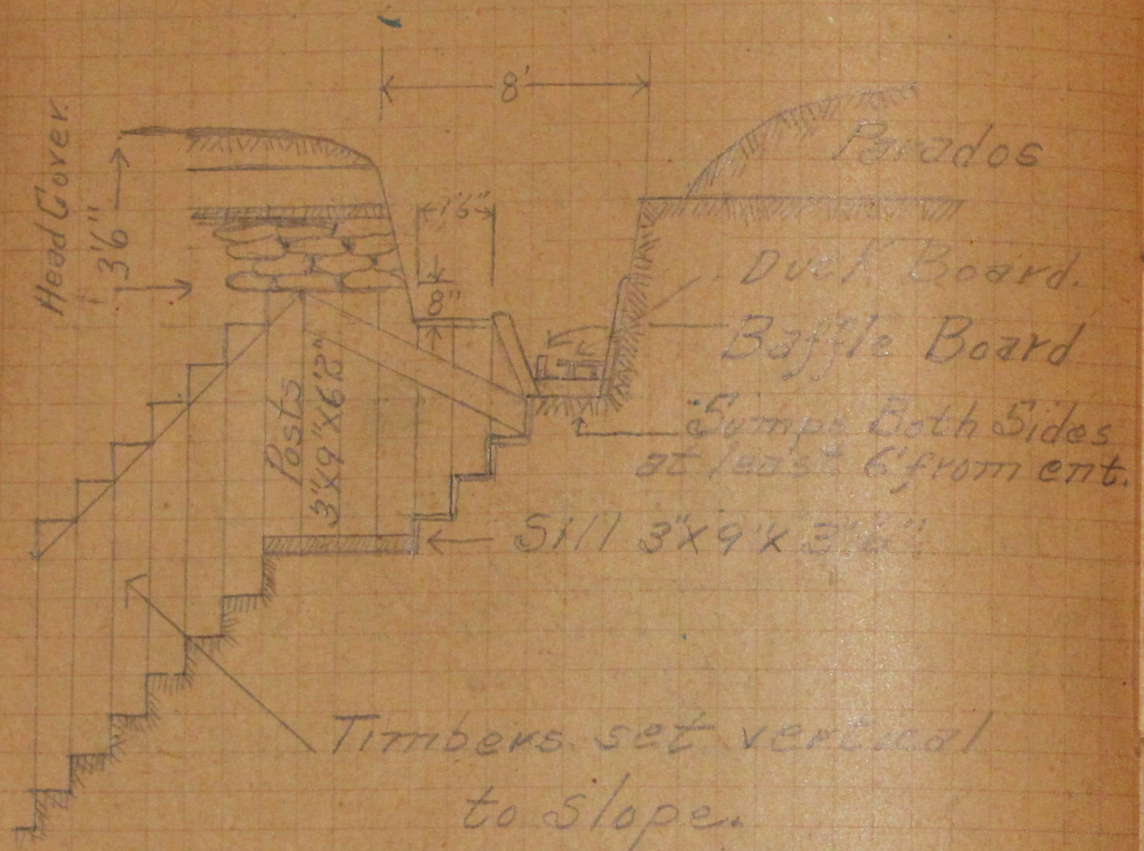
In type A, we have the least excavation, Drainage good.

In type B drainage becomes complicated. It is started at depth of 9' allowing 4'6" head cover.

In type C, the great advantage is that there is no radial turn to be made.

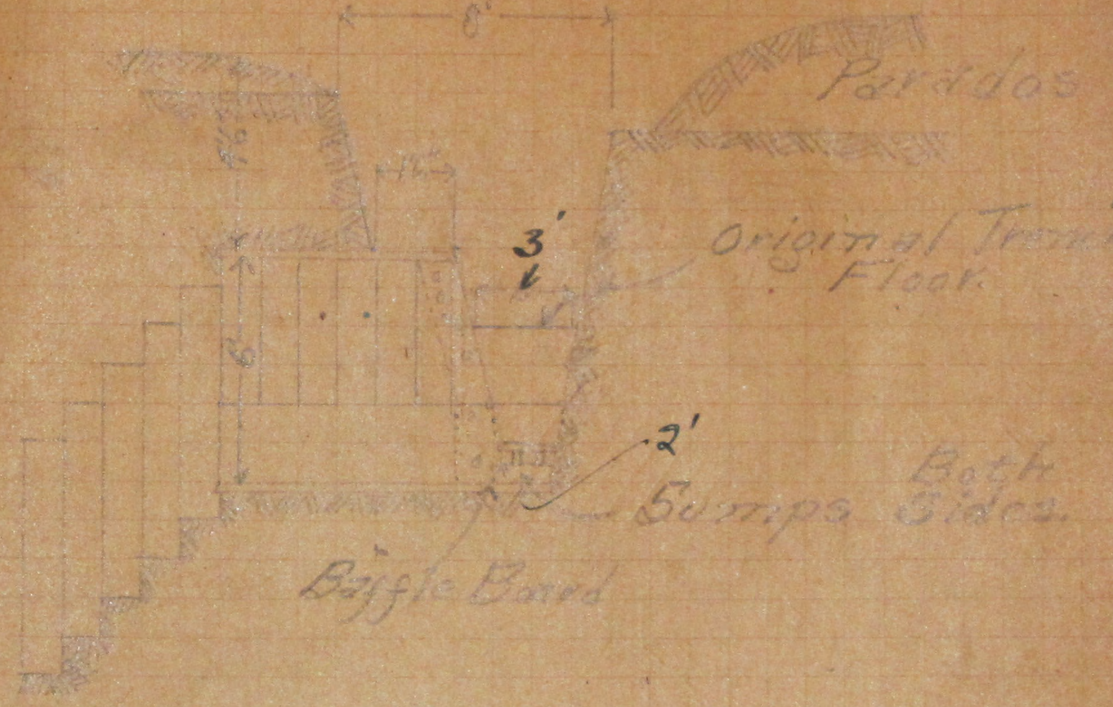
Type D is used in a 9' trench having 3 to 5 fire steps.

Type "A" Approach.
decent by steps.



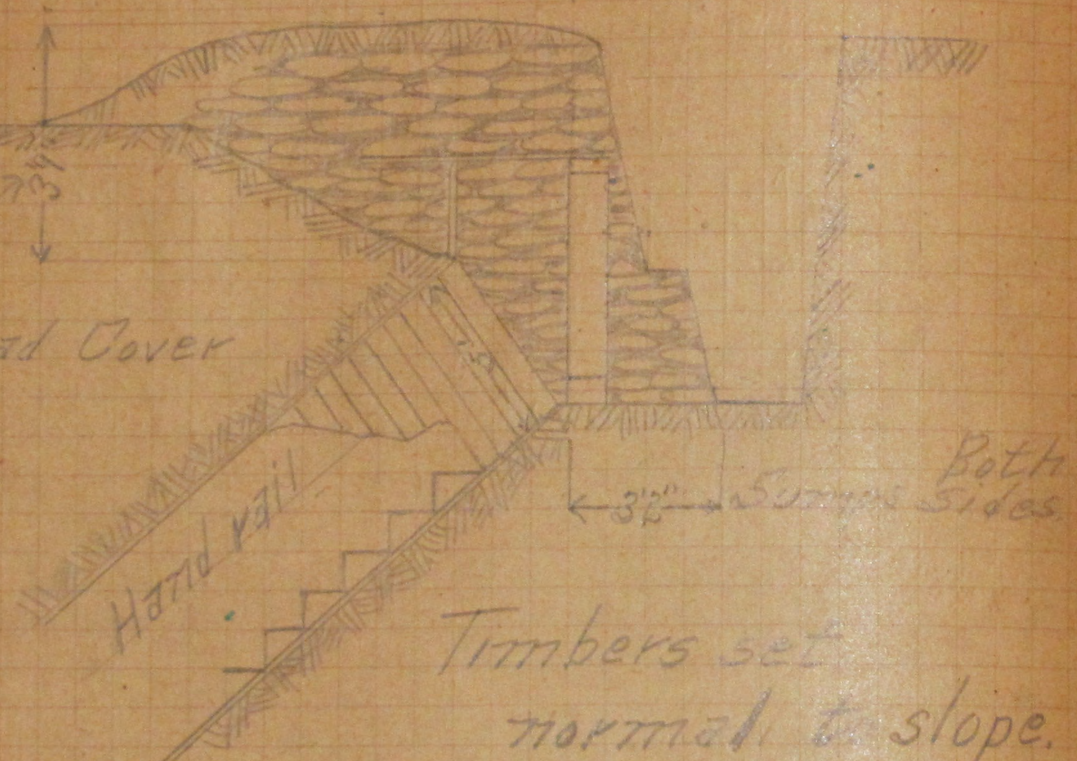
American Standard.

Type "B" Approach.
deepened trench with bottom sloped toward entrance.



American Standard.

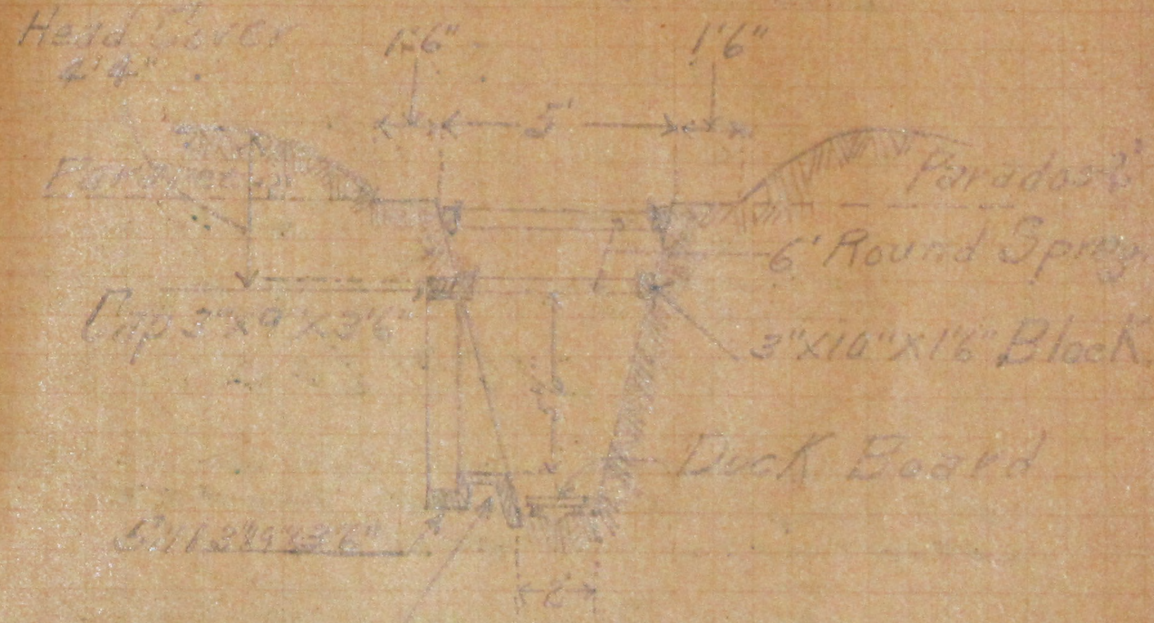
Type "C" Approach by sap with camouflaged rain shield.



Timbers set normal to slope.

