MANUAL

FOR

TRENCH ARTILLERY

UNITED STATES ARMY

(PROVISIONAL)

Part V

The 58 No. 2 Trench Mortar

Reprint of pamphlet prepared at Headquarters American Expeditionary Forces, France, March, 1918

WAR PLANS DIVISION
JULY, 1918

WAR DEPARTMENT Document No. 821
A. E. F. 520
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The following pamphlet, entitled "Manual for Trench Artillery, United States Army (Provisional)—Part V—The 58 No. 2 Trench Mortar," is published for the information and guidance of all concerned.

(062.1 A. G. O.)

BY ORDER OF THE SECRETARY OF WAR:

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General, Chief of Staff.

OFFICIAL:

H. P. McCAIN,
The Adjutant General.

MANUAL

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TRENCH ARTILLERY

UNITED STATES ARMY

(Provisional)

PART I.—Trench artillery.
PART II.—Formations and maneuvers.
PART III.—6″ Newton trench mortar (English).
PART IV.—240 mm. trench mortar (French).
PART V.—58 mm. No. 2 trench mortar (French).

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PART V

THE 58 No. 2 TRENCH MORTAR

CHAPTER I

MATERIEL

The Piece.

The piece is divided into four plain parts; the mortar proper, the carriage, the bed and the platform. Fig. 1 shows the assembled piece complete.

The Mortar Proper.

The parts of the mortar proper are the barrel, of steel with a smooth bore of 58.3 mm. (2.29 inches), the breech end, the elevating-band with two elevation locking bolts, washers, and wing nuts for clamping the mortar at the proper elevation, and the firing mechanism adapter, screwed into breech end. Fig. 2 shows a longitudinal section of the mortar proper and Fig. 3 the percussion firing-mechanism.

The Carriage.

The carriage consists of two cast iron *cheeks*, each with a slotted guide for the elevation bolts (Fig. 1); a *trough* into which the cheeks fit, the *axle*, which is inserted through holes in the trough, the cheeks, and through the breech end of the mortar, and the *elevating mechanism*. This elevating mechanism consists of a steel oscillating support, threaded internally with a left-hand thread, a bronze elevating hand-wheel on a bronze screw threaded externally with a left-hand thread to fit the oscillating support and internally with a right hand thread of twice the pitch. A steel screw, threaded to fit the right hand thread of the bronze screw, is fastened by a pin to a small yoke on the elevating band of the mortar. The oscillating support is fastened by two bolts through the slotted guides of the two cheeks of the carriage (Fig. 4). The back part of the trough consists of a high circular plate on the back of which is bolted a steel piece carrying a lug and the traversing clamp screw. The trough is provided at the front with two transportation rings and at the back with two traversing rings.

The Bed.

(Fig. 5). The bed consists of five oak timbers, two short and three long, the latter being fastened together at the front by a channel iron and bolt through the middle of each timber. The middle bolt carries a clamp for holding the front of the trough to the platform. At the back the five timbers are

held together by the back plate, which is sunk into the wood to a depth of 1.5 centimeters (0.6 inches) and fastened with five bolts, one in the centre of each timber. The base of the back-plate is provided at the front with a row of thirty traversing holes, one inch between centres. The rear surface of the back-plate is divided into eighty equal divisions, each graduation having a value of ten mils, the horizontal field of fire being 800 mils. The middle point of each division is marked by a dot, and each hundred mils is stamped with the figures. The right hand edge of the lug of the circular plate is used as the index with these graduations in setting the mortar in direction. The center board of the bed carries a pivot projecting one centimeter (0.4 inches) above the wood. This fits into a hole in the under surface of the trough and is the pintle centre of the piece. This pivot is 60 centimeters (23.6 inches) in front of the face of the back-plate, which is curved to this radius.

WEIGHTS OF PARTS OF THE 58 No. 2 TRENCH MORTAR.

	PART	WEIGHT Lbs.	Kg.	
Mortar.	Barrel	100	43	Total 166 lbs.
	Breech-end	53	24	" 75 kilos.
	Elevating band and wing nuts	13	6	(carried by 2 men).
Carriage.	Cheeks (2 of 65 kgs. each)	286	130	
	Trough	132	60	Total 497 lbs.
	Elevating mechanism	18	6	" 226 kilos.
	Axle	66	30	(carried by 7 men)
Bed.	Back-plate	130	59	
	Middle timber with channel iron	77	35	Total 356 lbs.
	Long timbers (2 of 28 kgs. each)	123	56	" 162 kilos.
	Short timbers (2 of 6 kgs. each)	26	12	(carried by 6 men).
Under Platform.	Front timber	114	52	
	Second timber	66	30	
	Plain timbers (5 of 28 kgs. each)	309	140	Total 860 lbs.
	Back timber	160	72	" 390 kilos.
	Channel iron	110	50	(carried by 14 men).
	Angle irons (2 of 23 kgs. each)	101	46	
	TOTAL for piece with platform		853 kilos (1879 pounds).	
	" " " without platform		463 kilos (1019 pounds).	

THE PLATFORM.

The platform is not always used, but it is employed where the soil offers very little stability, and always for the firing of heavy bombs (Fig. 6). The platform consists of eight cross timbers held together by two long angle irons between which the bed is placed. Near the front of the platform are bolted two small angle irons which hold the front of the bed firmly in place. The rear timber is shod with a channel iron. Two clamps are provided on the front timber and three on the back timber for holding down the bed. Each timber has a ring at each end to facilitate handling.

Bombs.

Three types of bombs are used with the 58 No. 2 mortar as shown in the following table:

Name	BOMB		EXPLOSIVE		
	WEIGHT		WEIGHT		KIND
	Kilos	Lbs.	Kilos	Lbs.	
L.S.	18	40	5.350	12	P
D.L.S.	35	77	10.000	22	P
A.L.S.	20	44	6.400	14	P

L. S. and D. L. S. bomb.—Fig. 7 shows a longitudinal section of an unloaded L.S. bomb. The three main parts of the bomb are the body, the tail and the six wings. The body, of steel, consists of three parts welded together, a cylindrical portion with a tapering part at each end, as shown. The nose of the bomb is threaded for the fuse well in the L.S. bomb (in the case of the D.L.S. bomb it is threaded for a retaining plug) and the rear part of the body is threaded for the tail. The tail, a steel tube 57 millimeters in diameter, is screwed into the body. The wings are of pressed steel with a pressed rib to give rigidity and are welded to the rear tapering part of the body. When the bomb is in position in the mortar, the tail is in the bore up to the body of the bomb and wings are outside of the barrel.

Fig. 8 shows in detail the obturating device used in both L.S. and D.L.S. bombs. A is the tail of the bomb; B is a steel plug turned to 58 millimeters, external diameter, fitting rather loosely into the tail and held in by three pins G spaced 120° apart. When the piece is fired the pressure on the plug B is sufficient to crush and expand the copper ring R and force it against the wall of the bore of the mortar, thus preventing the escape of gas around the tail of the bomb. In place of this obturator some bombs are provided with a steel plug accurately turned to 58 millimeters external diameter, forced by hydraulic pressure into the end of the tail.

The total over-all length of an L.S. bomb is 79 centimeters (31 inches) and of a D.L.S. bomb 95 centimeters (37.5 inches).

A. L. S. bomb.—The bomb (Fig. 9), differs from the L. S. and D. L. S. bombs in that it has a hollow tail and three wings made of light channel irons held together by a steel ring. The charge is inserted in the tail, thus placing the force of the explosion nearer the center of gravity of the projectile, increasing the range and accuracy of the mortar. This bomb is not yet in common use.

Loading of Bombs.

The interior of the body is first carefully painted with tar to prevent contact of the explosive with the metal. The explosive is then well tamped into the bomb and a hole bored in it axially with a copper bit. The retaining plug and the

exploder of solid melinite are inserted and the fuse well, containing the detonating charge of powdered melinite, is screwed into the retaining plug. A small tin cap is placed in the fuse well to keep out dirt.

Marking of Bombs.

Data relating to the manufacturer of the bomb itself is stamped in the metal near the nose of the bomb. The data usually given is as follows:

(1) Initials of the contractor.
(2) Number of the order on which bomb was furnished.
(3) Initials of intermediate contractor, if any.
(4) Lot number.
(5) Last two figures of the number of the year in which bomb was manufactured.

In white paint on the wing are given the data relating to the manufacture of the explosive as follows: (*a*) letter showing kind of explosive; (*b*) initial of place where explosive was manufactured; (*c*) figures showing day, month, and year of manufacture.

