War Department,
Office of the Chief of Ordnance,
*Washington, December 1, 1918.*

This handbook of Ordnance Data compiled in the Information Section of the Administration Division, Office of the Chief of Ordnance, by Capt. Herbert T. Wade, Ordnance Department, United States Army, is published for the information of the officers of the Ordnance Department.

C. C. Williams,
*Major General, Chief of Ordnance, U. S. A.*



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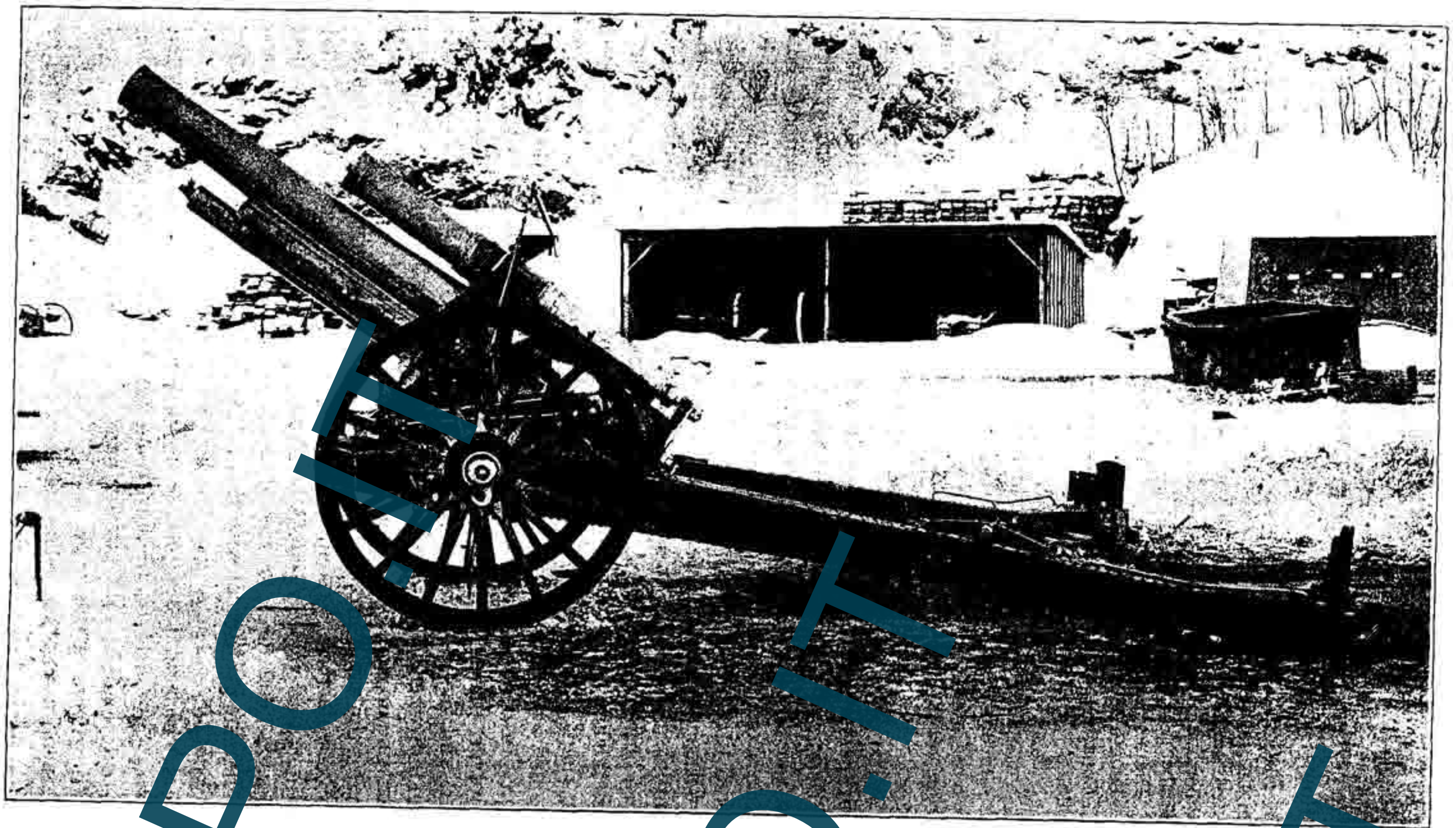


FIG. 19.—6-inch howitzer, Bethlehem type, pilot piece.