American Standard

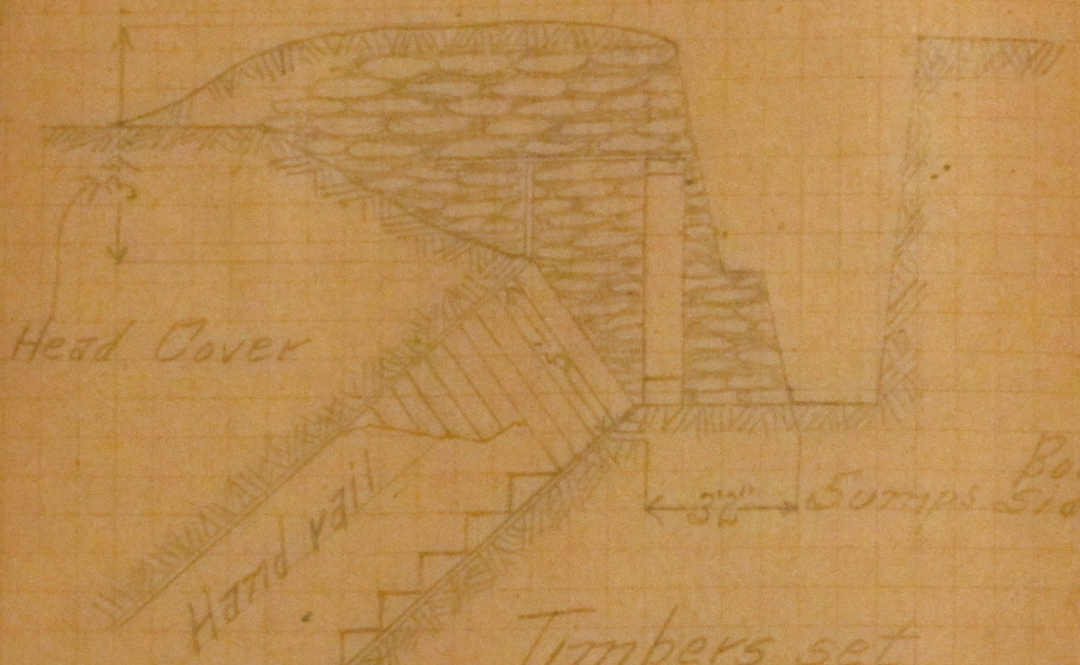
Type "D" Approach. by special deep trench.



Depth of Trench 6'5"

American Standard.

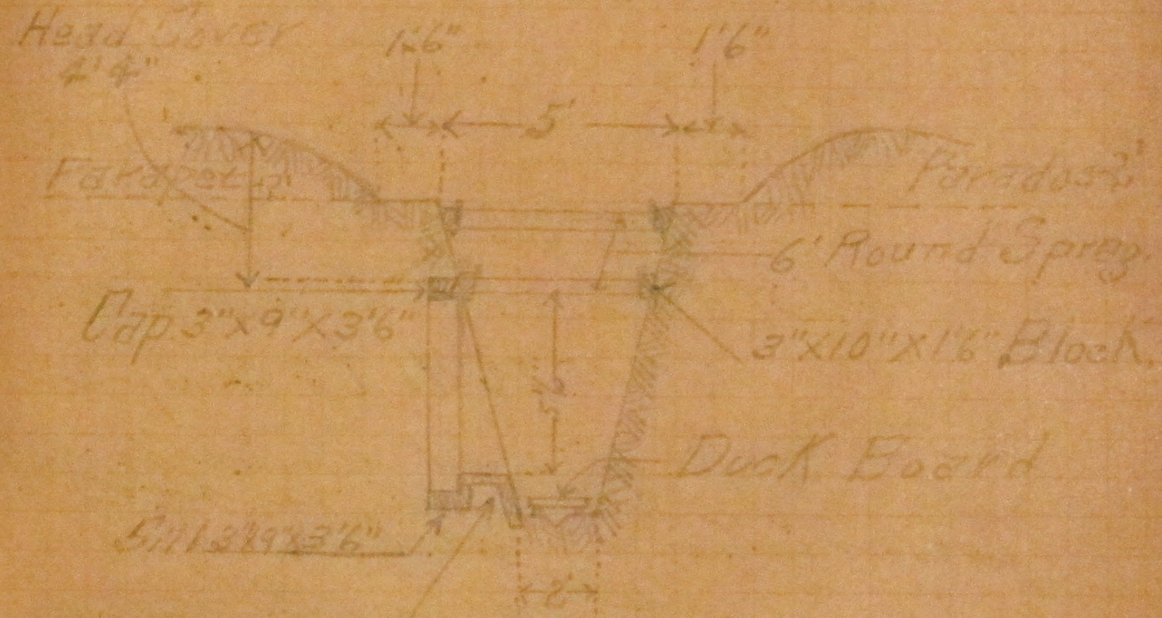
Type "C" Approach by sap with camouflaged rain shield.



Timbers set normal to slope.

American Standard.

Type "D" Approach. by special deep trench.



Depth of Trench 6'5"

American Standard.

Inclines.

Types.

1. Standard American Set. normal to slope.
2. Standard American Set. vertical to slope.
3. Standard French Set. normal to slope.
4. Standard French Set. vertical to slope.

The first and third types are the best and most commonly used.

Type three is the type best suited for timbering in hard rock.

In type one we get a head room of 6'1½". Sets are placed skin to skin the first 15' and for the remainder of the incline are placed 3' center to center.

All sets are well braced and wedged. Stair stringers are nailed to posts.

Standard Materials.

	W.	H	Post	Cap	Sill.	
Special Grand Gallery M.D.1.	1.33	1.95	15x15	15x22	15x10	Chambers Cut and Cover
New Major Gallery M.D.2.	2.	1.95	15x15	15x24	15x10	
New Grand Gallery M.D.3	1.	1.95	15x15	15x22	15x10	Vertical on Incline.
Old Grand Gallery	1.	2.	13x13	13x16	13x10	
Old Major Gallery	2.10	2.	17x17	17x25	17x14	
Demi-Gallery	1.	1.50	11x11	11x16	11x10	
A.S. Grand Gallery	6'4"	3'	3"x9"	3"x9"	3"x9"	Spreaders (Cap & Sill) 1"x9"x3'
" " " " Round Timbers 7" dia.	6'4"	3'	3"x9"	3"x9"	3"x9"	
" " Half Gallery	3'	5'	3"x9"	3"x9"	3"x9"	Inclines - Spreaders 1"x9"x3'
" " Round Timbers not Less 7" dia.	3'	5'	3"x9"	3"x9"	3"x9"	
" " Shaft Timers	3'x3' 4'8"x3'	→ 3"x9" Material.				

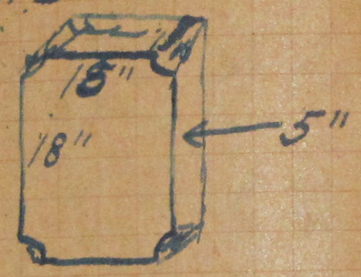
Material.

Lagging
This is usually from 4" to 6" wide and 1½" to 2" thick.

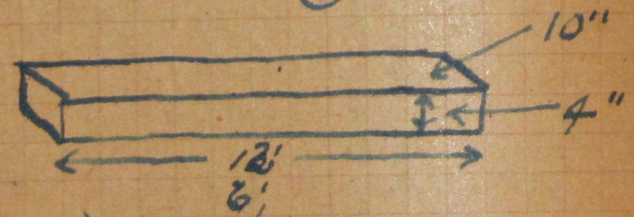
Wedges.
Proper size of wedges 3"x5"x10"

Other Timber
Varied lengths { 2"x4", 2"x6", 2"x9" / 3"x6", 3"x9" / 6"x6" }

Concrete Bursters
18"x18"x5"
Weight 130 lbs.



Concrete Beams
4"x10"x6'-12' or 15' Long.



Weight 40 lbs per running foot.

Bill of Material.
American Standard Cave Shelter.

Bunks for 60 Men.
30' Head Cover
42' Center to Center Entrances.
Type "C" approach - Sap.
Type 1 incline.

	No.
Standard gallery sets.	16
" incline "	84
" chamber "	22
" " Posts.	44
" Shoes [I Beam]	44

Roof lagging
entrances 303
galleries 49
chambers 360
Total 712

Side lagging		
entrances	702	
galleries	182	
chambers	624	
		1508
Stair stringers		30
Wedges		720
Bunk posts		16
Spragging 3"x8"		
entrances	108'	
galleries	32'	
chambers	120'	
Total - lineal ft.		260'
1"x6" material - lin. ft.		90'
2"x4" " entrances	60'	
2"x4" " chambers	652'	
		712'
Nails, 10, 20, 30d. - lbs.		122
Sand bags - entrance		900
Corrugated iron 6' sheets		12
" Chamber " 9" "		42

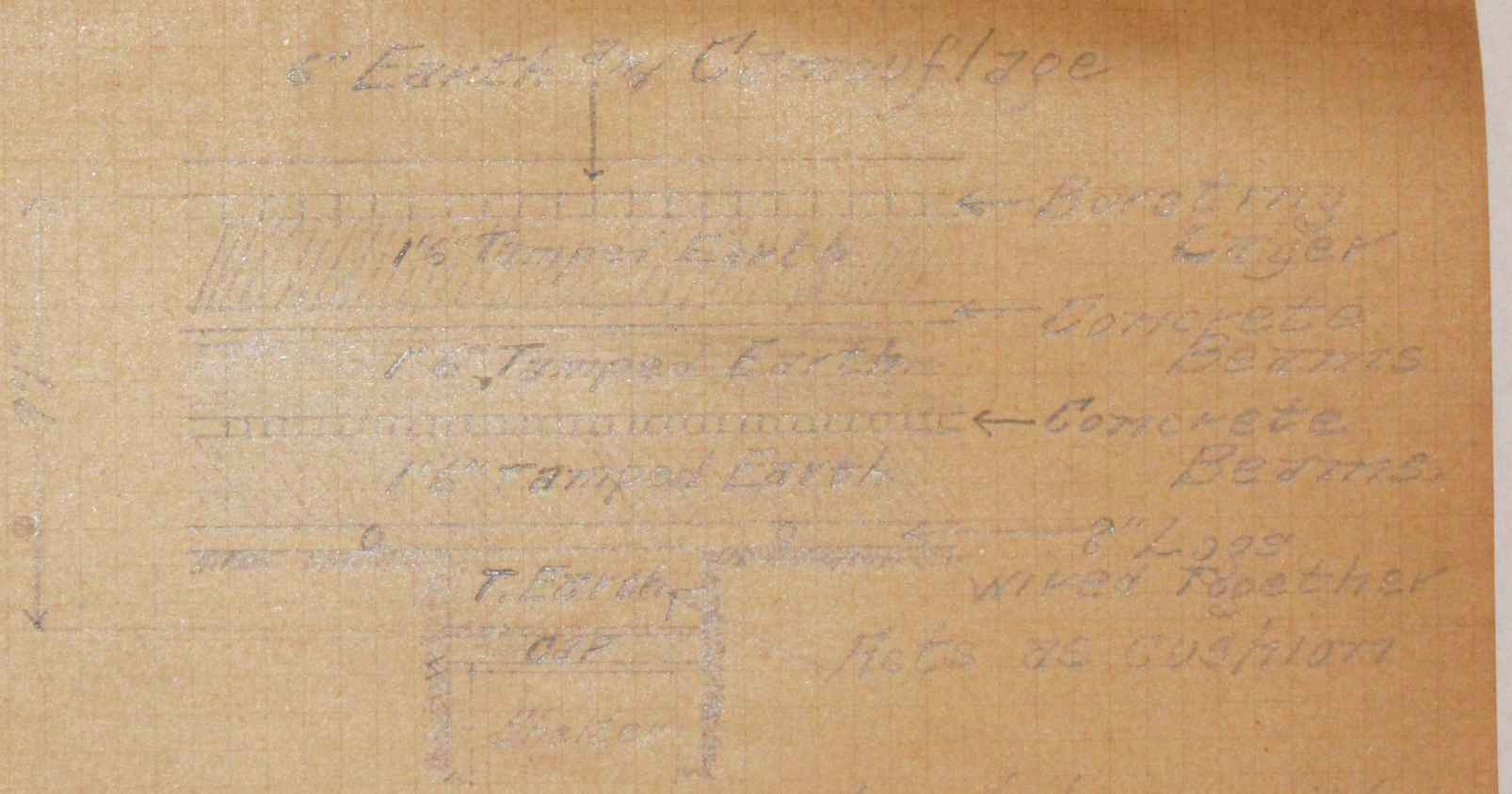
Size of Shelters.