On another wing in white paint are given data as to the loading of the bomb as follows: (*a*) initials of place where loaded, (*b*) figures showing month and year of loading. On the reverse side of the same wing in white paint is weight in kilos to within 100 grams for the L.S. bomb and 500 grams for the D.L.S. bomb. Bombs loaded with explosive P, have the ogive painted green. Bombs loaded with special liquids are painted green and have the number of the liquid indicated in white paint.

Propelling Charges.

The charges used with the 58 No. 2, with the percussion firing mechanism, are the following:

Type of Bomb	Charge	Range Obtained
D. L. S.	(60 *grams* *B C powder* + 12 *grams* F_3).....	100 to 260 m.
	(60 " B C + 12 F_3) + 25 gr. AH. 12 . .	160 to 370 "
	(60 " B C + 12 F_3) + 2x25 gr. Att. 12	240 to 540 "
	(135 " *Att.* 12) + 12 F_3	320 to 670 "
L. S.	(60 *grams* *B C* + 12 *grams* F_3)	120 to 350 m.
	(60 " B C + 12 gr. F_3) + 25 gr. Att. 12	220 to 490 "
	(60 " B C + 12 gr. F_3) + 2x25 gr. Att. 12	340 to 700 "
	(160 " *Att.* 12 + 12 *gr.* F_3)	500 to 980 "
	(160 " Att. 12 + 12 gr. F_3) + 25 gr. Att. 12	640 to 1250 "
A. L. S.	(185 *grams* *Att.* 12) + 12 *grams* F_3	460 to 920 m.
	(185 " Att. 12 + 12 gr. F_3) + 65 gr. Att. 12	760 to 1450 "

In the above table the charges in italics are the base charges, either B. C. powder or attenuated ballistite No. 12 (Att. 12).

The other charges are obtained by adding to these base charges increments of attenuated ballistite No. 12 (Att. 12). The base charges and increments are as given below.

Kind of Charge	Weight of Charge	Type of Powder	Diameter of Bag	Weight of Igniting F_3 Powder Charge
Base charges.	60 grams. 135 " 160 " 185 "	B. C. Att. 12. " " " "	50 to 55 mm. " " " " " "	12 grams.
Increments.	25 grams. 65 "	Att. 12. " "	50 to 60 mm. 35 to 39 "	12 grams.

The base charges are contained in a linen bag with a false bottom of silk muslin which contains the 12 grams of igniting F_3 powder (black powder). To prevent confusion of the three base charges of Att. 12, the 160 grams charge is contained in a green bag with two seams as a distinguishing mark for night firing. The 65 grams increment Att. 12 is contained in a white linen bag with a silk muslin bottom and the 25 gr., Att. 12 in a silk bag.

In each case the bags are plainly marked with the weight of the charge, the size of the powder, the date of manufacture and initials showing the place of manufacture.

In addition to the above charges the following old charges are still in use:

B. C. powder-charge 1-105 gr.+12 gr. F_3 powder.
" 2-120 " +12 " " "
" 3-135 " +12 " " "

Ballistite No. 15 charge 1-80 gr.+10 F_3 powder.
" 2-105 " +10 " "
" 3-130 " +10 " "

Fuses.

The I. T. fuse.—This is an instantaneous percussion fuse, the action being as follows (Fig. 10): The percussion head and firing pin are held up by the shearing wire and safety ring. Before the bomb is fired this safety ring is removed. On impact the blow on the percussion-head breaks the shearing wire, drives the firing pin into the percussion cap, ignites the charge of pressed powder and the detonating charge of fulminate of mercury.

Note.—These fuses are sometimes marked "a tige." They come as shown in Fig. 10a.

The 24/31 Model 1916 fuse.—This is either a non-delay action fuse or a one-tenth (1) second delay action fuse. It requires nearly normal acceleration to arm this characteristic greatly reducing the danger of premature explosion.

The action of this fuse is shown by Figs. 11 and 12, Fig. 11 showing the fuse unarmed. Fig. 12a shows the inertia plunger, the safety block and boss in detail, in the unarmed position. In this position the percussion cap, which is at the end of the spindle of which the boss is a part, cannot touch the firing pin because of the fingers of the safety block. As the bomb accelerates when the piece is fired, the inertia plunger, due to its weight, moves down the spindle as shown in Fig. 12b until the fingers of the inertia plunger are disengaged from those of the safety block. The safety spring then forces the safety block down the spindle, rotating it slightly at the same time, until the head of the safety block is against the boss as shown in Fig. 12c. The spindle, with the percussion cap, can now move a distance equal to the length of a finger of the safety block. When the bomb strikes, the spindle, inertia plunger and safety block as a unit are thrown forward by inertia, causing the percussion cap to strike the firing pin. The delay action is given by the time train, as shown in Fig. 11. For non-delay action the time train is omitted. The action of a non-delay P. R. fuse is never as rapid as that of an I. T. fuse, as very little of the P. R. fuse projects from the bomb.

The R. Y. fuse.—This is an instantaneous fuse.

It requires nearly normal acceleration to arm and is similar to the P. R. fuse. The action of the fuse is as follows (Fig. 13): In the unarmed position shown, the central spindle, the lower end of which is the firing pin, cannot be driven against the percussion cap as the distance is too great and motion of the percussion cap is prevented by the fingers of the safety block which are between the two bosses of the percussion holder. When the inertia plunger moves downwards, allowing the fingers of the safety block to spread, the arming spring then moves the percussion cap and holds it upward until the fingers of the safety block are behind the lower boss. On impact the firing pin is now able to reach the percussion cap. There is no intermediate charge between the percussion cap and the detonating charge and thus it is as instantaneous in its action as the I. T. fuse.[1]

Primers.

The primer used is very similar to a blank rifle cartridge, consisting simply of a brass shell with fulminate of mercury percussion cap and black powder held in by a wad.

[1] Formerly, in place of the present percussion firing mechanism, slow match ignition was used for the 58 No. 2 mortar. A primer of Bickford fuse with a small perforated cupper cup of pressed powder at the lower end was inserted through the tapped hole in the upper part of the barrel which was provided with brass bushing. A slow match was used to ignite this primer which burned for 5 seconds before igniting the propelling charge which was always of BC powder. The present percussion system gives more rapid firing and better obturation.

CHAPTER II

INSTALLATION OF PLATFORM AND MORTAR

In rocky soil it is necessary to deepen the excavation by 10 in. and fill with loose sand, soft earth or sand bags.

The bottom of the emplacement is prepared by digging a space 6½ feet square to a depth of about 5", levelling off and removing all stones. The timbers of the platform are then installed in order from rear to front.

An interval of about ½" should be left between timbers. The two longitudinal angle irons are laid perpendicular to the row of timbers, in their proper places, with the upright side facing inward and the timbers and channel iron are bolted to the angle irons. The platform is then levelled and the bed is placed on it in such a manner that it fits between the angle iron timber number 2. It is then fastened to the platform by the front and rear clamp.

The trough of the mortar is laid on the bed so that it fits over the pivot and engages under the clamp in front. In this position it should rest against the graduated iron circle, yes also revolve easily. The barrel and cheeks are assembled, placed in the trough, and the axle and elevating mechanism put in position.

The level of the platform should be checked and, if more than 1 degree off, corrected by piling earth beneath the platform.

CHAPTER III

TRANSPORTATION OF THE PIECE

Transportation by escort wagons.—This is the easiest method of transportation, but can only be used on roads or over smooth ground. One wagon can carry three 58 No. 2 mortars without platforms. (See Ammunition.)

Transportation by mortar carts.—For transporting the mortars across difficult ground a special light 2-wheeled cart is provided (Fig. 14). It is designed to carry one mortar with pivot platform, the equipment chest, and two fuse boxes. It can be drawn by horses or by man power with a towing bar and four towing ropes.

Transportation by hand.—In trenches it is necessary to transport all the materiel by hand. A carrier consisting of a steel rod with a yoke at each end is provided (see Fig. 15). The part to be carried is slipped over the rod, which is in two sections, and is carried by two men, each supporting a yoke on his shoulders.

For carrying the materiel 30 to 35 kilograms (65 to 75 lbs.) is the normal load for one man.