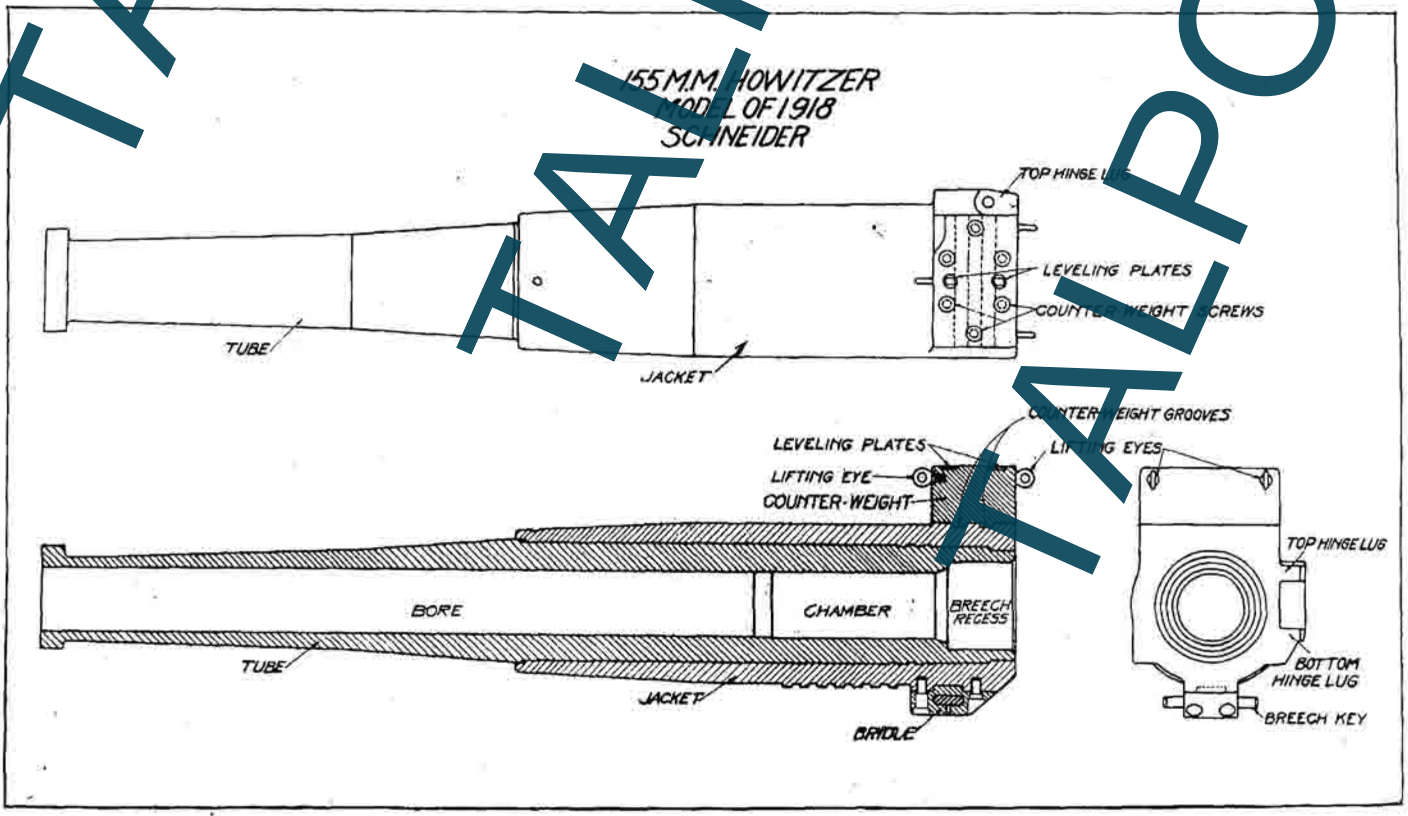



FIG. 20.—155-mm. howitzer, model of 1918 (Schneider).

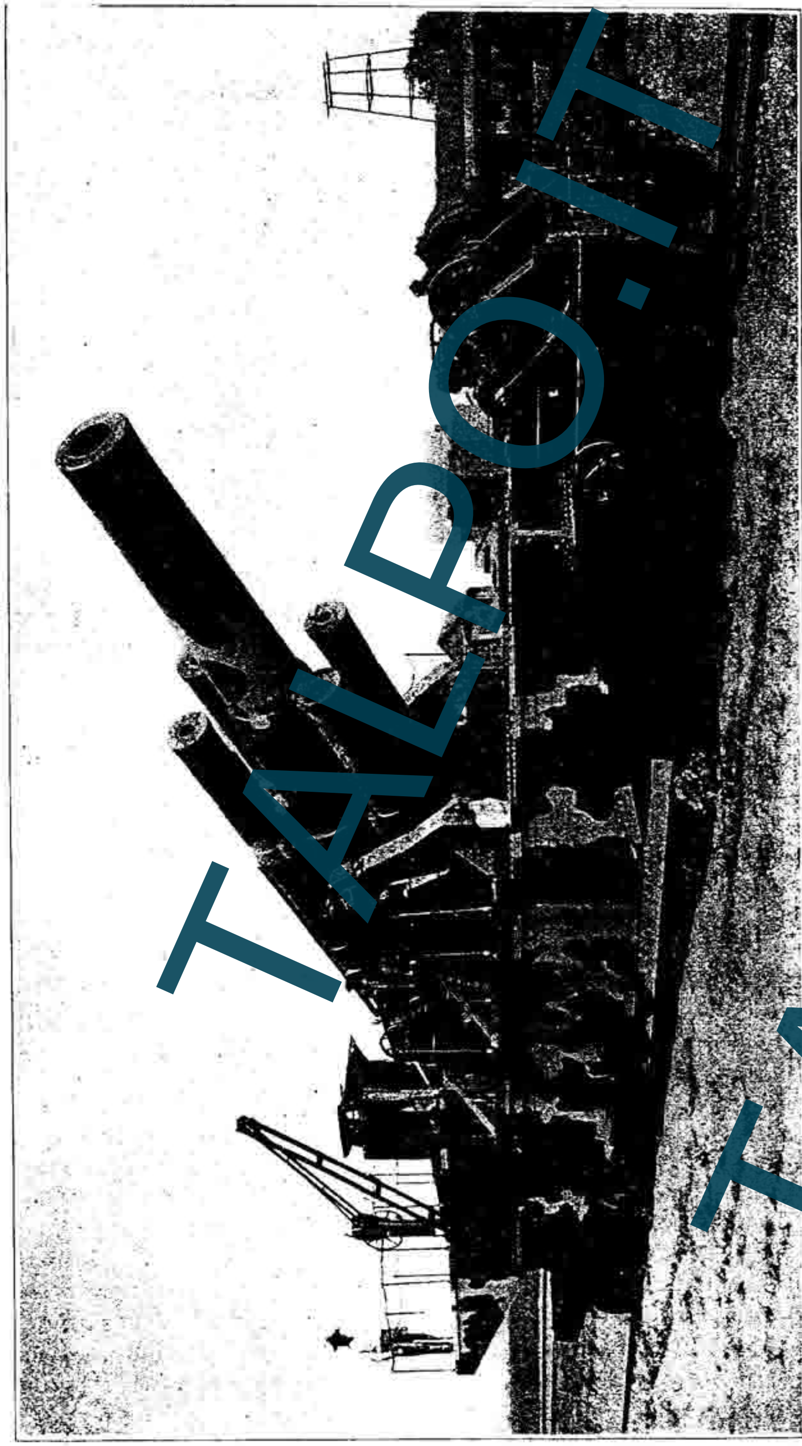


FIG. 38.—16-inch howitzer railway mount, model of 1918.