~~Shelters are small near active front, grow larger back further to accomodate more men.~~

~~First aid shelters are of special construction to facilitate handling of litters both on the outside and the interior. One type has two chambers for patients, one used as an operating room and one used for a mess and kitchen.~~

Table of Floor Space.

		Sq. Ft.
Post of Command	Platoon	100
	Company	200
	Battalion	400
	Regiment	600
	Brigade	800
	Division	1600



Cover earth to 15'3" hard dry earth.

Method of placing layers for Cut and Cover Shelter

Military Concrete.

This term is generally applied to concrete used to resist shell fire.

There are two general types of construction.

1. Pouring concrete in place

2. Building shelters out of blocks, made in the rear.

In building shelters it is necessary to follow general principles of construction.

Two types of concrete are used.

1. Plain concrete.

Concrete in this form is strong in compression, but its tensile strength is not very much, therefore it is not adaptable for dugout work.

2. Reinforced concrete.

This is concrete with steel rods embedded in mass. If these are properly placed and constructed the concrete in this form will stand much tension.

There are three general

rules for placing steel.

1. Steel must be put in where tension is.

2. Steel must be able to take tension from the concrete

3. Steel must be placed in sufficient quantity.

There are two kinds of tension.

1. Gradual distributed tension.

2. Local concentrated tension

The fastening of the iron to the concrete is known as bond of which there are two kinds.

1. Normal Bond.

2. Positive Bond.

1. In normal bond 60 dia. of round steel are necessary to take the full tensile strength of the unit of steel used.

It is therefore advisable to use steel rods small in diameter.

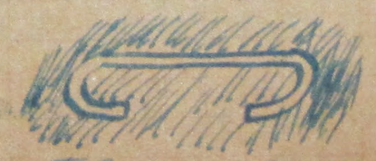
Square rods do not take bond as good as round.

2. In positive bond the grip is developed more quickly.

Steel twisted or with lugs on it develops bond in shorter length than round rods.

In using expanded metal the full tensile strength is developed in three or four inches of metal

Rods are also always looked at ends for anchorage.



Flat rods are almost worthless.

Location of Tension in Concrete.

1. Resting layer.
2. Cushioning system.
3. Distributing system.

1. The resting layer is that part of cover which is penetrated. The layer of earth, if any, should be as thin as possible.

2. The cushioning system is used to ease and delay the full force of the blow. The material for this may be of any available stuff.

3. Distributing system helps spread the force of the shock.

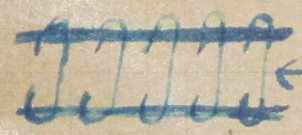
A shell hitting solid concrete, acts as a wedge and tends to break up shelter into huge blocks. If small blocks are used they are easily broken up by this concentrated force.

A great mass of concrete with grilled reinforcement is superior.

For this grillage system the French use 3/8" iron rods spaced 4" centre to centre. Sometimes in first layer these centers are 2" apart.

By using expanded metal much labor and time are saved, also it is superior to rods.

The different layers of rods are fastened together by steel hooks called stirrup.



In solid concrete shelter the layers of rods extend down 1/2 or 1/3 the thickness, and are placed about 6" apart.

Concussion.

A shell bursts and sends concussion or vibration waves thru out the mass. If in this mass there are large sections of steel, such as rails or I beams, the vibration will tear concrete away from it.

Heavy sections of steel should never be used. Steel over 1" in cross section must not be used.

Concussion vibration has tendency to break huge portions off bottom of layer. Reinforcement placed at bottom and tied to top layers with stirrups will prevent this breakage.

Roof is bombed most on account of the high angle of dropping shells.

The front and side walls must be built as strong as roof & above ground.

Judge surrounding earth with view to resisting penetration power of shells.

Types of Construction.

1. S/a b. (Normal)
2. Arch construction
3. French special (thin slab.)

1. In the slab type the shells have a tendency to break roof loose from sides.

Reinforcement placed near outside of walls to prevent this

Roof, sides and floor need extra reinforcement to prevent their breaking apart.

2. The arch type is stronger than the slab.

The tension effect is not as great as in flat slab.

In this type reinforcement is placed near outer and inner surface.

The objections to this type are the difficult form work involved and the difficulty of placing the reinforcement.

Elephant shelter is used as inside form, stulled on inside

The common method is to make outside square with corners cut off as in figure 1.

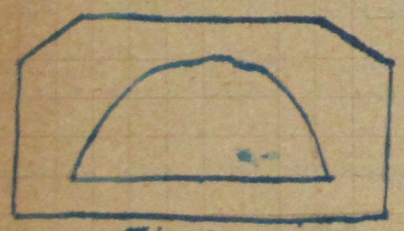
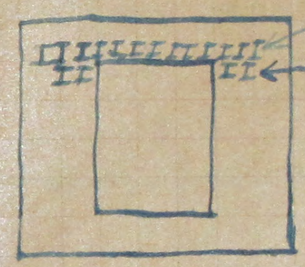


Fig. 1.

3. The chief objection to the French or this slab type is that it requires too much steel.

In this type a layer or two of I beams are used as a grillage to support roof. Also two or three I Beams are placed on side as a bearing surface for the other beams.

Concussion here expends itself on inside of shelter.



The anchorage on the sides is especially heavy, 3/4" rods being placed 6" center to center.

A shelter of this type will resist a 210 m.m. shell.

Steel placed in sequence of importance.

1. Most important steel is that on inside of roof and front sides.

2. Steel on outside of roof, sides and bottom.

3. Steel added for resisting surface penetration

4. Steel stirrips in sides open to shell fire.

5. Subsequent layers of steel to resist penetration.

THICKNESS (concrete)

In flat slab- thickness must not be less than 1/2 distance of least span.

A maximum span of 8' is allowed in these structures.

The inside span may be shortened by cutting corners.

Thickness of slab must never be less than 1/3 of clear span.

Necessary thickness may vary as much as 50% all depending on material, labor, skill and design.

Two Factors.

1. Based on men who have experience in the work.

2. Based on men who have had no experience.

On a 6' span the thickness required to resist a 150 m.m. shell would be 3', a 1-2-4 mix being used and placed by inexperienced men.

150 m.m.
.02 constant used
3.00 thickness

For experienced men a constant of .016 is used.

Back walls must be able to resist shells hitting near it. It also supports the roof.

Must be 2/3 thickness of front walls.

Floors must be built in shelters to resist 150 m.m. shells. It is made as thick as the back wall. It is reinforced on bottom of floor.

Concussion.

Concussion wave or vibration resulting from hit may be great enough to kill men on inside of shelter.

The inside form is left in to help resist concussion and stop flying fragments.

Air chambers are also used to resist concussion. These are placed next to chamber and must have 1' space to be effective. Air chambers put on sides subject to direct hits. The least span of chamber is now considered to outside of air chamber.

Blast.

With concussion we get a terrific air blast which tends to rush down the entrance.

To resist air blast we must have indirect entrances or at least 2 turns in the entrance.

Entrances.

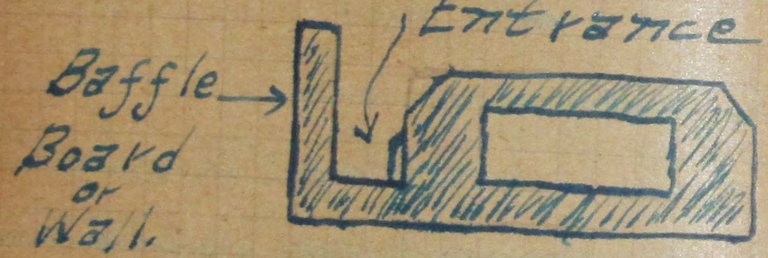
1. Direct entrance.

This entrance is very

liable to be blocked and in it, fragments and splinters have easy access to the enemy.

2. Indirect entrance.

This type is the most simple and best. Protecting it a concrete baffle board is built at entrance as part of the main shelter.



3. Shaft entrance.

This type is used in extra heavy shelters to resist 210 m.m. shells.

Ports.

Ports are points of weakness. Never put a port opening towards the enemy in living quarters of the men.

In putting in a port for machine gun fire care must be taken not to lessen support of roof.

To prevent ricochette shots taking effect steps must be put on faces leading to port.

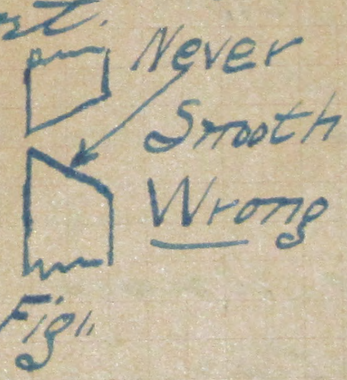


Fig 1.

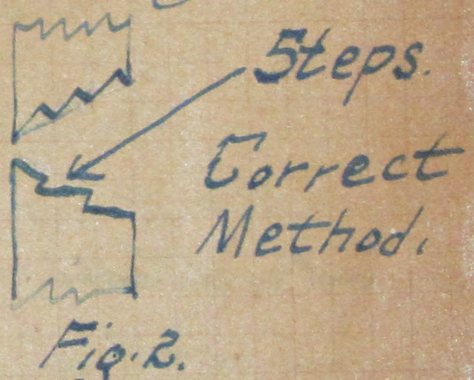


Fig. 2.

Blocks.

In using blocks for a concrete shelter it is highly important to arrange them to resist tension throughout.

British or Belgian are made with grooves on the surface to embed the steel rods when a layer is down They also have holes thro them. Grout is poured and this gives a satisfactory job.

These are also called as a bursting course

Right.

Wrong

Laying blocks.

Size.

If shelters are too small they are easily displaced by shells or tanks.

Corners are added which contain at times as much concrete as the shelter itself. These produce stability of structure.

Cement.

High grade Portland cements are to be obtained in France.

Best materials must be used, Deteriorated cement to be discarded as useless.

Cement is measured by weight. An cubic foot equals 94 lbs. or weight of Standard American sack. Standard barrel holds 4 sacks.

French cement comes in 50 and 100 kilogram sacks.

Camouflage.

Wherever possible build shelters in existing building or a temporary one, leaving the latter ~~stand~~ after the shelter is complete.

Amount of Material.

1 cu. yd. of concrete requires about 60 to 100 man loads of material.

For 1 cu. yd. of concrete 1.55 cu. yds. of cement, sand and stone is the exact requirement,

For a 1-2-4 mix.

Cement 1/7 — 22 cu. yds.
Sand 2/7 — 44 " "
Stone 4/7 — 88 " "
1.54 cu. yds.

20% of Water.

Demolition.

Capt. Earle.

In trench warfare or in open warfare plays an important part.

Purpose is to destroy all articles which will be of use to enemy

Permissable only as a military necessity.

Deliberate demolition

1. Time of no great importance
2. Materials very important

Calculate amount of material and 10%

Hasty demolition.

1. Time of prime importance
2. Material secondary.

Calculate material and add 50%.

Do not cut dynamite when frozen and use no steel in making hole for cap.