The following table shows the usual distribution of loads for transporting the materiel by hand:

Mortar proper		75 kilos	2 men with carrier.
Carriage	Cheeks	65 kilos each.	4 men with 2 carriers.
	Trough	60 "	2 men with carrier.
	Axle	30 "	1 man.
	Elevating gear	6 "	In equipment chest.
Bed	Back-plate	59 kilos	2 men.
	Middle timber	35 "	1 man.
	With channel iron		1 man.
	Long timbers (1 man for each) each 34 kilos		2 men.
	Short timbers (both)		
Platform	1 Sleeper, 3 clamps		2 men.
	1 Sleeper, 2 clamps		1 man.
	1 Sleeper, 2 grooves		1 man.
	5 ordinary sleepers		5 men.
	1 rear angle iron		1 man.
	2 longitudinal angle irons		1 man.
	Service box		2 men.

Transportation of Ammunition.

The method of transporting ammunition from the line of supplies to the emplacements is determined by the battery commander. An ammunition sergeant has immediate supervision over transporting the ammunition and is responsible that the details under his charge are efficient in the performance of their duty.

One escort wagon can carry 48 L.S. bombs or 20 D.L.S. bombs. A light bomb cart (Fig. 16) is also provided. This is

drawn by either horse or man power and can carry 18 L.S. bombs or 10 D.L.S. bombs.

By means of a bomb carrier (Fig. 17) one man can carry two L.S. bombs or one D.L.S. bomb. When bomb carriers are not available bombs may be carried in sand bags connected by lashings to a strap placed over the shoulder. In transporting bombs care must be taken not to bend the wings or damage the tail.

CHAPTER IV

CARE OF MATERIEL

Daily care.—After firing, the bore of the mortar should be thoroughly washed, carefully dried with rags and greased slightly with the brush.

The firing mechanism must be cleaned. Heavy grease should not be used, but the separate parts should be wiped with a greased rag or a few drops of oil applied. Candle grease is put in the short lanyard where it rubs against the metal. The muzzle cover is put on.

The other parts of the materiel must be kept clean and in good condition. The platform must be inspected frequently for cracks.

CHAPTER V

SERVICE OF THE PIECE

Owing to the conditions under which the mortar is usually fired, slight variations from the drill may be necessary.

58 MM. TRENCH MORTAR DRILL.

The mortar section consists of a chief of section, two (2) mortar detachments and a driver's detachment.

Each mortar detachment consists of a gunner and four (4) cannoneers numbered from 1 to 4 inclusive.

To post the mortar detachments.—The gunner commands DETAILS POSTS, after the battery commander has commanded SECTIONS POSTS. The details take post as described in the drill.

After the details have reached their posts, the gunner commands PREPARE FOR ACTION.

To call off.—The battery commander may at any time give the command CALL OFF. This command is repeated by the gunner, and the cannoneers, beginning with No. 1, call off their numbers.

To load and fire.—The battery commander gives the line elevation, bomb, charge and fuse. The gunner repeats the data and commands LOAD. The battery commander may give the command LOAD in which case the gunner repeats the command. When the mortar is laid and loaded, the gunner commands TAKE COVER and reports No. — READY and pulls the lanyard when the command COMMENCE FIRING is given by the battery commander.

When the battery commander commands FIRE—ROUNDS COMMENCE FIRING; or FIRE—SHOTS, COMMENCE FIRING; the gunner commands LOAD before each shot of a series and at the end of a series reports No.—FIRED ROUND (S) or SHOT (S).

When the number of rounds is not specified the battery commander commands CEASE FIRING, or SUSPEND FIRING and the gunner repeats the command.

To suspend firing.—The gunner repeats the command SUSPEND FIRING given by the battery commander. If the mortar is loaded or being loaded, the cannoneers stand by to resume firing at any instant.

To cease firing.—The gunner repeats the command CEASE FIRING and commands REPLACE EQUIPMENT when the battery commander commands DISMISSED.

Misfire.—In case of a misfire the gunner reports No. — MISFIRE and after waiting one (1) minute a second trial of the primer will be made. If this also fails, after waiting two (2) minutes the gunner inspects the primer. If the primer has not been fired and the percussion cap is not dented a new firing mechanism will be used. If the primer has not been fired but the percussion cap has been dented a new primer will be used. If the primer has been fired, it will be necessary to unload the piece and insert a new charge.

TABLE SHOWING THE SERVICE OF THE PIECE

Detail	At Command Detail Posts	At Command Prepare for Action	At Command Load
Gunner (N. C. O.).	Commands "Details posts." Supervises the procuring of equipment and implements. Procures an adding charge of powder and haversack for primers, firing mechanism and long lanyard. Takes post one yard in rear of mortar facing it.	Commands "Prepare for action." Verifies the level of the platform. Inspects firing mechanism. Singes out the bore. Collects reports and reports No. — in order.	Commands LOAD. Supervises work of the detachment. Checks zero line, elevation, bomb, charge, fuse. Prepares and inserts firing mechanism. Commands TAKE COVER hooks long lanyard and reports No. — READY. At command FIRE or COMMENCE FIRING he pulls long lanyard. Reports No. — FIRED — ROUND (S) or No. — MISFIRE.
No. 1 (layer).	Procures chalk, plumb line, quadrant and traversing bars. Takes post one yard from mortar, facing it on the side away from the ammunition shelter.	Tests elevating and traversing mechanism. Reports to gunner.	Repeats line and elevation. Assisted by No. 2 lays mortar for direction, clamping the traversing clamp. Assisted by No. 2 sets mortar for elevation, clamping the wing nuts.

			Verifies elevation after wing nuts are clamped. Screws into bomb fuse given him by No. 4. Takes cover.
No. 2 (loader).	Procures rammer and sponge, extractor reamer and mallet. Takes post one yard from the mortar, facing it on the side opposite to No. 1.	Inspects mortar carriage, bed and platform Removes muzzle cover. Reports to gunner.	Assists No. 1 in laying piece. Inserts charge and obturator, rams them well home and takes cover.
No. 3 (Bomb details).	Takes post in bomb shelter.	Nos. 3 and 4 examine ammunition and see that component parts are correct and in good order. Nos. 3 and 4 report to the gunner.	Repeats designation of bomb after gunner. Brings up required bomb and gives it to No. 2. Takes cover.
No. 4 (Charge detail).	Takes post in charge shelter.		Repeats the designation of charge and fuse after gunner. Brings the charge to No. 2 and fuse to the gunner. Takes cover.

CHAPTER VI

AIMING AND LAYING

In direction.—When the target can be seen from the emplacement one of the following methods may be used:

(1) Plumb bob method.

The target is either seen with the eye, or its direction is indicated by a stake properly located in the parapet.

The gunner stands behind the mortar, aligning himself with the target (or stake) and the vertical plane through the axis of the mortar. He holds the plumb line to the height of his eye and directs the muzzle to be traversed right or left till the axis of the bore, the target (or stake), and the plumb line are in his line of vision. This being accomplished, No. 1, who did the traversing under the command of the gunner, tightens the clamp, being careful not to move the barrel. The gunner then notes the reading on the deflection scale.

(2) Plumb bob with periscope (Fig. 18).

This and the following methods are used to locate a stake in the parapet to give the direction of the target.

The end of a plumb line (10′ long) is held at the adapter by No. 1. No. 2 supports the other extremity of the plumb line at the end of a long wooden stick, leaving a short length hanging vertically above the parapet. The gunner holds a periscope above the trench and in back of the plumb line, and directs No. 2 to move the stick so as to bring the two parts of the cord in the line of sight to the target as seen through the periscope. When the proper direction has been determined a stake is set in the parapet and the mortar is laid as directed in method 1.

(3) Simple periscope method.

A plumb line is fastened to the top of a single periscope so that it falls across the center of the upper lens when the periscope is held vertically. The gunner stands behind the pintle center of the piece, sights through the periscope, and directs a stake to be set on the parapet, so that stake, string, pintle center and target are in the same vertical plane. The mortar may now be laid so that the axis of the bore coincides with this vertical plane, or it may be laid by method 1.

(4) When no target can be seen from the emplacement, the zero line of the piece may be determined as follows:

(*a*) **Compass method.**[1]

The angle between the desired zero line of the mortar and true north is determined from the map. This angle is corrected for magnetic declination.

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[1] Ordinarily the needle of the compass does not lie in the meridian, i. e., in a true north and south line. Its angle of deviation from that line is called the *magnetic declination*.

The magnetic declination varies (at a given time) from place to place and (at a given place) from time to time. The change in declination from place to place, or from time to time, is called the *magnetic variation*.

The magnetic declination in norther France is *west* of *north*.

Set up a stake about 20 meters directly in front of the center of each mortar. Place the compass on a stake, and, since the needle always points to the magnetic north, turn the compass until the N.-S. line makes with the needle the corrected angle as determined above. Sight along this line toward the mortar and set up two stakes in prolongation of the line, one on the parapet and the other on the parados. The stakes will determine the zero line. It is now a simple matter for the gunner to lay the bed for direction along the zero line.