Elevating gear.-The elevating gear is of the elevating rack-and-worm type operated by handwheels on each side of the car.

Transport trucks.-The trucks for transporting the gun mount are of the six-wheel equalized type, having 6 by 11 inch M. C. B. standard outside journals. These trucks are known as the Lehigh Valley type of heavy duty trucks.

Base ring.-The base ring on which the mount rests when put on its emplacement is of cast steel in four sectors of approximately 25,000 pounds each. It has a box section 40 inches wide, 30½ inches deep under rails, and 27 feet in diameter between center line of the outer rails. On the upper surface of the castings there is a finished vertical projection to which the traversing rack is fixed and which also serves as the pintle-bearing surface. An 80-pound rail, on which the carriage traverses, is bolted on both sides of this rack.

16-inch howitzer railway mount, Model of 1918.—The 16-inch howitzer railway mount, model of 1918, mqunting the 16-inch howitzer, model of 1918, was developed to provide a mount for use in the field capable of firing a high-explosive projectile weighing 1,660 pounds at from plus 20 degrees to plus 65 degrees elevation and to be traversed 5 degrees either side of the normal position.

A ground platform built up of timber acts as an emplacement and spade, the force of firing being transmitted through steel struts and jacks placed under the car frame.

The mount may also be fired without the ground platform from plus 20 degrees to plus 45 degrees elevation directly from the trucks.

The tipping parts are the same as used on the 16-inch howitzer carriage, model E, with slight modifications.

Railway artillery fire control.-The fire-control instruments required for railway artillery consist of the panoramic telescope, the elevation quadrant, and various accessories and instruments listed below.

Panoramic telescope.-A large panoramic telescope with magnifications, 4 and 10 power, is also provided for each railway mount. This panoramic telescope is similar to the Field Artillery panoramic sight. and is mounted in a special type of mounting somewhat similar to that used with the 75-mm. gun carriage, model of 1916. This mounting automatically corrects the line of sight and compensates for the amount which the base ring is out of level.

Elevation quadrant.-An elevation quadrant graduated in degrees and minutes is provided for each of the United States railway mounts. This elevation quadrant has a cross level so that correction can be made for the amount that the gun trunnions are out of level.

Fire-control instruments required for railway mounts.-The following instruments are required for each battery and each battalion of railway artillery :

tance of 10,000 meters. The recoil is variable from approximately 36 inches to 20 inches, and the field of fire is from zero to 80 degrees in elevation and 360 degrees in azimuth.

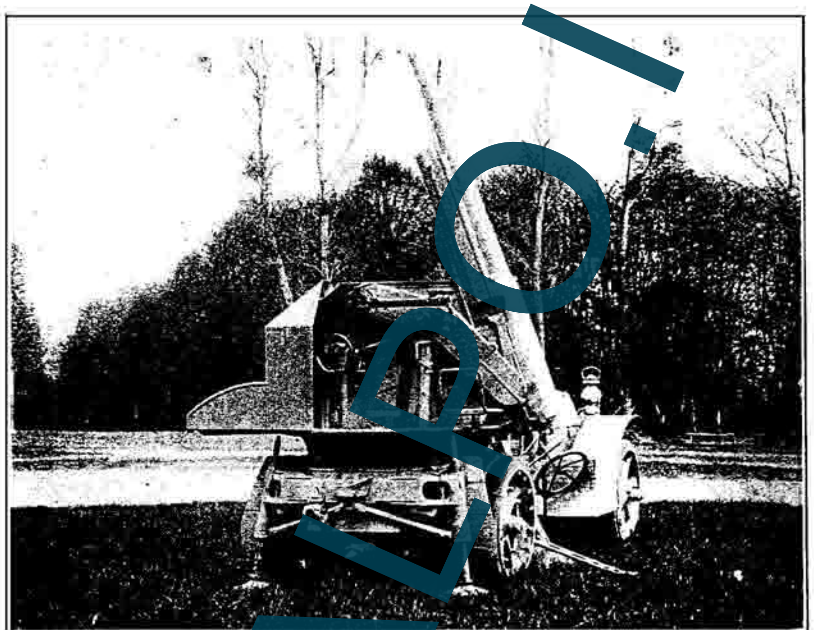


FIG. 44.—French 75-mm. A. A. gun on auto truck carriage.

## SIGHTS FOR ANTIAIRCRAFT CARRIAGES.

Sight for antiaircraft carriage, model 1917.—This type of sight was designed for the truck, trailer, and seacoast mounts. It was originally intended to place it also on the improvised mount, but this was found impracticable, as the design was developed. The operator on tha left side of the carriage keeps .the sight on the target at all times, and by moving certain pointers causes other operators to give the gun proper setting in elevation and azimuth. The truck mount will be equipped with this sight.

Sight for antiaircraft carriages, model 1918.—Upon recommendation from Gen. Pershing that the eyepiece of the sight be revolved through 90 degrees, so as to coincide with the axis of rotation of the objective, the sight model 1917 was slightly redesigned and the new sight called the model of 1918. This sight differs from the bight model 1917 only in the telescope and the method of mounting. This telescope is similar in design to panoramic sight for the revolving head and revolving prism, the eyepiece being stationary and placed in such position that the operator faces toward the gun.