Handle as little as possible as poisonous gases generate from it very easily.

If not freezing dynamite is to be had made with a nitro substitute.

Black Powder.

Combination of saltpeter, sulphur and charcoal. Percentage of saltpeter from 50-70% Larger percentage of saltpeter increases strength.

Low shattering effect.
Great lifting power.
About 1/3 as strong as T.N.T.
Keep perfectly dry at all times.

Gun-Cotton.

This comes in slabs weighing 15oz. and is reddish white in color.

Made by the nitration of cotton or cotton waste.

Slightly stronger than T.N.T.
.81b = 1lb. T.N.T.

Must be kept wet at all times to facilitate handling.

Not very sensitive to shock.

Detonated by dry gun or primer of gun cotton weighing 1oz. Kept dry at all times.

Melinite (French).

Is a picric acid powder.

It is a yellowish powder and comes in cartridges (brass covered weighing 3/10 lbs. or in shells weighing 1 or 20 kilos.

Nelmite has same strength as T.N.T. May make hands yellow in handling but is harmless.

Cheddite. (French.)

This explosive is a combination of ammonia chloride and some hydro-carbon oil.

It is a light gray color and comes in cartridge form weighing 60 or 100 grammes and also in fetards of 10 or 20 kilos.

Different factories make different grades and colors and these should never be mixed.

Will not freeze.

Strength about 1/2 T.N.T.

British Explosives.

1. Ammonal.
2. Amatol.
3. Blastine
4. Sabulite

All are ammonia-nitrate powders and must be kept dry.

Ammonal.

1= Cans of 5 and 50 lbs.

Put in small cans for use.

2=8 lbs. = 1 lb. T.N.T.

Blastine.

1= Cans of 5 and 50 lbs.

also cartridges 4 oz. and 16 oz.

Sabulite

1= Cans.

2=8 lb. = 1 lb. T.N.T.

Good in field as it is inflammable.

Use.

Never use T.N.T. underground where men have to go back into entrance again.

The gas formed is a deadly poison.

Use high strength powders for cutting steel.

Gelodite and Black powder for lifting effect.

These latter are well tamped to increase effect.

Placing Charges.

In cutting girders etc. whole surface to be destroyed must be covered by explosive.

Blocks of Triton must be in contact with each other and the object to be destroyed.

Charge as a whole must be firmly fixed to object and if possible tamped.

All fuses or lead wires or detonators must be properly arranged so charge will be exploded. All charges set off at same time.

Simultaneous Detonation.

1. Electricity with detonating cord.
2. Time fuse with detonating cord.
3. Electricity alone.
4. Time fuse with induced detonation.
5. Time fuse and instantaneous fuse.
6. Time fuse alone.

These are given in sequence of superiority.

Use two circuits to be certain. One may be disconnected by accident.

Time fuse easiest.

Always test time fuse for speed in burning which is usually 2'-4' per minute.

Instantaneous fuse burns 130' a second and is marked by an interwoven varied red braid.

Nelmite detonating cord is covered with a tin composition.

Never stretch or tie in knots.

Always wrap branch cord around main cord.

Rate.

23,000' per second (French).
17,000' " " (American)

A tetryl cap used to ignite initial ~~heavy~~ lead to start cord.

Rupture of one rail and tie section.

Arrangement of charge.

Bridges.

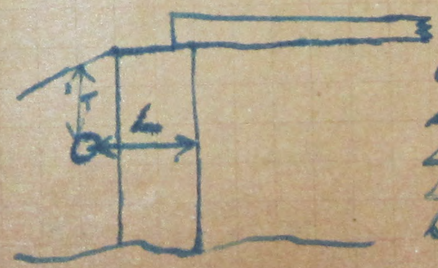
To demolish a bridge destroy one span, abutment and a pier.

1=Drive tunnel in from roadway to place charge for abutment.

If no roadway sink shaft.

Formula.

$C = 2/5 L^2 B$



C = T.N.T. (no. of lbs.)
B = Breadth in ft.
L = thickness " ft.
L = 1/4 B at charge
L = 2L " "

Good bridges should be buried.

Suspension Bridges.

Cutting main cables.

If not over 5" circumference 2 blocks of T.N.T. will cut them.

If over 5" in circumference.

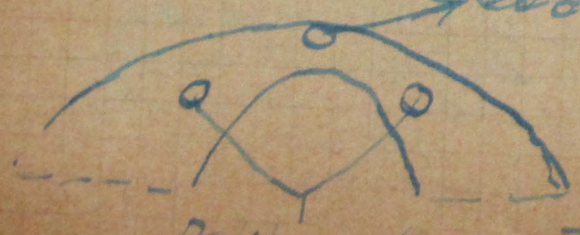
Number of Blocks = $\frac{C^2 \text{ circumference}}{12}$.

Single Arch (masonry)

For hasty work charge is placed over key-stone at top.

Otherwise charge is placed over haunches and soil removed, placed over middle.

Hasty demolition.



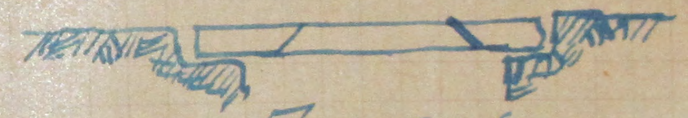
Reinforced concrete me 3 times as much explosive.

In multiple arch bridges cut truss cords of the least cross-section. Destroy the longest span. If spans are equal cut span where current is swiftest or deep.

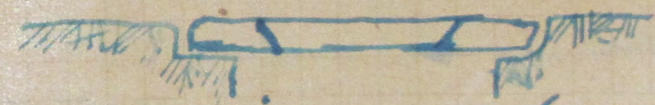
In steel bridges cut tension members.

No. of blocks = $\frac{3}{4}$ area in sq. in. of piece to be cut.

To cut girder bridge



Correct



incorrect.

Charge is placed against member and wedged to hold tight.

Railroad Tracks.

To make road useless take off fish plates and turn over section. If large sections are to be demolished charge are placed every three joints. Two blocks of T.N.T one placed on each side of rail. Three eight men in a party doing this work.

Tonnel

To block tunnel wreck old car in entrance.

Place charge about 5' high and 50 or 60 from entrance.

Rolling Stock.

Same part of each car should be destroyed.

3 blocks = Destroy cylinder

3 blocks = Destroy driver

3 " = " " boiler (cold)

3 " = " " Water tender.

3 " = " " Journal box.

3 " = " " water tank (inside

Small Buildings.

To destroy a 4 room cottage place 1/4 to 1 lb T.N.T for each cu. yd of volume of first floor. Place all in one place.

Artillery.

For 3" gun place 5 blocks in barrel near muzzle.

For 5" use 20 blocks

Guns can also be destroyed by Thermit.

Thermit is a mixture of aluminum and iron.

Place in barrel and tamp with clay. Light this

chemical and after burning 8 or 10 minutes add some carbon. A hole will form a solid mass of immovable high carbon steel.

Shells.

These will usually be destroyed or taken care of by Ordnance department.

To destroy them place shells to the amount of 200 lbs. in deep trench. Place charge of T.N.T and set off. 100 lbs gas shells are put in hole.

Wire.

Bangalor torpedos are used for this purpose. These are a casing of iron or iron pipe filled with explosive.

German Explosives.

1. Westphalite
2. Perdit.
3. Donerite
4. Blanckanf (will not burn unless mixed with one of the other explosives.

Place them in line and set afire.

Formulas.

Cutting down trees etc.

$N = .03 D^2$

N = number of blocks T.N.T.

D = diameter in inches of holes are bored.

$N = .008 D^2$

6 blocks for each square foot of section placed as a necklace around tree.

2 blocks per sq. ft. where holes are bored.

Concentrated Charges.
Masonry — Concrete.

$N = 5/4 R^3 K.C.$

N = number of blocks T.N.T.
R = radius of rupture.
K = material factor. } Field Manual 429 430.
C = loading factor. }

Radius of rupture is greatest distance to outside of wall from where charge is placed.

Masonry Walls.

$N = 4 R^2 KC$ for each lineal yard of wall.

Engineer School

Pioneer Notes.

Sgt. G. B. Shipman.
Co. B.
1st Engineers.

Pioneer Section.

Index.

Index.

Lecture.

Oct. 10, 1918.

Obstacles & Barbed Wire.

Lt Stanley.

Obstacles:

These are accessory defenses placed between our lines and the enemy's line.

Purpose.

To check and hinder any advance of the enemy.

Objects to attain.

Value of obstacles lies chiefly in our ability to cover them with our own fire.

To break up unity of action

of an attack and the cohesion of different units making attack.

To deflect direction of attack so that it will come into a well swept field of fire. and while under it to arrest enemys progress.

Siting.

Obstacles are placed far enough from our trenches to prevent enemy from throwing grenades into them. Distance is never less than 30 yards or more than 60 yards. and under fire.

Obstacles are not to be parallel to trenches but placed at varying distances as it goes along.

Concealment can only be such as the natural lay of the ground permits and it is rather a difficult matter.

Conditions such as having railroad cuts, another trench or a fold in ground greatly help to conceal obstacles.

Obstacles, when placed on edge of woods or in a furrowed field, running with furrows are quite well concealed.

Construction.

Working party should be well extended, when work is under enemy observation,

and should never be allowed to congregate in groups.

men always maintain complete silence and must be well trained and disciplined.

Preparation for work made in advance and a design picked, which has speed and is systematized. Work is done on home side

Style of wire should be capable of being added to in thickness and such that it would require maximum ammunition on enemy's part to destroy.

Therefore it should not be too rigid and should not have a surplus number of pickets.

Types of Obstacles.

All types of obstacles are considered with a view to time labor and material necessary.

Ditches which are seldom used require much time and labor and practically no material.

Trous-de-loup or wolfs pit is another form of obstacle which require much time and labor and little material. They consist of three holes placed in a triangular manner. They converge from a 6' diameter hole at top to 3' feet at the bottom. Here sharpened stakes are driven. Easily observed by aeroplane and used seldom.

Abbatis, another form are much used today. Trees are felled with branches sharpened and pointing towards enemy. Fire is added to make them more difficult of entry. Small saplings are also bent over and tied together and to ground making another form of abbatis.

Forgases or land mines are a good type of obstacle against tanks.

Barricades are made to block paths and roads into villages. These are to stop enemy and not to deflect his course. Passages are

left in barricades for our own use.

Inundating and flooding a certain area by water is a good obstacle but also reacts on those doing the flooding.

Barriers vs. Tanks.

A trench with a parados of very soft earth has proved a good obstacle against. The forward end of the tank having stopped the track strikes the parados and is here stopped the soft earth being insufficient traction to move any farther on.

In woods, abbatis are

made with stumps cut about 3' long and the trunk of the tree sloping toward the ground at an angle of about 30°

Inundation of three feet of water will stop tanks.

Trenches dug across roads, about 14' wide and 8' deep, and then covered with plank for ordinary traffic will prove a pitfall for tanks.

Craters blown in roads which are entrances to woods or villages will be obstacles for tanks.

Barricades made in villages

with a height of at least 6', with a ditch on defenders side are also obstacles.

Wire Entanglements.

Standardized Types.

1. Ribard.
2. Low Entanglement.
3. Double apron fence.
4. French high wire
5. Low apron entanglement.
6. Portable obstacles.

The infantry constructs wire in front of its positions men are divided into two parties, the wiring party and carrying party. The best men are picked for the wiring party. Patrols

work to be done and the enemy. Rapidity of construction depends on the simple design, confidence of the men, and plans for work made beforehand.

Materials.

Barbed wire is of two types; the military and (commercial types)

Military wire has large barbs spaced close, but is very scarce in France.