A string is stretched between the stakes in the parapet, and parados and the bed is laid with its axis directly under the string. The gunner may determine that the axis of the bed is directly under the string by sighting down on it from the parados or by hanging a plumb line to the string and directing the setting of the bed to bring its axis in the plane determined by the string and the plumb line. The mortar is then mounted.

(*b*) **Sighting method.**

If the bed has already been set with its axis approximately in the center of its field of fire, the zero line is determined as follows:

The gunner sets the mortar at zero (i.e., reading 400), then holds a plumb line at arm's length directly in rear of the mortar in the plane of the axis of the bore, and direct the driving of a stake on the line of sight in the parapet. A second stake is similarly located in the parados, the gunner standing in front of the mortar to sight. By sighting along these stakes some object shown on the map may be found on the line of sight. The zero line of the mortar is located on the map by drawing a line between this object and the point representing the emplacement.

If no such object is visible the magnetic bearing of this zero line is taken with the compass and transferred to the map by connecting for declination before explained. A zero line being located on the map, the directions to various targets are readily obtainable in mils, right or left of zero.

ELEVATION.

The piece having been laid for direction, the gunner announces the angle of elevation as ordered by the battery commander. No. 1 sets the level slide of the quadrant (Fig. 21) at the angle given, places the quadrant upon the muzzle in the plane of fire and assists No. 2 in elevating or depressing the barrel until the bubble in the slide is level. No. 2 adjusts the position of the barrel by means of the elevating wheel, and when the proper angle has been reached with the help of No. 1 he clamps the winged nuts. No. 1 again verifies the elevation and if more than one round is to be fired at the same angle, he verifies it again before each loading. The gunner must not let the piece be fired until he assures himself that the angle is such that the bomb *will not strike the parapet.*

When the quadrant is placed on the muzzle, the arrow must always point in the direction of fire.

CHAPTER VII

IRREGULARITIES OF FIRE

The most frequent irregularities are the following:

Misfires.
Hangfires.
Abnormal shots.
Premature bursts.
Failure to burst.

Misfires.

These may be due to failure of either the firing mechanism or the charge.

If the misfire is caused by firing mechanism it may be due to the cartridge. In that case the percussion system is unscrewed and another cartridge inserted. If due to the percussion system (worn out or broken firing pin, worn out spring, etc.) a new firing mechanism is used and the defective one sent out for repair.

If the misfire is due to the charge the mortar is unloaded.

Misfires due to the charges most frequently occur in rainy weather. Before firing the first shot do not neglect to singe the bore.

Hangfires.

Hangfires are caused by faulty ignition. In such cases the pressure developed in the gas chamber is below normal and the bomb falls short, sometimes not farther than the trench parapet.

They are primarily due to:

(*a*) Damp charge.

(*b*) The total omission or insufficient quantity of black powder at the bottom of the powder bag.

Abnormal Shots.

In trench artillery terms an abnormal shot is said to have occurred when the projectile reaches less than 2/3 of the distance indicated by the range table. Occasionally it happens that a bomb falls too far from the line.

Abnormal shots are caused by:

(*a*) Hangfires.

(*b*) Tumbling of the bomb due to a bent wing.

(*c*) Strong winds. These have great effect on the range especially when firing at high elevations.

Premature Bursts.

Premature bursts may be caused by:

(*a*) Premature action of the fuse. A fuse in good condition may work prematurely on account of a sudden change of the

initial velocity of the bomb in the bore; particularly when the tail of the bomb is not clean or when the plug is not quite smooth. The shearing wire may be defective.

The tail of the bomb may not be perfectly rigid or fit tightly to the body of the bomb. When it is loose the bomb *must not be fired.* In such a case a premature working of an I T fuse is almost a certainty.

(*b*) The bomb hitting the trench wall.

This may be due to hangfires, or to the elevating handles not being clamped securely, causing a dipping of the barrel; or to failure to check the angle of elevation to see that the projectile has free passage over the parapet.

(*c*) The spontaneous detonation of the bursting charge.

This being a chlorate explosive, is very sensitive to friction, which may occur when the bursting charge rubs against the inner surface of the bomb, (1) if the explosive is not well pressed or (2) if an abnormal pressure is exerted on the projectile when fired.

Failure to Burst.

Failure of the fuse to function. This may be due to (*a*) the fuse not striking the ground on account of the bomb tumbling in its flight or falling on a slope or ground upturned by shells or (*b*) poor condition of the exploder.

Detailed Report.

Every irregularity of fire must be reported by the battery commander to the commander of the artillery (through channels).

This report states:

1. Model and number of mortar.
2. Kind of bomb and fuse used.
3. The marking of the bomb.
4. The charge used and the angle of fire.
5. Approximate range attained.
6. Damage to materiel caused by accident.

If the report refers to case of a failure to burst the report also states:

(*a*) Kind of ground.

(*b*) Slope of ground at point of impact.

Precautions to be Taken for Preventing Accidents.

Transport of ammunition on railroad car and on wagons.

Bombs should be transported in crates.

Crates should stand on end with the tail of the bomb downward.

This precation is imperative.—Bombs should not be placed in the same wagon with charges and fuses. If this must be done a layer of straw should be used to prevent relative movement of bombs, charges and fuses during transportation.

Bombs should be left in their cases as long as possible.

Care of ammunition.—An uncrated bomb must never rest standing on its tail. *Officers should superintend* the storing of all ammunition. They should personally see that the tail and tail plug are not loose and that the wings are straight.

Bombs must not be exposed to the sun rays since that melts the paraffine and vaseline composition of the explosive and renders it unstable.

Charges and fuses.—Charge cases and fuse boxes must be sheltered from rain and dampness and opened only at the time of firing, one case at a time. Cases and boxes should be closed when firing is over.

All powder bags affected by dampness must be eliminated. If there are doubtful bags in a case the whole case should be discarded.

The gunner is responsible for the execution of the above precautions.

Inspection of materiel.—Materiel must be carefully inspected frequently and especially after periods of intensive firing.

Any mortar, the bore of which is wearing out or shows cracks, should be replaced by a new mortar. The same precaution is to be taken when the adapter works loose.

Precautions while firing.—For each bomb, No. 3 verifies:

(*a*) That the tail and tail plug of the bomb are not loose.
(*b*) That they are clean and have no defects.
(*c*) That wings are straight.

No. 2 verifies that bomb is well seated.

No. 4 verifies that each charge bag is dry and contains the igniting charge of black powder. If firing in rainy weather he will take care that charges, fuses and cartridges are protected from dampness.

No. 1 verifies that the shearing wire of I T fuse is not broken.

It is forbidden to screw or unscrew the metallic fuse well.

The gunner sees that the cannoneers observe all the preceding precautions.

The battery commander takes all necessary measures to prevent accidents to the personnel. *He compels cannoneers* to take shelter while each shot is being fired. In all cases he will keep in touch with the infantry commander to have the zone in front of the position evacuated by the infantry during periods of firing.

CHAPTER VIII

TARGETS AND METHODS OF ATTACK

When fire for effect does not immediately follow the adjustment of fire, the elements of this adjustment are verified before firing for effect. This is necessary because atmospheric conditions and state of ground on which the piece stands may have changed. During the fire for effect all rounds are observed and corrections applied to make fire more effective.

Dispositions should be made to insure continuation of the firing whatever may be the difficulties in the transmission of orders. It is advisable to give the chief of section written orders, as shown in par. 108, part II.

Night firing.—At night, except under particularly favorable circumstances (when searchlights or rockets are used), it is impossible to observe the points of impact of the projectiles. Night firing, therefore, can only be done effectively when fire adjustment has been exercised during the daytime, either upon the objective or upon an auxiliary target. The data for this fire for effect having been previously determined is sent to each position commander. If in exceptional cases it is possible to observe shots with certainty they should be recorded for correction of fire.

Effects of Projectiles of 58 No. 2 Mortar.

Craters.—The 58 No. 2 projectile with a delay action fuse produces a crater of variable dimensions according to the nature of the ground. The following dimensions were obtained in a hard clay soil:

L.S.	D = 1.50 to 3 m. d = 1.30. h = 0.80 to 1 m.	D.L.S. bomb	D = 4 to 4 m. 50. d = 2 m. h = 1 m. to 1 m. 20.