Upon receipt of further information from France, it was found that this sight did not correct for " complementary error," and that the sight had no way of correcting for lateral windage except by placing it on lateral deflection correction scale. Drawings were at once made changing this sight in accordance with these suggestions. This sight is known as antiaircraft sight, model of 1918, MI. A universal joint is placed between the sight telescope and the elevation pointer. This automatically takes care of the "complementary error." Another lateral deflection correction scale was added to take care of cross winclage. (See Ord nnnce Department assembly drawings 15–15UA–2 and 15–15UA–3.)

Sights for antiaircraft trailer mount for 4.7-inch antiaircraft guns.—The sight for the antiaircraft trailer mount for the 4.7-inch antiaircraft gun is similar in construction to the sight for antiaircraft carriages, model of 1918, MI. In it are incorporated a universal joint for the "complementary error" and also means for correcting for lateral windage. The fuze-setter range disk has been made larger to facilitate reading and a few necessary minor changes to conform to this enlarged disk. (See Ordnance Department assembly drawings 15E–15 TA-1.)

## ANTIAIRCRAFT FIRE-CONTROL INSTRUMENTS.

Antiaircraft fire-control in France.-The subject of antiaircraft fire control has presented many difficulties, and the evolution of methods and instruments toward definite standards of practice has been slow and difficult. To show briefly the status of antiaircraft fire control in France after three years of service, the following is quoted from the report of three United States Army officers, who in 1917 made a special trip to France to investigate this matter. "It was not foreseen that such a chaos of instruments, methods, and conflicting ideas would be encountered. There is no such thing as a French system of aircraft defense. There are systems of defense, some of which are taught in L'Ecole de Tir contre Avions at Arnouville * * * a.nd the result is a combination of systems and methods which appall one who has heard of the French system mentioned as if it were a tangible thing. Instruments themselves differ in type."

System of United States Army.-The antiaircraft section of the carriage division about April, 1917, designed instruments to furnish firing data under a proposed system of firing control based upon the latest information from France. In general, this system consisted in the determination of the altitude of the target, combining this altitude with the observed angle of site to find the fuze-setter range, then correcting this range for angle of travel, wind, drift, etc.

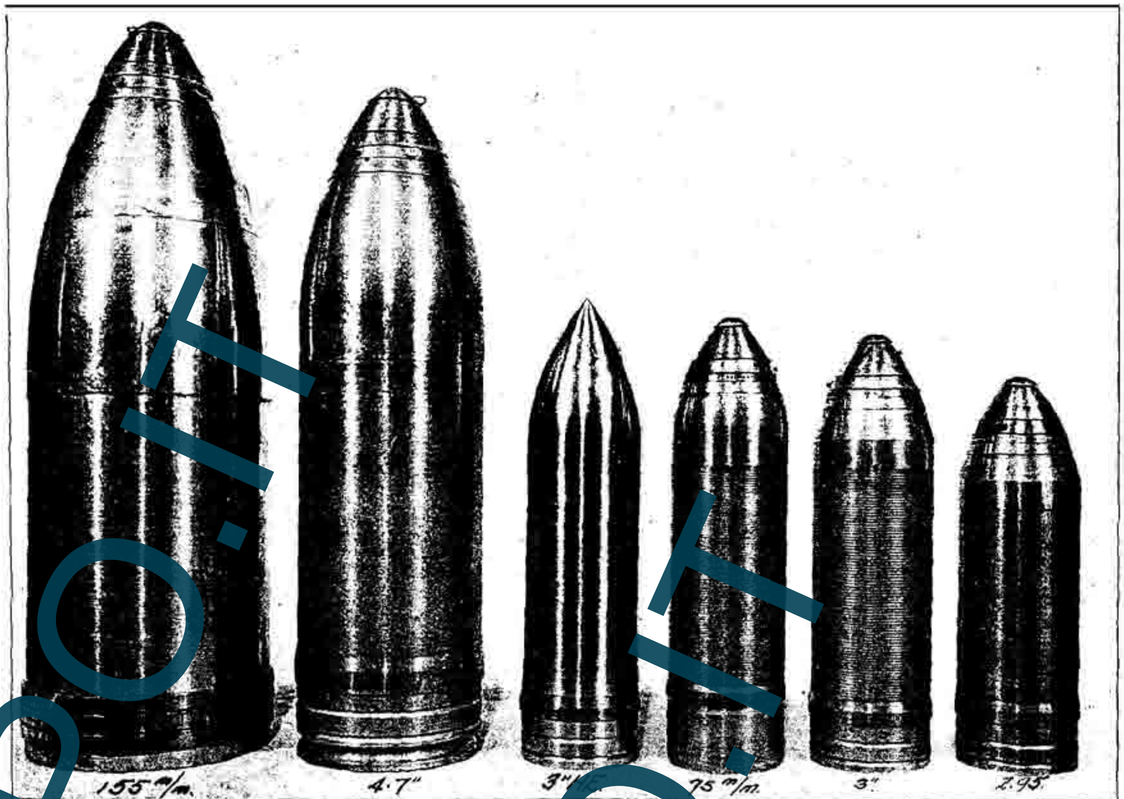



Fig. 46.—U. S. artillery ammunition. Exterior views of shrapnel and shell. Shrapnel assembled with time fuzes.