Commercial wire is most extensively used. This comes in 5 and 100 yard coils. These coils are made up into bobbins containing 25 yards each to facilitate

handling. This work is done in the rear of the lines.

Pickets used are of two kinds the iron and wood pickets.

Long wooden pickets are 5½' long and should not be less than 2½" in diameter. Short pickets are 2½' long and have same diameter.

Iron pickets are the best as no noise is made putting them in and they are difficult of observation.

3 legs long (French)	5" long	5/8" iron.
4 " " (English)	5" "	
Medium —	3½" "	
Anchor —	1½" "	

Standard Double Apron Fence.

Drill.

Party	Nos.	1st Task	2nd Task	3rd Task	4th Task	5th Task.
N.C.O		Direction and Supervison.				
A.	1, 2, 3	Carry out three bundles pickets	Screw in long pickets	Front diagonal wire	Bottom wire on fence	Rear diagonal wire.
B.	4, 5	Carry out two bundles anchorage pickets	Screw in front anchorage pickets	Front trip wire	2nd wire on fence	Top horizontal wire on rear apron.
C.	6, 7	Carry out 2 bundles anchorage pickets	Screw in rear anchorage pickets	2nd horizontal wire on front apron	3rd wire on fence.	2nd horizontal wire on rear apron
D.	8, 9	Carry out 1 bundle of pickets and 14 coils barbed wire.		Top horizontal wire on front apron	Top wire on fence	Trip wire on rear apron.

Material.

For 50 yds.

4 bundles containg 4 (long) pickets each.

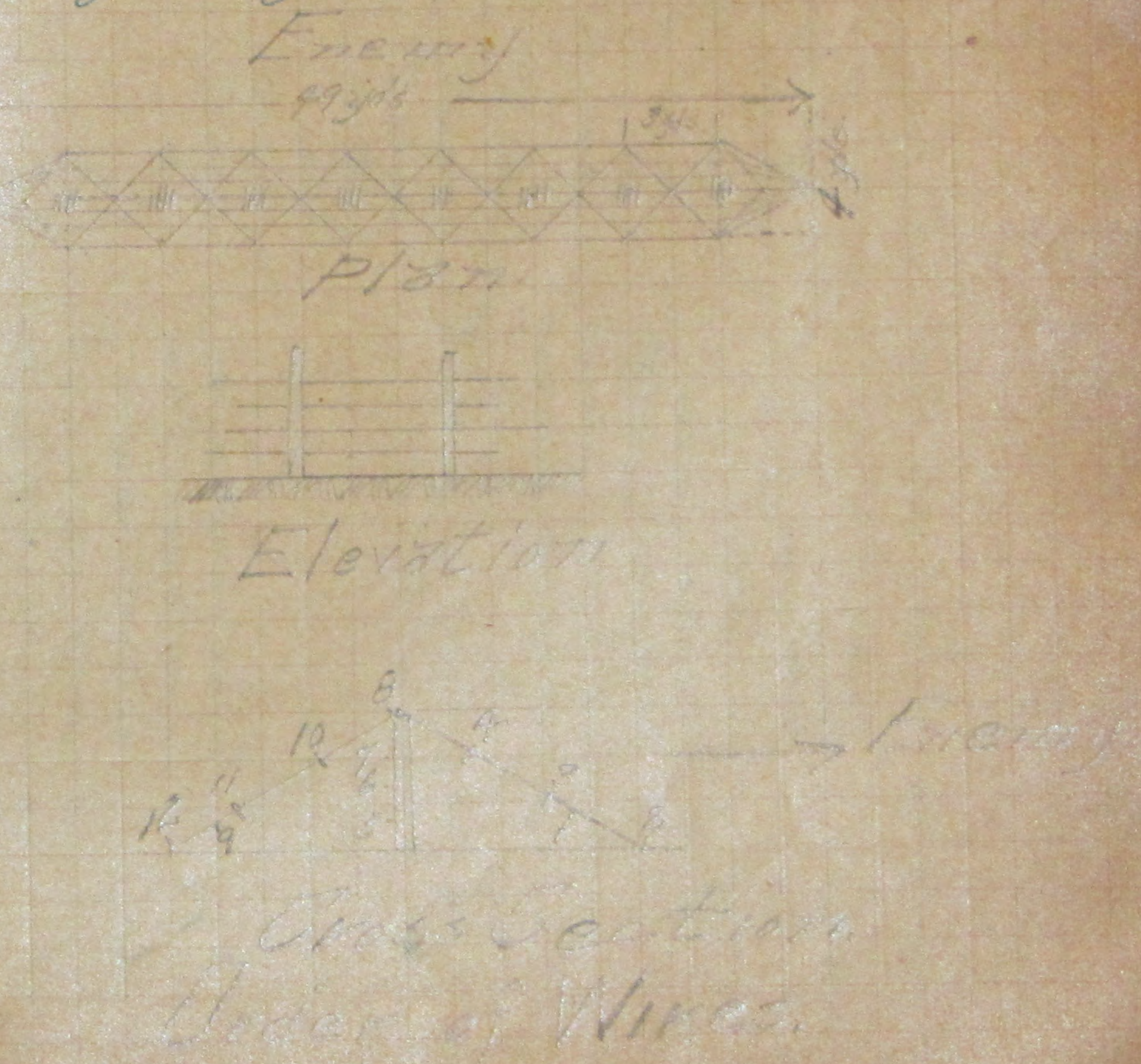
4 bundles containg 8 anchorage pickets.

14 coils (50 yards) barbed wire, or 2 coils (100 yards) and 10 coils (50 yards).

Wiring Party - One N.C.O. and 9 men.

N.C.O. carries wire pliers and rest windlasing stick

Carrying Party - One N.C.O. and 15 men.



Standard Double Belt Ribard Wire.

Party	No.	1st Task	2nd Task	3rd Task	4th Task	5th Task
N.C.O.		Carries out 1 coil of barbed wire	Direction and Supervision			
A	1 2	Carry out 1 bundle of anchorage pickets and four bundles of long pickets	Lay out and screw in pickets		Splice coils of first belt together	Splice coils of second belt together
B	3 4 5			Carry out and erect coils of the first belt.	Carry out and erect coils of second belt.	Run horizontal wire of first belt along top of pickets and windlass ribard coils up to it. ↑ on second belt.
C	6 7 8	Carry out and undo fourteen ribard coils and one coil of barbed wire				
D	9 10					Staple down both belts.

Material.

50 yards.

4 bundles containing 4 long screw pickets each.

1 bundle containing 4 anchorage pickets.

14 coils or cylinders ribard wire.

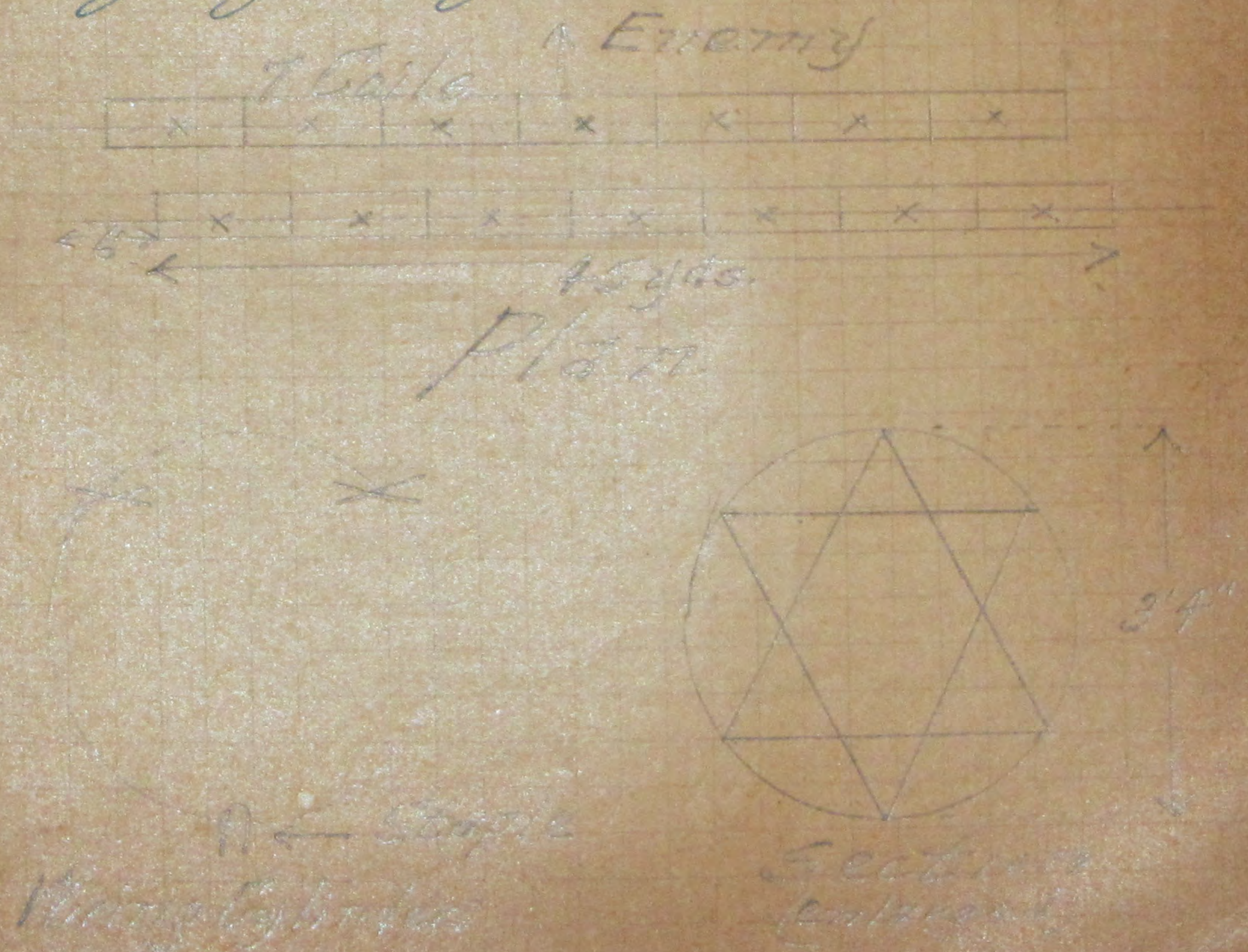
2 coils barbed wire

Thirty-two staples

24 strips #8 plain wire 8" long.

Wiring Party - 1 N.C.O and ten men.

Carrying Party - 1 N.C.O. and 24 men.



Maps

Oct. 10, 1918
Capt. Garett.

The first map in France was made by Cassini to a scale of 1/86,400. The first map made from this map was the General Staff map made in 1818 on a scale of 1/80,000. It was a black on white map, as no other colors were able to be printed at that time. Light spots show lowlands while the darker indicates higher ground. Conventional signs on hachured maps are numerous. Cross roads lined with trees, spots are set opposite each other, while streams lined with trees are staggered spots.

Staff maps are used for all purposes.
A new map was later made and new data used. This was printed in seven colors and the scale was 1/50,000. It was projected on Polyhedral system.

A later map, a reduction of the General Staff map was made to a scale of 1/200,000 and printed in five colors. The populations of towns and cities are given expressed in thousandths.

Geological maps in France are two made on scales 1/80,000 & 1/320,000. The colors on these maps indicate age of materials and not the kinds.

Battle Maps or Plans Directeurs.

These are the maps used in actual service. Made on the scales 1/5000, 1/10,000, 1/20,000.
There are two types of these maps. One is made with only the enemy forces shown.
The other shows the allied organizations. Allied positions are shown in red color and the German in blue. The map is printed with kilometric coordinates. Made on Lambert projection. The horizontal coordinates indicate the east and west distance and the vertical the north and south.