Effects on trenches.—A *D.L.S. bomb*, the point of impact of which is in the trench or within 0m.50 of the side of the trench, will destroy it for a length of 2 to 4 meters. An *L.S. bomb* under the same conditions will destroy from one to three meters of the trench. Both bombs level parapets and loopholes, fill up ammunition shelters, destroy sentry posts and often cause the explosion or the burning of hand grenades and sky-rocket magazines.

The D.L.S. bomb can break in the roof of an ordinary machine gun shelter by destroying the timbering and closing the entrances.

Effect on barbed wire.—With an instantaneous fuse

these projectiles clear up barbed wire entanglements. The radius of destruction is:

2 m. to 2 m. 50 for the L.S. bomb.
3 m. to 4 m. for the D.L.S. bomb.

Chevaux de frise are displaced by these bombs, and when chevaux de frise are attached together or fixed to the ground the D.L.S. bomb is effective, in destroying them.

MANNER OF ATTACKING VARIOUS TARGETS.

(*a*) **Block houses, observation posts, light machine gun shelters, minenwerfer emplacements, listening posts, sap heads, organized houses, barricades, organized craters, etc.**

Against these small targets firing should be executed with precision with delay action fuses, preferably with D.L.S. bombs.

For demolishing the usual 3 m.×3 m. blockhouse, from 60 to 80 D.L.S. bombs or from 100 to 150 L.S. bombs are required.

(*b*) **Portion of trenches.**

In destroying these targets delay action fuses are used. Enfilade fire is advantageous because of the greater precision of the mortar in direction.

Enfilade fire.—If a portion A B of a trench is to be destroyed, the elevations corresponding to points A and B not differing in value by more than half the fork angle, all the bombs are fired at the elevation and direction corresponding to the middle point M of portion to be destroyed. If elevations corresponding to A and B differ by more than half the value of forks, for example 62° and 68°, fire is executed on points M_1 and M_2 such that A M_1 = B M_2 = ¼ A B, i.e., with elevations 63½° and 66½°.

The levelling of an enfiladed trench for a length of 80 to 100 m. at ranges from 40° to 500 m. requires:

From 300 to 400 L.S. bombs.
— 150 to 200 D.L.S. bombs.

Frontal fire.—The target is divided into sectors 40 mils in width. Fire for effect is executed on points M_1 and M_2, the centers of these sectors. The number of bombs necessary for the destruction is about double the number required in the previous case.

Trenches are generally doubled by a circulation trench parallel to the front trench and about 20 yds. in the rear. It is best to conduct fire for effect on point M situated midway between the two trenches.

(*c*) **Barbed wire entanglement.**

Barbed wire entanglements are generally from 20 to 30 meters in front of the trench and consist of one or more lines of wire and chevaux de frise. The width of these entanglements are, on the average, from 20 to 30 meters.

To destroy these, instantaneous fuses are used.

Frontal fire is preferable.

(1) **When direct observation is possible.**—Fire is controlled on middle or side of entanglement. Fire for effect to make a passage is executed with a single elevation and with directions differing successively by 40 mils.

To make a passage 40 meters wide in an entanglement 30 m. deep will require:

200 L.S. bombs.
120 D.L.S. bombs.

(2) **When direct observation is impossible.**—After adjusting fire on visible auxiliary target, fire is shifted to the zone of the entanglement.

(3) **Salient. Resistance center. Closed trenches.**—The destruction of such an organization requires the combination of the various types of firing. The work is distributed among the mortars of the battery, each one being given a definite target. Convergence of fire is used to obtain the maximum of effects.

(4) **Asphyxiating gas.**—Bombs with instantaneous action fuse break up asphyxiating gas clouds.

APPENDIX A

TRENCH MORTAR 58 No. 2

RANGE TABLE

L.S. Bomb. 18 Kg. (40 Lbs.) B.C. Powder Charges.

Percussion firing

Range in Meters	105 gr. BC powder 12 gr. F3 powder	120 gr. BC powder 12 gr. F3 powder	135 gr. BC powder 12 gr. F3 powder
	Angle of elevation in degrees		
240	75		
260	74		
280	73		
300	72		
320	71		
340	70		
360	69	75½	
380	68	74½	75½
400	67	73½	74¾
420	65¾	72½	74¼
440	64½	71½	73½
460	63¼	70¾	72¾
480	62	69¾	72¼
500	60½	68¾	71½
520	59	67¾	70¾
540	57½	66¾	70¼
560	55½	65¾	69½
580	53	64½	68¾
600	49½	63¼	68
620	Maximum	62	67¼
640	range about	60½	66½
660	610 meters	59	65¾
680		57¼	65
700		55¼	64
720		53	63
740		49½	62
760		Maximum range	61

Percussion firing—Continued

Range in Meters	105 gr. BC powder 12 gr. F3 powder	120 gr. BC powder 12 gr. F3 powder	135 gr. BC powder 12 gr. F3 powder
	Angle of elevation in degrees		
780		About 750 meters	60
800			59
820			58
840			56¾
860			55½
880			53¾
900			52
920			49
940			Maximum range about 930 meters
960			
980			

Bracket: 3° for 60° and higher angles of elevation.
" 6° for angles of elevation less than 60°.

D.L.S. BOMBS. 35 KG. (77 LBS.) BC POWDER CHARGES.
Percussion firing

Range in Meters	105 gr. BC powder 12 gr. F3 powder	120 gr. BC powder 12 gr. F3 powder	135 gr. BC powder 12 gr. F3 powder
	Angle of elevation in degrees		
200	74		
220	72½		
240	71	76	
260	69	74½	
280	67	73	75
300	65	71¼	74
320	63	69½	72½
340	60	67½	71
360	56	65½	69½
380	53	63½	68
400	45	61	66½
420		58	65
440		54½	63½
460		49	61½
480		Maximum range about 470 meters	59½
500			57
520			53½
540			48½ Maximum range about 550 meters

Bracket: 3° for 60° and higher angles of elevation.
" 6° for angles of elevation less than 60°.

L.S. BOMB. 18 KG. (40 LBS.) BALLISTITE 15 CHARGES.

Percussion firing

Range in Meters	80 gr. ballistite 10 gr. F_3 powder	105 gr. ballistite 10 gr. F_3 powder	130 gr. ballistite 10 gr. F_3 powder
	Angle of elevation in degrees		
140	80		
160	78½	82	
180	77½	81¼	
200	76	80½	
220	74½	79½	
240	73	78¾	81½
260	71½	77¾	80¾
280	70	77	80
300	68½	76	79¼
320	67	75	78½
340	65½	74	78
360	64	72¾	77¼
380	62½	71½	76½
400	61	70½	75¾
420	59	69½	75
440	56½	68¼	74½
460	53	67	73¾
480	45	65¾	73
500		64½	72¼
520		63	71½
540		61½	70¾
560		60	70
580		58½	69¼
600		56¼	68½
620		53½	67¾
640		50	67
660		Maximum	66
680		range about	65¼
700		650 meters	64½
720			63½
740			62½
760			61½
780			60½
800			59½
820			58½
840			57¼
860			55¾
880			54
900			51½
920			48
			Maximum about 930 meters

Bracket; 3° for 60° and higher angles of elevation.
" 6° for angles of elevation less than 60°.

D.L.S. Bomb. 35 Kg. (77 lbs.) Ballistite 15 Charges.

Percussion Firing

Range in Meters	80 gr. ballistite 10 gr. F_3 powder	105 gr. ballistite 10 gr. F_3 powder	130 gr. ballistite 10 gr. F_3 powder
	Angle of elevation in degrees		
100	80		
120	77½	82½	
140	75	81¼	
160	72½	80	
180	69½	78¾	
200	66½	77½	81¾
220	63	76½	80¾
240	58	75	80
260	51½	73½	79
280	Maximum	72	78
300	range about	70½	77¼
320	270 meters	69	76¼
340		67½	75½
360		66	74½
380		64	73½
400		62	72½
420		60	71½
440		58	70½
460		55	69½
480		50	68¼
500		Maximum	67
520		range about	65½
540		490 meters	64
560			62½
580			61
600			58
620			57
640			53
660			45

Bracket: 3° for 60° and higher angles of elevation.
" 6° for angles of elevation less than 60°.

APPENDIX B.

COMPLETE LIST OF MATERIEL FURNISHED A BATTERY OF 58's.

12 58 mm. No. 2 Trench mortars, each comprising:

1 Barrel.
1 Breech end.
1 Elevating band.
2 " washers.
2 Wing nuts.
1 Elevating band nut.
1 Cheek, left.
1 Trough.
1 Axle.
1 Elevating mechanism.
1 Firing mechanism, percussion.
1 Platform.
1 Stake, iron, platform.
1 Wrench, socket, double ended.