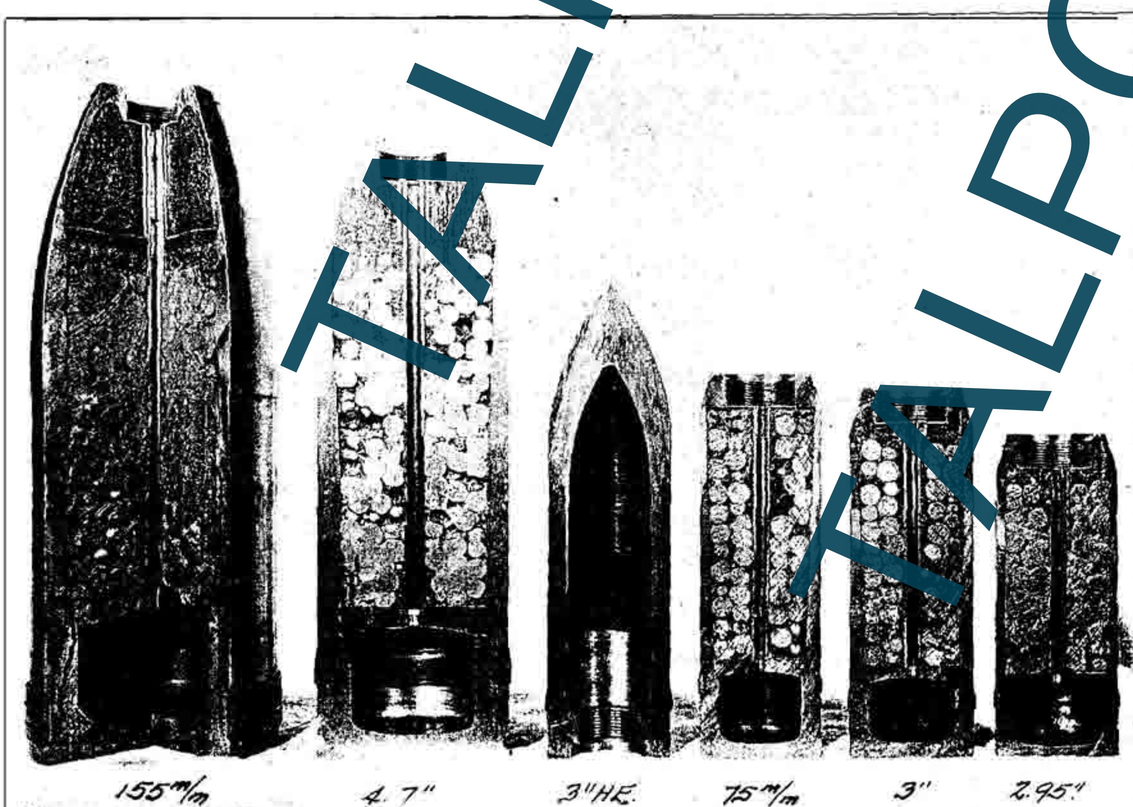



Fig. 47.—U. S. artillery ammunition. Sections of shrapnel and shell shown in Fig. 46.

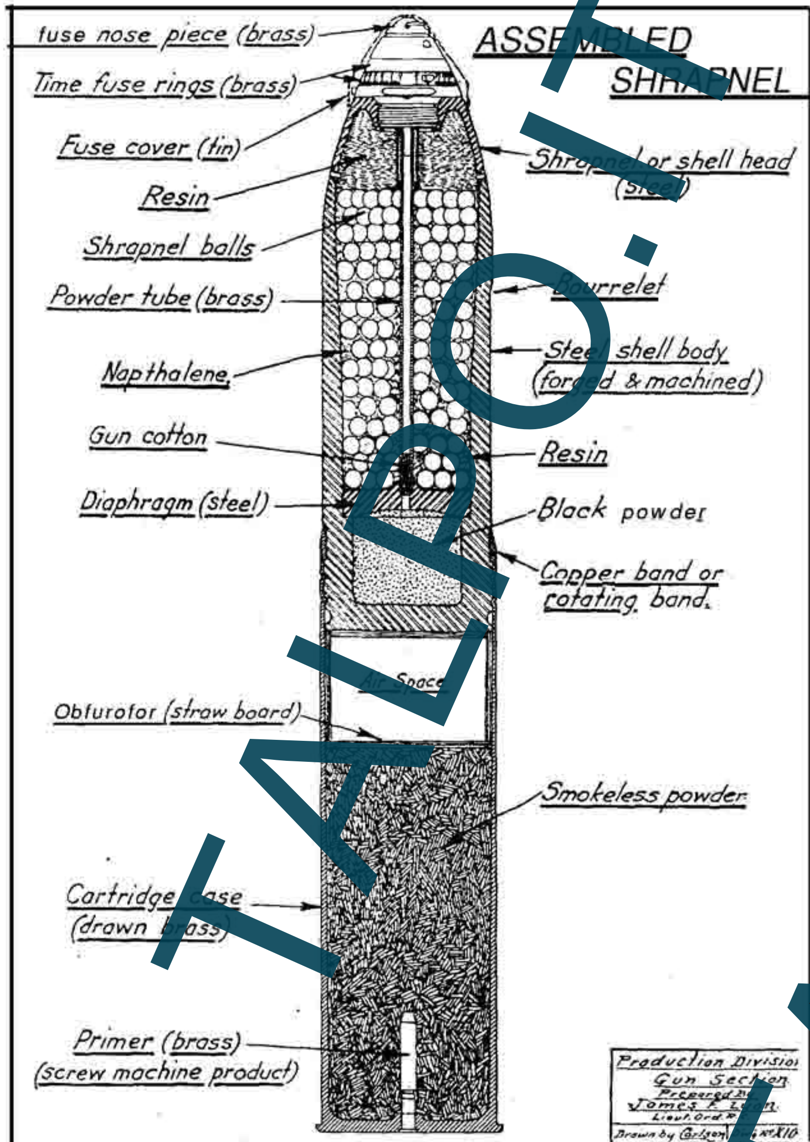



FIG. 48.—Section of assembled shrapnel.