Lecture.

Oct. 11, 1918.
Capt. Langlois.

General Construction and Field Fortification.

Field fortification is a very important subject. It is necessary for cover and to give the best possible range of our weapons. The more powerful the arms used the more extensive the fortifications are. Ditches were used up to 1885, when they were done away with and counter scarp coffers came into general use. There is ordinary & improved

bi conditions of arms and shells.

Present Form of War.

A Improvement in explosives and in rifle bullets, the shells giving high penetrations and flat trajectories.

B. Extensive use of improved mechanical devices for firing such as automatic arms.

C. Adoption of quick firing artillery guns, permitting accurate and powerful barrage.

D. Improvements in shells and increase of their efficiency.

E. Increase in organization and transportation of heavy artillery.

F. Perfect liaison maintained.

G. Application of motor power to fighting devices.

Most of these are beneficial on defense as well as offensive. At present large forces are used and great influence fortification.

Defensive and offensive are diverse efforts, that is the offensive is not possible all the time. Therefore some parts of frontier always on the defensive. Careful construction increases efficiency of defense and liaison.

The economy of forces and the convergence of efforts direct all actions of war. Always use minimum number of men to gain any point.

It is due to modern weapons that fortifications have to be used. In any case they are part of the manoeuvres. The infantry have two weapons viz: rifle and shovel.

Quotation by Napoleon I.

Field fortifications are always useful – never prejudicial when well understood – asserting that victory will be gained by the one who moves, marches and manoeuvres; and that no field works should ever be done is making pleasing but contemptible discourse.

Different Kinds of Fire. (Art.)

1. Time when projectile explodes.
   a. Percussion shelling.
   b. Time fuse. " "

Time fuse shelling is either shrapnel or splinters.

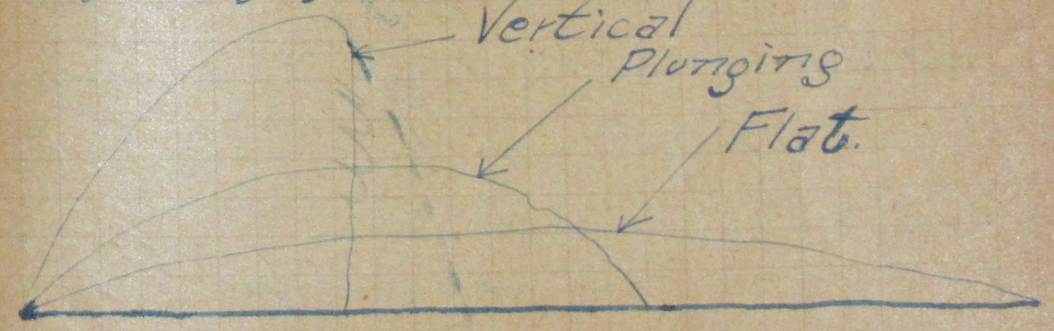
Shape of Trajectories

a. Flat.
b. Plunging.
c. Vertical

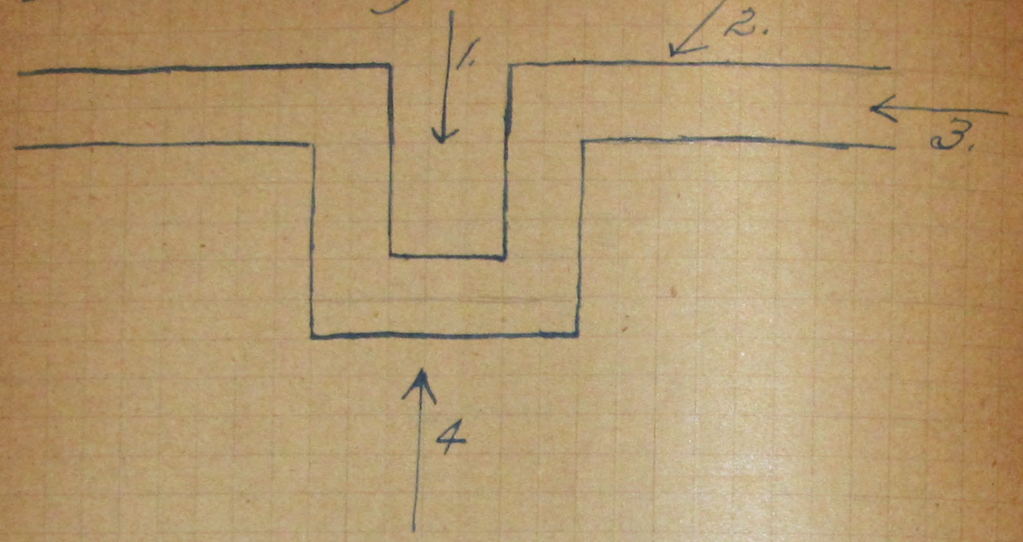
a. Rifles have great initial velocity and give flat trajectories.

b. Howitzers have smaller projectile, smaller propelling charge and have high angle of fire.

c. Mortars have small projectile, small propelling charge and very high angle of fire.



Direction of Fire on Trench.



1= Normal.
2= Oblique.
3= Enfilade.
4= Reverse.

Penetration of Rifle Bullets.

German.

1= S. Normal - nickel jacket - lead core.
2= S.M.K. Penetrating. - nickel jacket steel core

S Bullet.		
Plain Soil	.80 M. - 2'9"	Range 150. 200 M.
Clay "	.80 M. - 2'8"	
Oak	.50 M - 1'8"	
Fir	.70 M - 2'4"	
Brick or Limestone	.40 M - 1'4"	

8 m.m. steel plate at any distance S direct
10" " " " 20 M. S inverted.
14" " " " 30 M. S.M.K.

Effects of artillery fire on entanglements.

French 75s or trench mortars are used for this work. One square metre of wire requires two 3" shells for destroying. One square metre requires one large or two small 58 m.m. mortar shells.

Divergence of Fire.

There is always a certain divergence of fire which obeys definite rules. A table giving dispersion of shells see over following page. The proportion of shells is constant always.

Table of Dispersion.

	1½%
	7%
	16%
	25%
	25%
	16%
	7%
	1½%

Guns fired under same conditions will not hit target in same spot.

To lay a gun means to bring mean point on target.

Accuracy of gun is shown by size of rectangles made by its shell fire.

Attack and Defense of Positions.

Any advance must be preceded by preparation. Artillery and tanks destroy wire and position is taken and held by infantry. Present methods limit to use of surprise attacks.

Attack of positions.

1. Preparation works.
2. Preparation.
3. Execution.

1= Includes execution of necessary earth works; getting ammunition, rations and assembling troops. All done as quietly as possible.

2. Means all destruction of defenders works, hostile batteries, trench mortars. Batteries are

neutralized by gas shells. Shelling of machine gun posts, crossings, shelters, observation posts etc. Counter slopes shelled by gone shelling to prevent assembling of reserves.

3. Destruction of wire for passage of infantry. Indirect machine gun fire directed on counter slopes to prevent any repair of gaps in wire. This is done when preparation lasts several days.

Too much preparation gives much notice of an attack.

Stead of preparation infantry faces exactly in front of objective. Jumping off trenches are now seldom used.

Execution is by infantry—

assisted by the whole artillery. Aerial observation is here most valuable during progress of attack and barrage. Troops cling as close as possible to barrage.

In divisional front, sections are allotted to each regiment. Each place a battalion on a front of about 400 metres. Final objective is usually planned beforehand.

If on the defensive, and attack is launched by enemy roads and points used for assembling areas are shelled heavily, using much gas. First line trench is fully manned. A defensive barrage is placed on no mans land about 150 metres in front of own infantry

-ments. This barrage should not stop even if first line gets thro. It will still be a big difficulty for on coming reserves to overcome.

Organization of Positions.

Oct. 12, 1918.
Capt. Langlois.

Positions organized so as to best utilize the terrain and to be able to fight under favorable conditions and enemy unfavorable.

Favorable.

1. Observing stations so that artillery is in perfect liaison with infantry.

Organization of posts of command so that they all have direct view. Placed on highest surrounding points.

2. Natural obstacles.

Such as rivers, canals, swamps, thick forests. All these are obstacles for tanks.

3. Natural Concealment.

Use counter slopes wherever possible and wooded areas.

4. Easy communication with back areas.

5. Good quality of ground to dig in. No water to contend with.

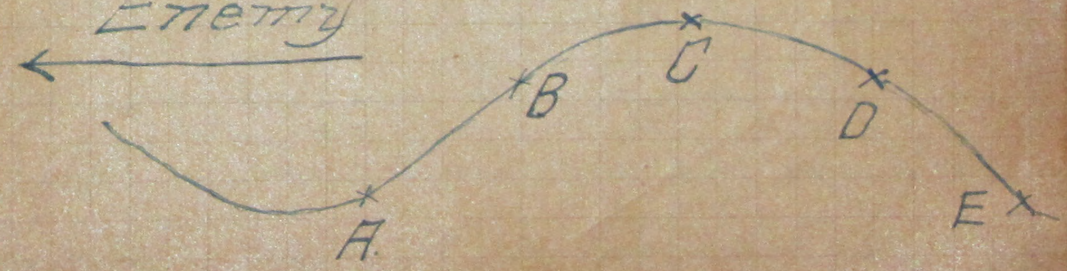
6. Try to get good views of all space in front of position. Lead as many disadvantages to enemy as possible, such as swampy ground for his position.

The combat group is element of whole organization. Trenches connect combat group positions, but are not necessarily manned at all times.

The front parallel is placed on a continuous line with ground sloped in front of trenches so that artillery can place a barrage in front of it.

Machine guns are placed outside obvious regular lines of trenches and will not likely be systematically shelled. Placed so as to be away from any effect of trench shelling. A consideration of the meanders is necessary.

Sites for Trenches.



A. Position A has advantage of good field of fire and has good observation stations. Its disadvantage is that communicating trenches to rear are likely to be under direct fire of enemy.

B. This position, called the military crest has no dead space for rifle fire and only short communication trenches are necessary, but it is sometimes hard to lay an accurate barrage in front of trench.

C. The topographical crest is on sky-line and usually has much dead space. Position easily observed and artillery support is not very good.

D. On this rear counter slope we would have neither distant or near view and field of fire is very short. Enemy cannot see position or entanglements well. Good artillery support can be had here. Good for support lines.

Organization in Depth.

In depth, position is organized to give surprise in defense the same as in offense.

1- Main parallel trench.

Sometimes 1/3 to 1/2 of machine guns are placed near this trench.

2. Support parallel.

Located 200 or 300 metres behind main parallel, on account

of shelling between trenches.

3. Reserve parallel.

Focus of battalion reserves used for reinforcements and counter attacks. Located about 1000 or 1500 metres from front line. If possible place beyond range of hostile trench mortars. Woods and villages are good locations for these.

Surveillance parallel.

Is in front of main parallel, placed so as to have good view and rear, preventing surprise attacks.

Panelling of Ground.

An adversary who has penetrated our lines must be prevented from spreading to either side. This is

done by panelling ground. Defense here quickly manned by those who may have fallen back from main parallel. Entanglements are placed along communication trenches as part of this defense.

Distribution of Forces in Sector.

Combat group is the unit of formation. These are grouped into strong points usually consisting of of a company. Strong points grouped into a centre of resistance which corresponds to a battalion. All these are grouped in width as well as in length.

A division usually has about 5 or 6 kilometers of frontage

quiet sector. This is further divided into four regimental sectors. In each of these a battalion occupies first position. In second position are two battalions usually housed in billets. The rest of the battalions are further back in billetting area and are brought up in case of emergency.

Organization of Villages and Woods.