12 service boxes, each containing:—

1 Sledge hammer.
1 Riveting hammer.
1 Pliers, par.
1 File, 3-corner.
1 Mallet, wooden.
1 Extractor hook.
1 Vent cleaner.
1 Grease brush.
1 Rammer and brush.
1 Brace.
1 Bit, screw driver.
3 Levers, wooden.
4 ½ Rags, kilos.
1 Quadrant.
1 Holster, quadrant.
1 Bolt, holster, quadrant.
1 Case, wood, quadrant.
1 Paddock.
1 Lever, traversing iron.
1 Rule, meter folding.
1 Emery cloth, ½ meter.
1 String, 3 mm., ¼ kilo.
1 Lanyard.
1 Muzzle cover.
1 Box, grease, containing 1 (2 lb.) kilo heavy grease.
1 Can, oil, containing ¼ liter of oil.
1 Flashlight.

Wagon Equipment.

3 Escort wagons.
1 Forage wagon, 2 extra tongues.
3 Covered wagons, 2 singletrees extra.
12 Mortar carts.
24 Bomb carts.
24 Hods.
1 Rolling kitchen.

Accessories.

6 Tongues, metal, towing, carts.
6 Singletrees, cart.
10 Pins, picket, large.
10 Pins, picket, small, cart.
6 Shafts, cart.
4 Paulins, wagon, escort.
12 Paulins, 3x4 meters.
72 Traces, cart.
144 Hauling ropes.
30 Padlocks and keys.
50 Thongs, leather, axle pin.
10 Traces, cart, extra.
50 Bags, trace.
4 Pails, grease.
10 Ropes, lashing.
6 Battery bags.
12 Lanterns, candle.
20 Lanterns, kerosene.
20 Candles, packages (1 doz. to package).
26 Axle pins.
1 Brush, large.
2 Farriers cases, leather.
1 Kilo caulks.
1 Kilo caulks, keys.
25 Saddles, draft.
6 Saddles, draft.
6 Three horse sets, draft.
4 Two horse sets, draft.
48 Horse sets single, draft.
10 Picket ropes.
99 Blankets, horse.
650 Horseshoes.
64 Boxes nails.
99 Sursingles.
99 Nosebags.

Fire Control Materiel.

2 Field glasses.
1 Periscopic goniometer.
1 Tripod, periscopic goniometer.
1 Case, periscopic goniometer.
12 Sheets tracing paper.
6 Sheets drawing paper.
1 Periscopic alidade.
1 Rule.

1 Scale, meter.
1 Box, "Accessory."
1 Box, tool.
1 Protractor, celluloid.
12 Pencils, colored.
3 Pencils, drawing.
1 Ink, red, bottle.
1 Ink, blue, bottle.
1 Eraser.
100 Tacks, thumb.
1 Leveling alidade.
1 Compass, drawing.
1 Tape, decimeter.
1 Square.
1 Plane table.
1 Tripod, plane table.
1 Pen, drawing.
1 Declinator, plane table.
2 Screws, declinator.
1 Extension bar, drawing, compass.
1 Bicycle.
1 Bicycle lantern.
1 Bicycle tool box.
1 Bicycle inner tube.
1 Bicycle pump.
2 Bicycle oil cans.
1 Bicycle horn.
1 Chest, signal, containing:
    3 Batteries, sets in leather cases.
    3 Lights, signal.
    12 Batteries.
    1 Bulb, extra.

BLACKSMITH TOOLS.

1 Anvil, field.
1 Block anvil.
1 Forge, field.
1 Tools, branding (set 0 to 9).
6 Taps.
4 Hammers, blacksmith, short handle.
7 Hammers, blacksmith, long handle.
1 Sledge.
1 Vice, field.
3 Blacksmith rods.
1 Blacksmith palette.
5 Blacksmith tongs.
2 Blacksmith cold chisels.
1 Blacksmith anvil cutter.
1000 Kilos coal.
2 Bags, coal, canvas.
1 Horse shoe nails, box.
2 Punches.
3 Files, bastard.
1 Rasp.

ENGINEER AND BATTERY TOOLS.

12 Spades.
48 Shovels.
12 Handles, shovel.
36 Pickaxes.
8 Pickaxes, handles.
4 Sledges.
2 Handles, scythe.
2 Blades, scythe.
4 Bolos.
12 Shovels entrenching.
12 Carriers entrenching shovel.
4 Picks, rock.
8 Axes.
4 Handaxes.
3 Bucksaws.
1 Bag, canvas, scythe tools (2 rings, 1 whetstone).
2 Wirecutters with cases.
2 Chisels.
5 Handles, file, extra.
1 Stock bit.
4 Bits screwdriver.
4 Bits, wood, assorted.
1 Punch.
1 Square, try, metal.
1 Hammer, square head.
1 Spoke shave
1 Saw, keyhole.
1 Plane.
6 Saws, cross-cut (2 man).
6 Sheaths for 2 man saws.
20 Sickles.

SADDLERS TOOLS.

1 Saddlers tool chest, containing:
1 Case for awl blades and needles.
25 Awl blades.
5 Needles, assorted, packages.
2 Awls, pegging.
2 Awls, seat.
1 Dividers.
1 Shears 4-inch blade, pr.
1 Nippers, small, pr.
2 Thimbles.
1 Cold chisel.
1 Splitting knife and case.
1 Knife, round.
1 Hammer, riveting.
1 Screw-driver, small.
1 Punch.
6 Palms.
1 Stitching clamp.
6 Girths (saddle).
1 Harness leather, roll.

1 Harness leather, strip 4″ by 60″.
1 Canvas, heavy, square meter.
1 Oilcloth.
1 Sheepskin.
1 Rag, woolen (half blanket).
2 Packing, saddle (2 lbs.).
6 Thread, brown harness, balls.
1 Thread, white linen, ball.
3 D-rings.
26 Buckles, roller (assorted sizes) nickeled.
30 Buckles, roller (assorted sizes) Japanned.
6 Buckle rings, Japanned.
2 D-rings 1½ inch, Japanned.
1 3-inch ring and pin, Japanned.
2 Edgings, saddle, brass (front and rear).
24 Studs, brass.
50 Rivets, copper, assorted.
40 Ornaments, brass, (assorted).
5 Rings, brass, 1″.
3 Rings, brass, 1½″.
6 Rings, brass, 2″.
4 D-rings, 1″ brass.
4 Rings, square, brass, 1½″.
20 Roller buckles, brass (assorted).
8 S-Hooks, brass.
25 Screws, wood, flathead, 1″.
25 Screws, wood, round, flathead, 1¾″.
25 Screws, wood, flathead, ½″.
4 Tacks, split, round, oz.
4 Tacks, split, flathead, steel, ¼″.
6 Tacks, split, flathead, steel, ½″.
2 oz. saddlers wax.
1 Beeswax, cake.

Telephone Materiel.

8 Wire, reels, insulated.
2 Bags, work.
9 Batteries, electric.
1 Switchboards, 4-way.
2 Switchboards, 2-way.
3 Bells, electric.
6 Field telephones.
1 Wire, copper, roll, bare.
1 Drill, breast.
3 Stakes, grounding.
1 Pliers, pair.
1 Pocket knife.
1 Pamphlet telephone.
4 Poles, bamboo.

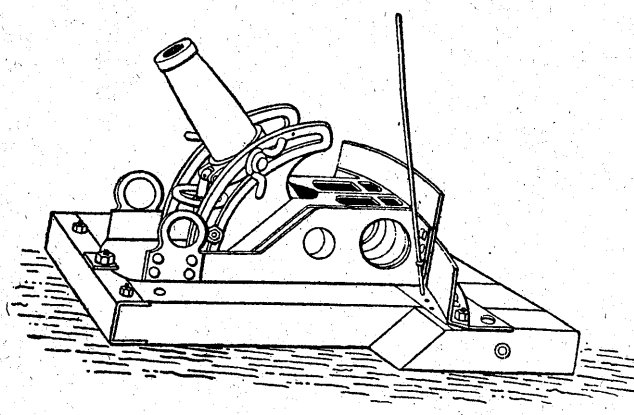

Fig. 1. — Assembled Piece.

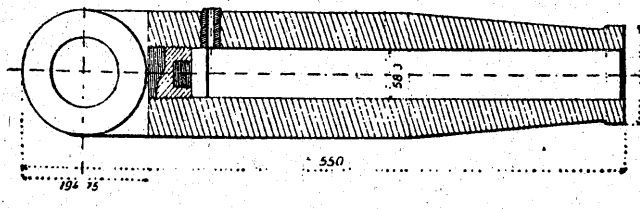

Fig. 2. — Mortar Proper (longitudinal section).