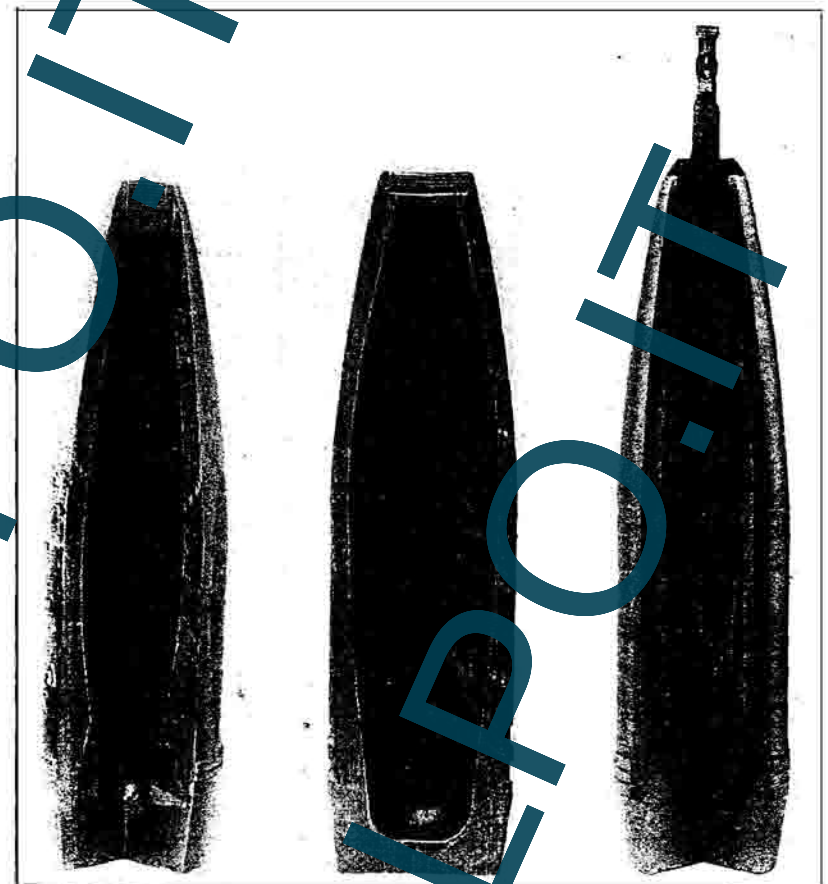
Shrapnel.-The earliest departure of importance in the United States in regard to ammunition was the decision to manufacture shrapnel for the 75-mm. field gun. Projectiles of the following sizes similar to well-established types used by the United States were designed and put under manufacture in quantity, though the require-



ments of shrapnel subsequently appeared to be a much smaller percentage of the total than was first anticipated.

75-mm.
3.8-inch.
4.7-inch.
155-mm.

All of the above shrapnel used the Frankford type of combination fuze, described and illustrated on page 167. A typical section of American shrapnel is illustrated on the opposite page.



Semi-steel shell. Steel shell. Steel shell filled and fuzed with Mark III fuze.

FIG. 49.—High-explosive shell—cross sections.

High-explosive shell.-This is the most commonly used and probably the most important type of projectile. Its use is general throughout all calibers and all types of guns, howitzers, and mortars, including

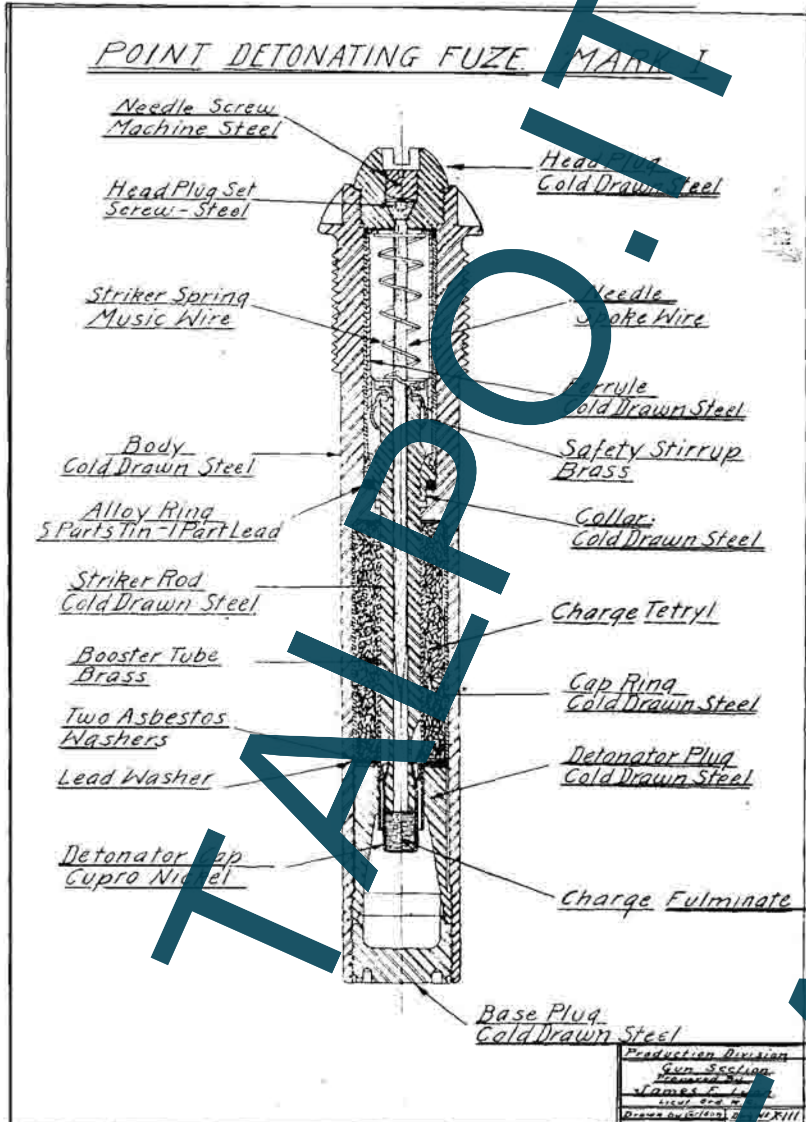



FIG. 55.—Point detonating fuze, Mark I.