Oct. 14. 1918.

Capt. Langlois.

Villages and woods play great role in all organizations

General rules applying to them.

1. A screen
2. An obstacle
1. Forbs making them are not seen if elementary precautions are taken.
2. Woods exceeding difficult to pass them unless using regular thoroughfares. Few men needed to prevented passing therefore giving economy of forces. If taken

a lasting shelter to clean woods. Wooded obstacle is made by tree cutters resulting. They are obstacles to infantry and tanks. Large woods cannot be cleared on account of the tremendous amount of ammunition and time necessary.

Villages are usually at intersection of roads and possession of them gives control of local road system. They also insure other benefits, such as ready made shelters used in open warfare. Masonry walls protect against rifle fire, but are no protection against artillery fire. All sorts of material is then for barricades. Work is possible at nearly all times on account of the excellent concealment

afforded.

In stable warfare life in positions in woods and villages is more comfortable.

Small villages and woods are subjected to concentrated shelling which will wipe them out. Therefore they should be occupied by few men.

Gas shelling is more efficient in woods and villages, but their other advantages more than balance this adverse one.

Organizing Positions in Villages.

1. Defend the outskirts of the village in same way as in open. Flank all obstacles by means of mutual flanking fire. Should not be placed on immediate outskirts, but

at least 50 meters from all buildings, so as not to draw fire or be in 50% shell zone.

Rest machine gun posts are in turn protected by riflemen, the whole forming different combat groups.

2. Buildings forming edge of the village are prepared for occupation, but are not permanently occupied.

3. Divide village into sections and organize each one as an island of resistance, under a capable man.

4. Locate automatic weapons, enfilading all thoroughfares. Strong concrete emplacements may be made if time is available. Place loopholes

high enough, so that debris, caused by shelling, will not block field of fire.

5. Barricade all roads liable to give passage to tanks or armored cars. Have points equipped with anti-tank guns.

6. Big artillery preparation is made on villages and they will, where possible be completely surrounded. Interval between strong points are well flanked by machine guns.

7. A group or groups of reserves are located at point in village farthest away from enemy in good shelters. Position called "position reduit". Covers all exits out of village at about 150 meters distance.

8. Provide good shelters to small interior garrisons. Water supply, wells etc., are protected by shelters. 2 meters of good broken stone are protection against 210 m.m. shells.

9. In elaborate organizations, have interior communication by trenches or by subways.

In rapid organizations, the flanking of the outskirts by combat groups; the enfilading of the streets, barricading, and the defense of the intervals is first work to be done.

Subsequent work to be on communicating trenches.

Organization of Woods.

This organization of woods is very much like that of villages.

In large wooded areas, edges are flanked as in villages, but the machine guns are placed inside the woods.

Outposts are on edge of wood and this is divided into sections, each surrounded by wire, using trees as gabets.

Flanking of intervals is very essential and all paths and routs are enfiladed by machine rifles and also barricaded.

Cut and cover shelters are best in woods on account of high water levels.

Reserves are located so as to best meet prospective attacks.

It is of prime and essential importance that appearance of woods is not changed by cutting off branches and clearing for fields of fire.

Small woods are never used for positions of importance. Trenches are placed about 50 meters of rear edge with wire in front. Use the front of the woods as outpost position.

Trenches.

Oct. 14, 1918.

Lt. Root.

Trenches are the most used form of defense. They are for two distinct purposes. One is to make our arms more effective and the other to make the enemy's arms less effective.

Many fire trenches are placed in a sector and communicating trenches are also organized for fire trenches.

Trace of a trench is the projection of its principal lines on ground.

Profile is section made by plane perpendicular to trace of trench.

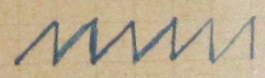
The general trace is determined by conditions. It is usually laid down in advance by staff.

A detailed trace is made providing against enfilade fire and bursting shells.

Straight line cut. ——

Redan 

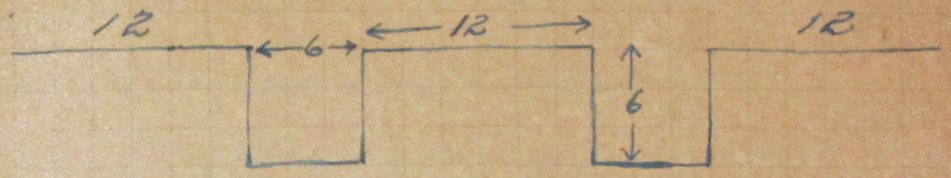
Lunette 

Tenaille 

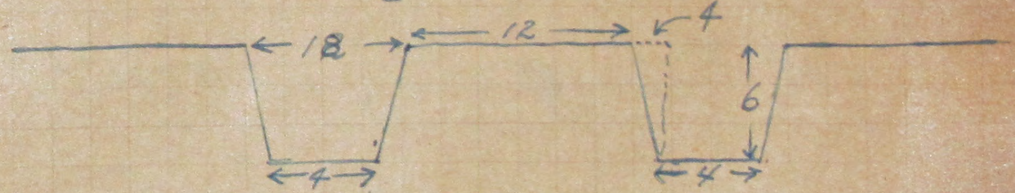
Bastion 

Forms of Trenches.

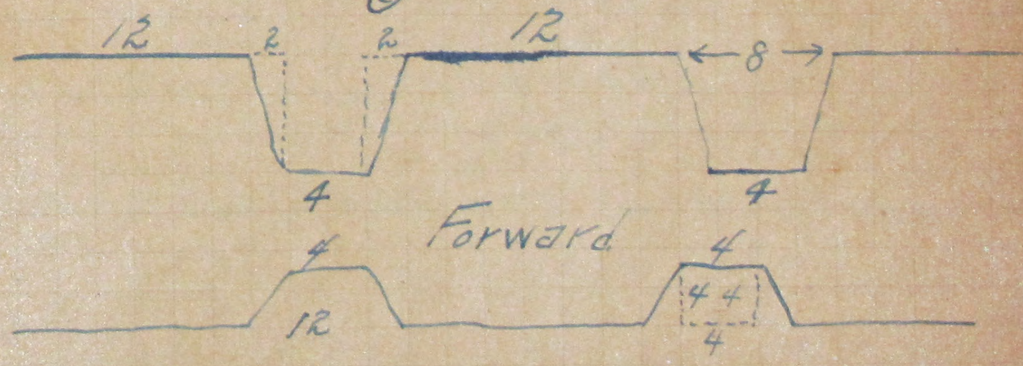
Rectangle.



Hexagonal #1.



Hexagonal #2



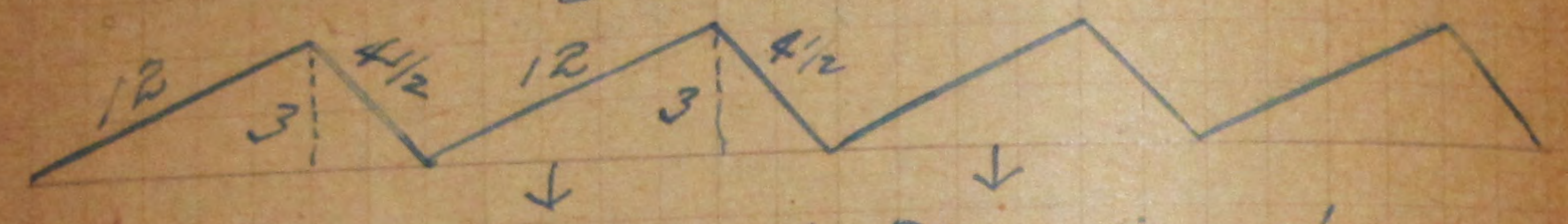
Note.

Numbers denote ordinary steps.

Communicating Trenches.

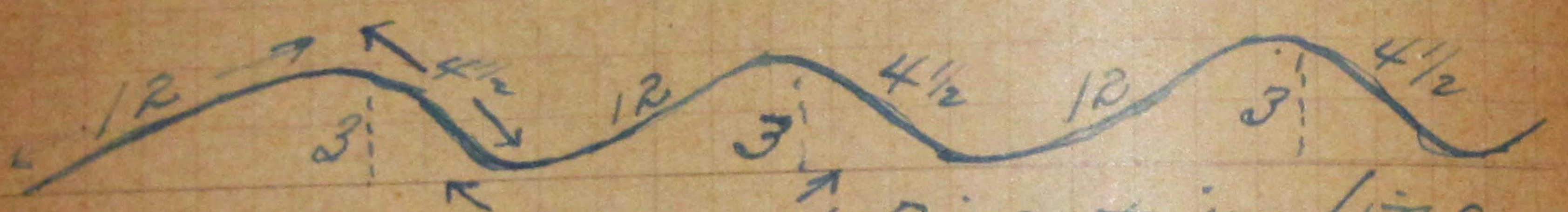
Traces.

Saw Tooth.



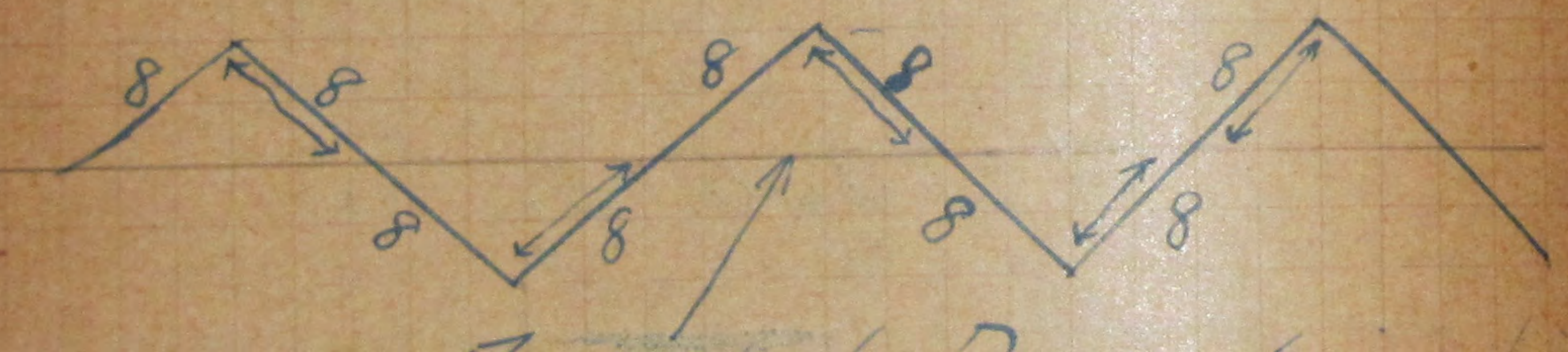
General Direction line

Sinuous Trace



General Direction line.

Zig Zag Trench.



General Direction line.

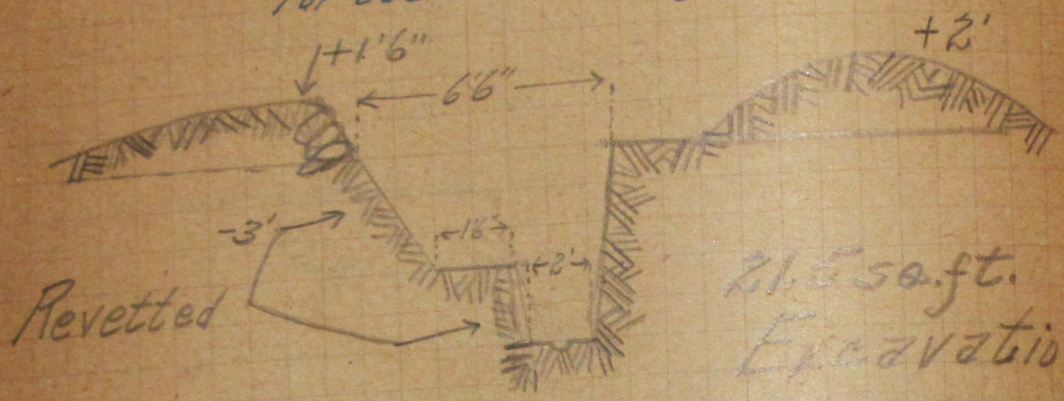
Numbers denote ordinary steps.