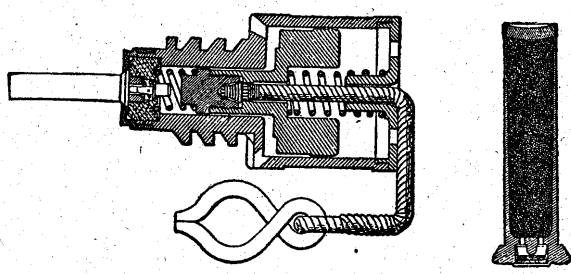

Fig. 3. — Firing Mechanism and Primer.

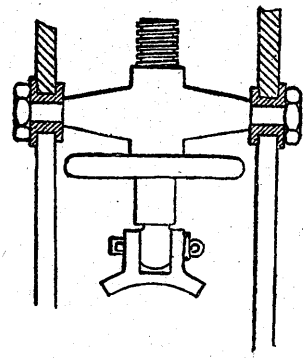

Fig. 4. — Elevating Mechanism.

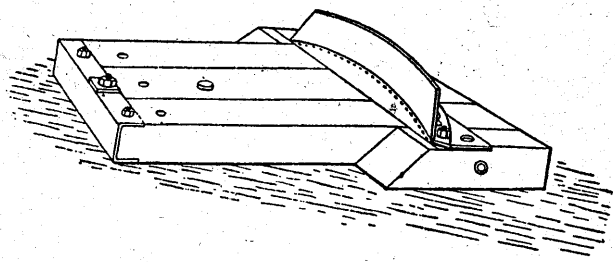

Fig. 5. — The Bed.

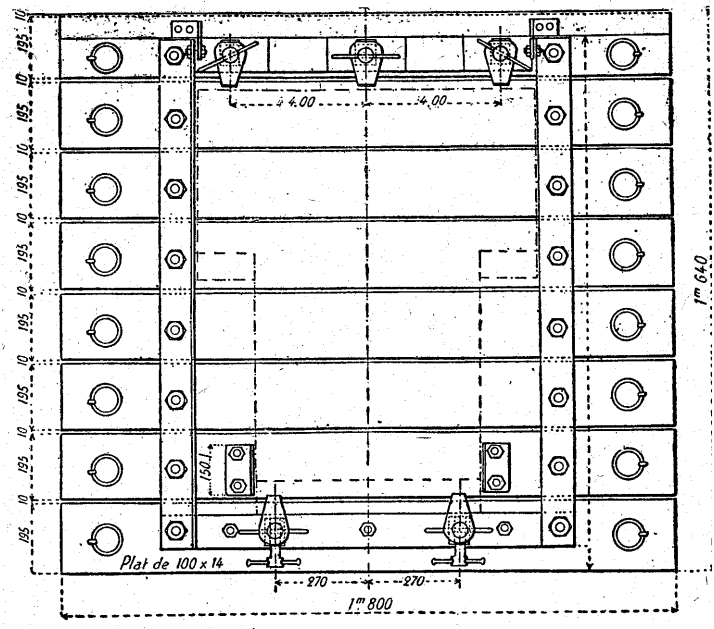

Fig. 6. — The Platform.

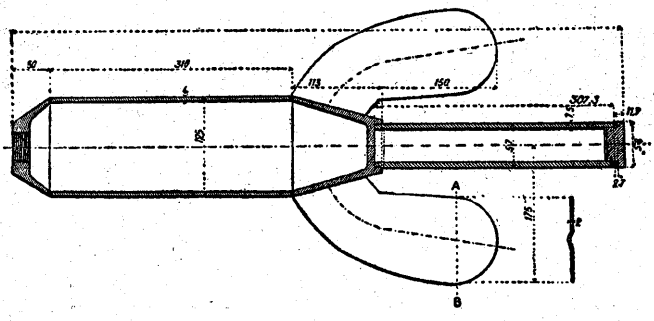

Fig. 7. — The L. S. Bomb.

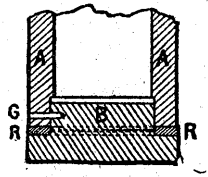

Fig. 8.

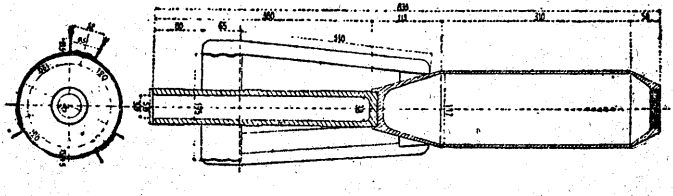

Fig. 9. — The A. L. S. Bomb.

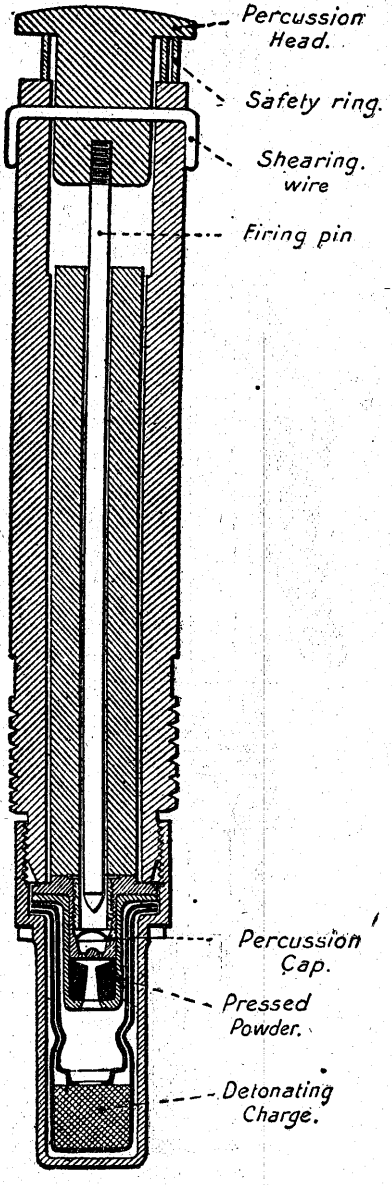

Fig. 10. — I. T. Fuse.

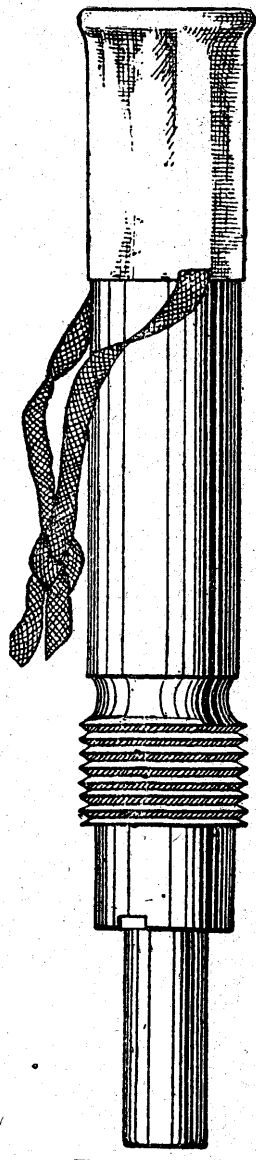

Fig. 10 *a*.—I. T. Fuse.

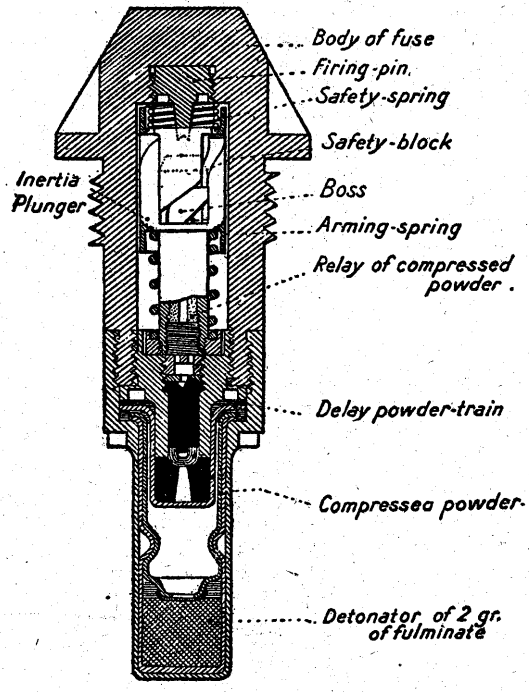

Fig. 11. —Assembled P. R. Fuse.