**Marks I and II fuzes.**—Just previous to the outbreak of the war, some tests had been conducted with Russian 3 GT point-detonating fuzes, which had been produced in large quantities in this country, and which were considered very safe fuzes on account of an effective bore safety device. This type of fuze was early adopted, and referred to as the Mark I. At the same time, layouts were made and experiments inaugurated to modify the 4 GT Russian fuze—which is



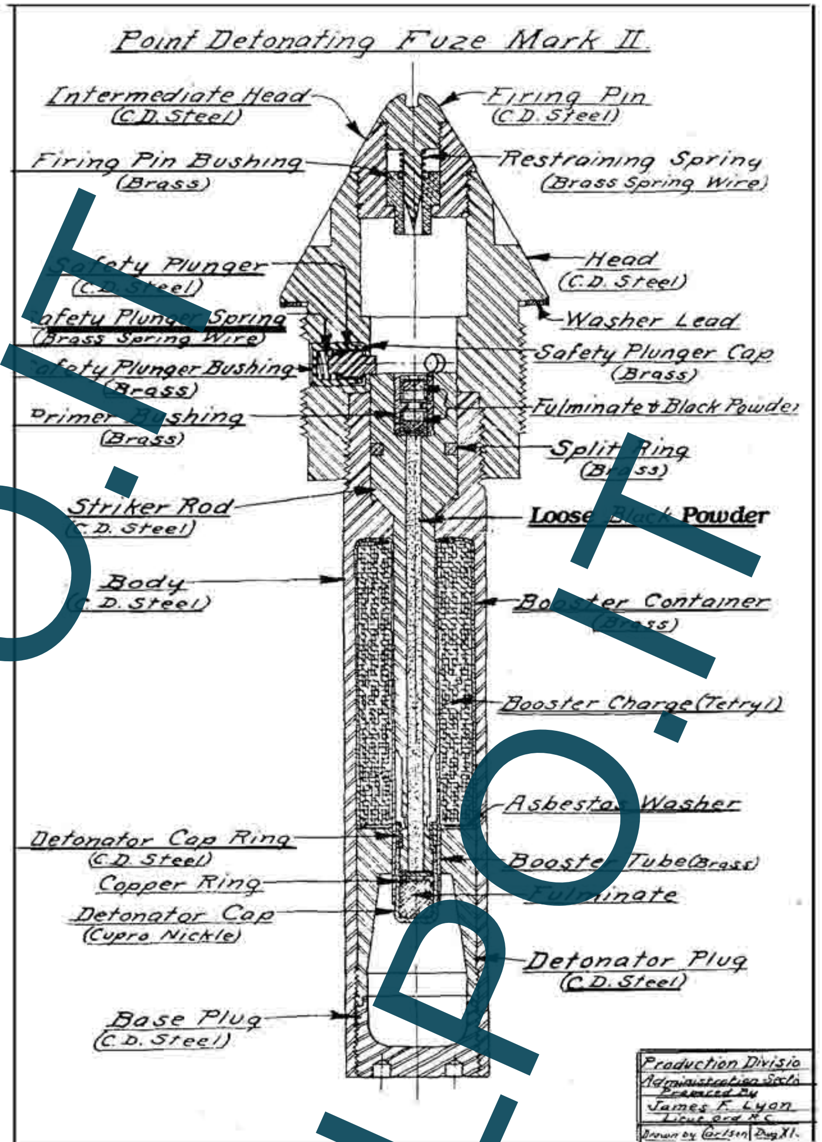



FIG. 56.—Point detonating fuze Mark II.

similar to the 3 GT except that it is larger to provide arming by rotation instead of acceleration, and to provide a delay action feature. It was proposed to use this modified fuze, called the Mark II, in all shell above 3-inch.

The Mark I fuze was ordered in quantity for 3-inch shell ammunition, but many orders were canceled after the adoption of French types of fuzes.

French fuzes.—During the visit of the French commission headed by Marshall Joffre is was decided that we would procure considerable ordnance matériel, including guns, carriages, and ammunition, in France, in order to tide over the period until we could develop quantity production of this matériel. It was, therefore, decided that we would adopt certain French calibers, using the 75-mm. in place of our 3-inch and the 155-mm. in place of our 6-inch, and would make ammunition interchangeable for these calibers. This decision led to the quite general adoption of the French fuzing system incorporated in our Marks III, IV, and V. These fuzes contain no bore safety features; and the considerable number of prematures obtained by the French indicate that they are not particularly safe, and, further, we could obtain no authentic information that these fuzes would arm and otherwise function satisfactorily in the larger calibers. We therefore decided to continue the development of the Mark II fuze, which was bore safe, and **to use** this fuze for the 8-inch caliber and above. Information obtained at that time indicated that the French did not use the Mark IV or V fuze in any of their larger calibers, and effort to obtain information as to the type actually used resulted in the submission of a fuze considerably larger than the Mark IV and V, called the 30/45 Model 1878–1881, M. 15.