Communicating trenches are designed for protection of personnel traveling from one point to another.
They should change direction every 60 or 100 yds. and aid in panelling ground. Drainage is important. ~~In~~ a regimental sector, at least two communicating trenches and two per company between main and support parallel.
Always enter communicating trenches into middle of firebay or traverse.

Trenches should have sign-boards throughout with each trench named.

One latrine at least is made for each platoon by digging a small sap from trench with a T head. Wires are strung along A frames or on revetment.

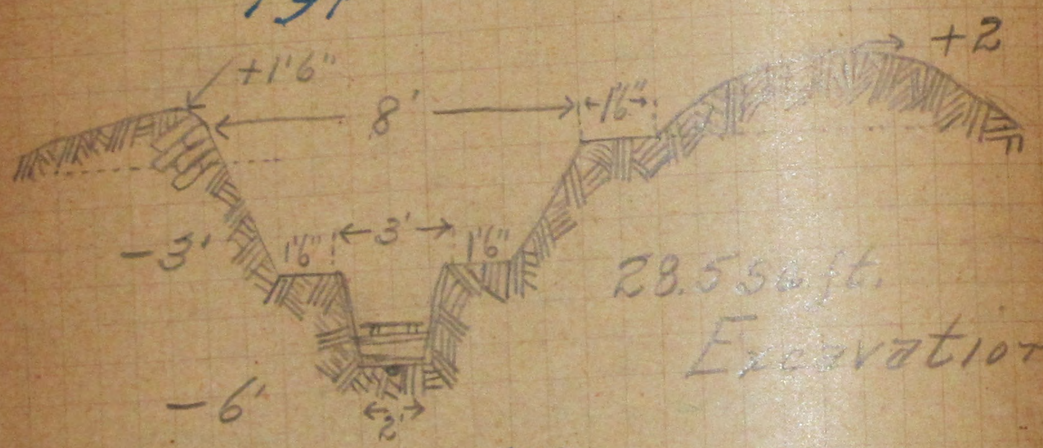
Profiles.
Fire-Trenches
Type A.
For use without "A" frames.



Revetted

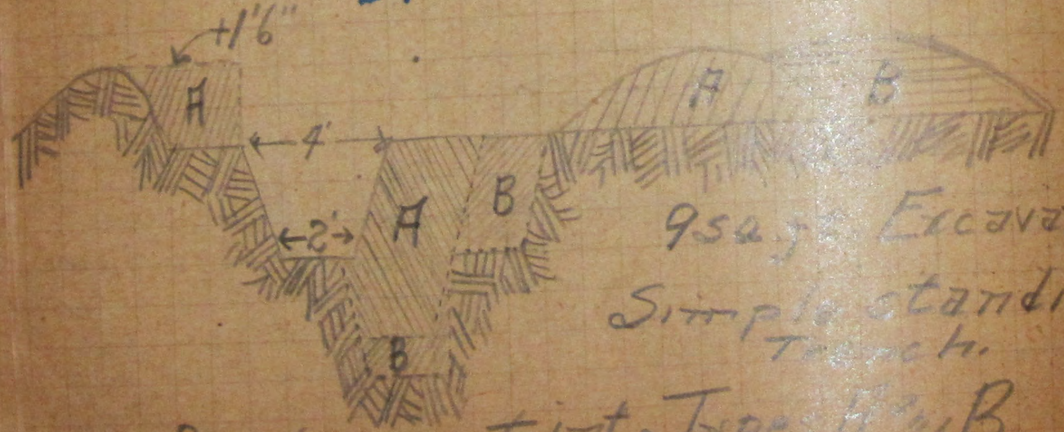
21.5 sq. ft. Excavation

Type "B" (used with "A" frames.



28.5 sq ft. Excavation.

Type "C"



9 sq ft Excavation
Simple standing Trench.

Developement into Types "A" & B.

Profiles.
Communicating Trenches.
Type "A"
(For use without "A" frames.)

Type "B" (with "A" frames)

Type "C"

2 Duck Boards

Organization of Second Position.

Oct. 15, 1918.
Capt. Langlois.

A position is never finished, there is always a possibility of improvement.

Part of available labor is devoted to development of intermediate positions.

In second position more choice of positions is left to those making it. It is usually 6 to 8 kilometers from the front, and work can be done in the daytime.

The object of successive positions is to check a local success of the enemy.

All trenches included

in field of artillery fire are considered in first position.

The principles of organization in second position the same as in first position.

Distance between two successive positions should be far enough so as not to come under a barrage at the same time as first position.

This distance is usually 5 to 8 kilometers from main parallel of first position to main parallel of second. This distance may be lessened slightly in broken country.

First position work is done by its occupants.

Second position is called Army Corps position.

Order of Urgency.

7. Digging of flanking trench elements and building machine gun emplacements. Continuous belt of entanglements

B. Observing stations, headquarters and essential liaison.

C. Shelters and continuity of main parallel.

D. Important communication trenches.

E. Battery emplacements

F. Support parallel.

Dig all trenches to first stage.

Intermediate Positions

Are built for special

it is light weight and quickly put up.

Communication with rear for ammunition and ration parties is next established and is extremely important.

2nd Stage consists of methodical improvement. Trade as soon as possible by engineers and other constituted units. No matter how temporary position must be prepared for counter attacks.

Position may have been planned beforehand by maps and relief maps.

Order of Urgency.

Fixed by headquarters

One plan should not be changed greatly if results are

looked for.

Communication work most important for engineers. An advance can not be successful unless communications are maintained at all times.

Stringing up wire will fix position. In first line wire and trenches are put up together.

Defense of depth makes necessary making of successive positions. In an advance men are in depth and can do the work.

New first position.

Surveillance line

Good sight of enemy not necessarily continuous.

Resistance line is the next important.

Reserve lines may be sectioned for sometimes as may be switch trenches.

Strong points completed and fully manned first.

Arrangement of machine guns is really the making of the line.

Working.

Never divide troops into too small groups or do not begin too much work at one time. Work must be done rapidly, therefore distance to work is made as short as possible.

In a rapid advance work should be, wherever possible, done in daytime when more efficient work is done.

Engineers have special duty in their war, which is to work.

During an attack they must not be divided too much or sent in too soon. They are kept intact until they are sent out to do work of definite character. A platoon unit is set for work. Too small units make results negligible.

Duties.

To destroy mines.
To remove obstacles.
Bridges over trenches.
Communications include wide field of work.
Trenches.
Tracks for men and wagons.
Regular roads.
All sorts of bridges.
Railroads.

Revetements.

Oct. 16, 1918.

Capt. Gravier.

Systems to keep earth
walls in place are termed
revetements

Trenches to last a long
time, especially in winter
need revetement.

Also used in outside
embankments.

When not using revet-
-ment in communicating trenches
leave a good slope to sides and
a gallon berm to help in
case of shell fire.

Revetment is most
useful in fire trenches.

Breast works is term
applied to trenches above
-ground.

Revetement requires much
material. Choice of type de-
-pends amount of material nec-
-essary. Ease of repair also im-
-portant. Wooden material is
better for repair than metal.

One type of revetement
stands by its own weight
like a wall and is thick
enough to resist side pressure.

Stone Walls.

Sods.

Sand-Bags.

Gabions.

Stone walls made of
flat stones found near work.
Top of wall covered with earth
on account of bullets and splinters.

Square sods are used to
make a wall. Size about
12" x 12" x 6"

Sand bags
Use of these always
increasing. Their scarcity makes
use limited. Repair of work
easy with them. Must not
be placed in conspicuous places.
Should wall of them, a small
channel is dug for first
layer. Good slope to wall
is necessary.

Other revetting material
consists of two parts the
revetting and stiffening part.

Revetting Parts.

Planks, Hurdles,
Facines, Brushwood,
Wire Netting
Expanded metal.
Corrugated Iron.

Stiffening Parts.

Frames.
Pickets (Wood, Iron)

Here are complete frames
and also "A" frames. Frames may
be cut to desired dimensions.
Planks or sides last lateral
pressure well. Expanded metal,
corrugated iron used as siding
with frames.

"T" frame is best type.
It makes for good circulation
thro trench and also drainage.

Hurdles & Pickets.

Hurdles 6'6" long 2'7" wide.
Two pickets 5' long 3" dia.
are used with one hurdle.
They are driven in ground, and
wired from top to an anchor

stake placed about 18" from trench. Hurdles are not expensive material, are strong and will last long time.

Gabions are circular baskets, (33" high 2' dia.) made of brushwood, make good revetment, but are clumsy for transportation. Not used much for front line or trench work. Used in outside embankments.

Facines are branches in cylindrical shape about 8' long and 8" thick. Used for heavy revetment work.

Brushwood is made in place and is good type of revetment. Available in wooded areas.

Fire netting, when light, is doubled and makes a good type of revetement.

Expanded metal and corrugated iron are too expensive and too much waste of material to be used in revetment.

In selecting material always remember the question of quick repair.

Drainage.

Water and mud are main source of suffering of troops. Very likely to cause trench feet. And will continually block trenches and traffic. Always consider when tracing trenches. Try always to collect water in a low distant point. Sumps with field pumps

Artillery.

Oct. 16. 1918
Capt. Langlois.

Object of artillery is to support infantry. Infantry can attack by fire and movement while artillery can fire only. Infantry can fight without artillery, but this latter can not fight without infantry

Artillery depends upon liaison and observation for efficiency of fire. Liaison is close communication between the two fighting branches.

In attack artillery makes clear path, destroys machine-gun nests, enemy batteries and shells backareas and rear zone.

In defense it destroys enemy trenches, shells slotted

batteries and places where enemy expects to advance using gas.

Various Guns and Projectiles.

Long guns fire shells with high propelling charge and initial velocity making flat trajectory. Navy uses these guns to large extent.

Howitzers use small propelling charge, and have smaller barrel. Fighter guns fire same size shell as long guns.

150 m.m. = Heavy field howitzer.
105 m.m. = Light " "
Trajectories less than 45°

Mortars Trajectories more 45°
French mortars are light projectors of small caliber and are used for clearing entanglements and front line shelters in an advance

Artillery divided into:

Light artillery which follow troops.

Heavy artillery.

High power artillery of either short or long guns.

Trench artillery.

Allotment of artillery.

Divisional artillery 75 m.m., 155 m.m. howitzers. the former with range of 8 kilometers. Short howitzers 10 to 11 kilometers.

Corps artillery.

155 m.m. long guns.

Reserve includes 75 m.m.

Trench mortars batteries belong to army corps.

Army artillery composed of high power guns.

Location.

Batteries are not ascribed to units to which they belong but are all practically on same line.

Location on defense.

Placed far enough from front line so that batteries are not endangered by a local advance of enemy. Distance about 2½ to 3½ kilom.

Location on offensive.

Located close enough to front line so that it is not necessary to move them, before infantry has established itself.

Installation.

In open or forest guns are camouflaged.

Barrage.

It is considered efficient when one shell is falling every minute in 8 meters front.

Firing 6 rounds in defense or 3 rounds in offense per gun.

Defensive.

6 rounds per gun covering 50 meters

24 rounds per battery - 200 m.

Offensive

3 rounds per gun covering - 25 m.

12 " " battery " 100 m.