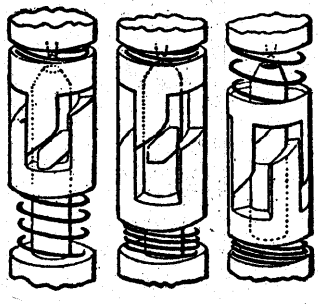

Fig. 12. — Details P. R. Fuse.

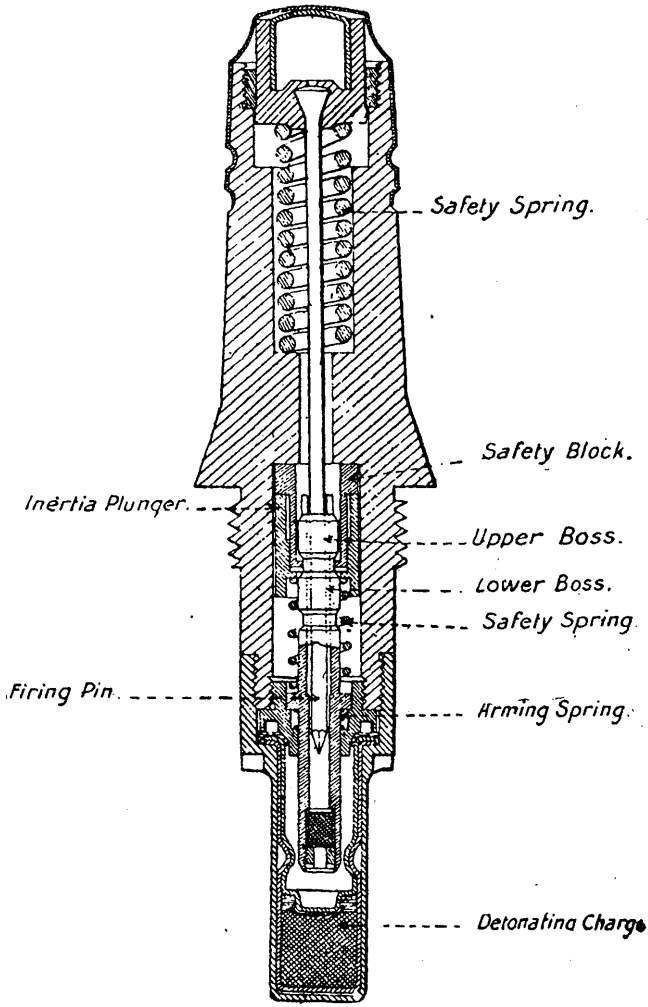

Fig. 13. — R. Y. Fuse.

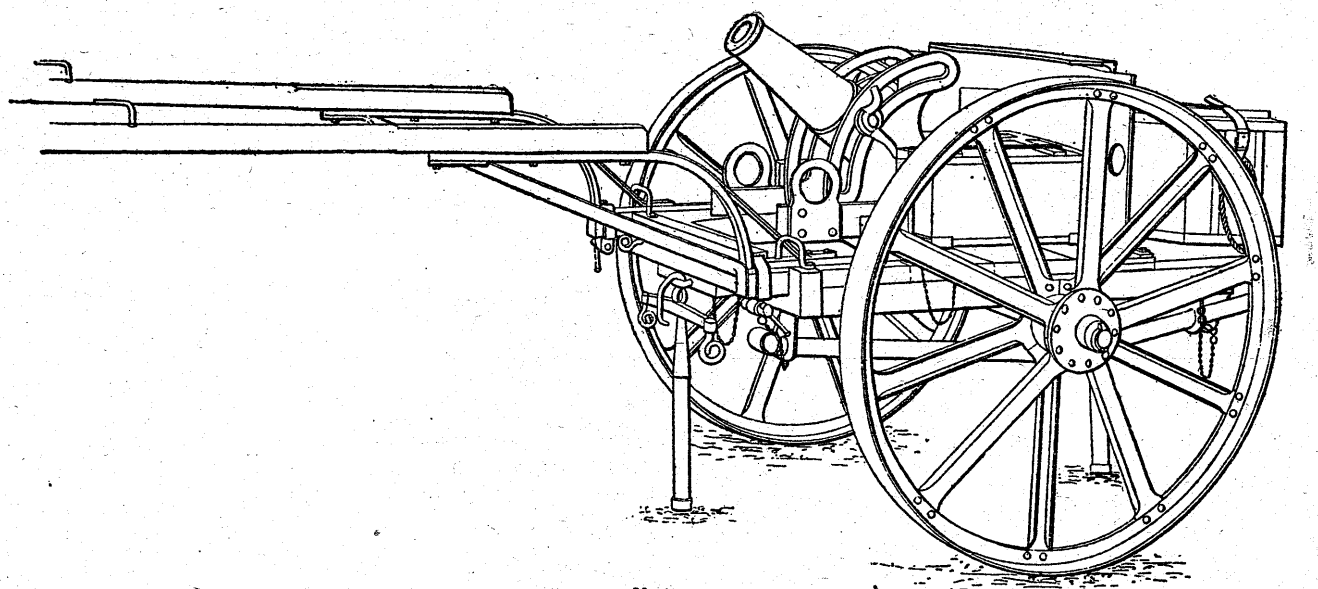

Fig. 14. — Mortar cart.

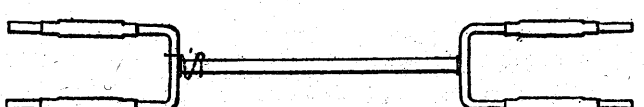

Fig. 15.

Fig. 16. — Bomb cart.

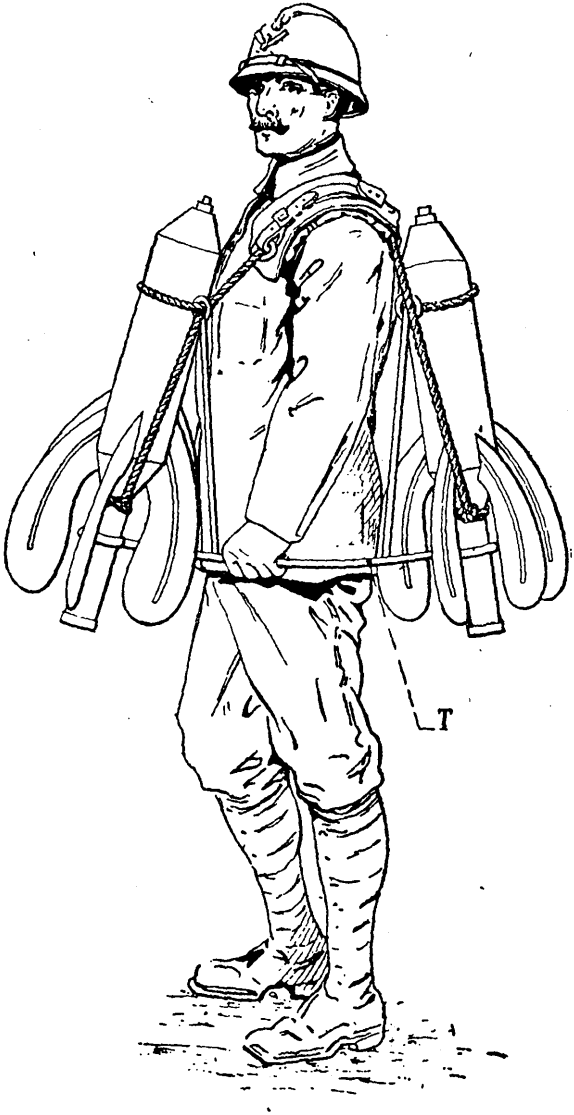

Fig. 17. — Bomb Carrier.

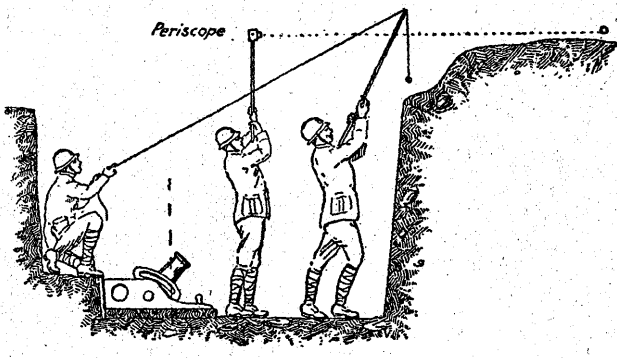

Fig. 18. — Plumb bob and Periscope.