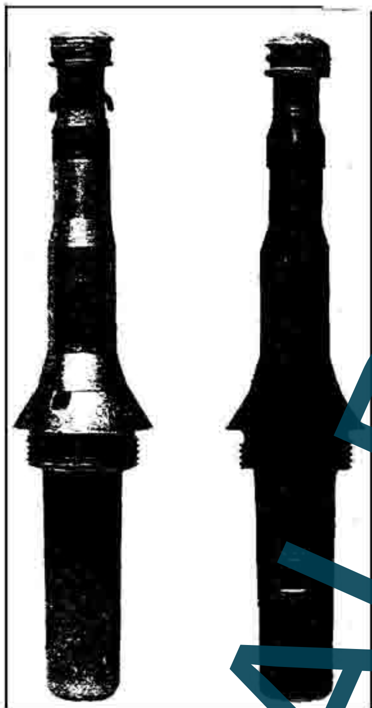


FIG. 57.—Mark III point detonating fuze, exterior view and section.

The French fuze system gives great flexibility to meet tactical requirements. The Mark III fuze (French T. A. L.[1]) is a supersensitive type which bursts the shell above ground. This fuze is generally used for high-explosive shell fired against personnel, where the effect of shell fragments is desired. It is also generally used in gas and smoke shell where burst is desired before the shell buries itself. The Mark IV and V fuzes are in some degree interchangeable with respect to their functions. Both types are made up with nondelay, short-delay,

[1] Signifies Instan te Allongé Lefevre, or instantaneous elongated fuze of Lefevre design.



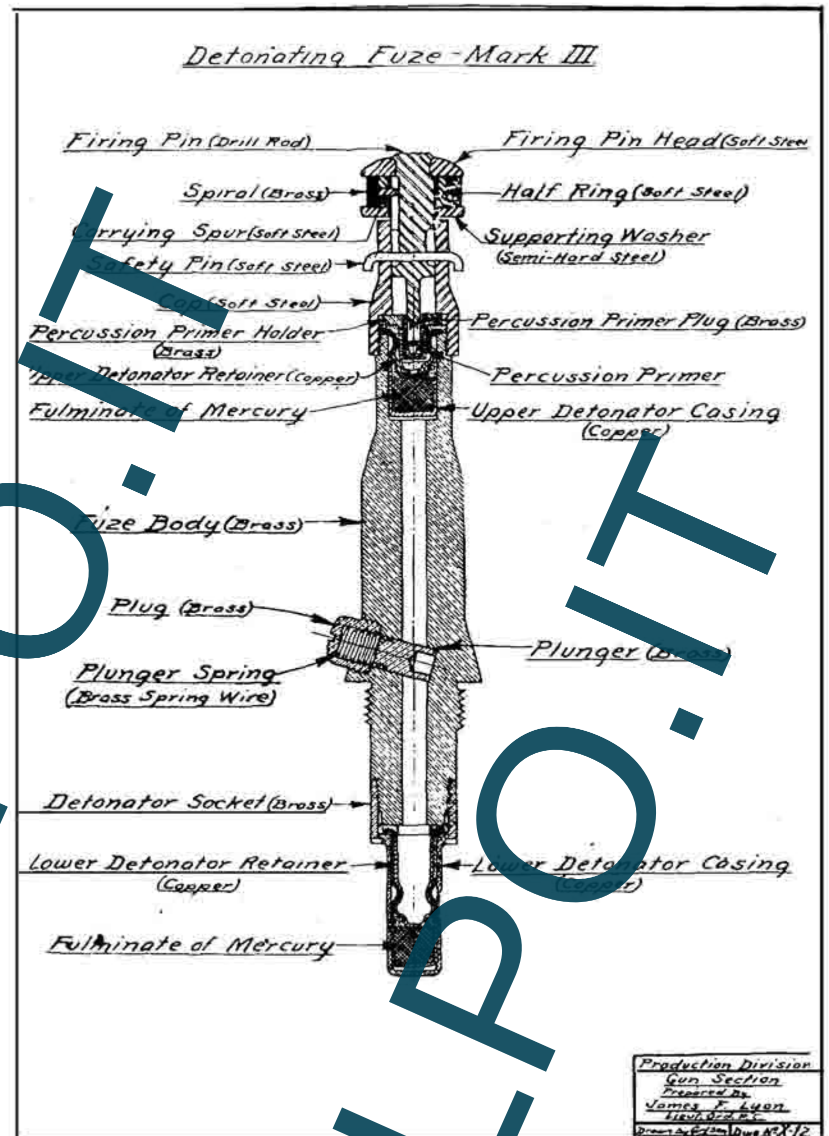



FIG. 58.—Point detonating fuze, Mark III.

and long-delay action. The main difference between the two is that the Mark V has an additional safety feature which requires somewhat higher acceleration to function than the Mark IV type. The method of introducing this safety feature, however, so weakens the fuze at the point that the Mark V is not suitable for the more powerful guns and is therefore generally used with 75-mm. shell.

Notes on the above fuzes.—The artillery ammunition section of the Engineering Division, after a consideration of the entire fuze program in 1918, noted the following conclusions in regard to the above fuzes: Mark I and Mark II fuzes were considered to be bore safe. Bore safe designs were needed to replace Mark III, IV, and V, and were being worked up at Frankford arsenal. A bore safe type which may be used as a substitute for Mark II was also being developed at the Frankford Arsenal. A bore safe type to replace a medium and major caliber base-detonating fuze was being tested at the proving ground. There was also under test a design to replace the Mark III fuze. Studies and designs for Mark III fuze modified were also put under way, the modified type to be similar to the French fuze but without a primer, and with an elongated firing pin to strike directly on the upper detonator.

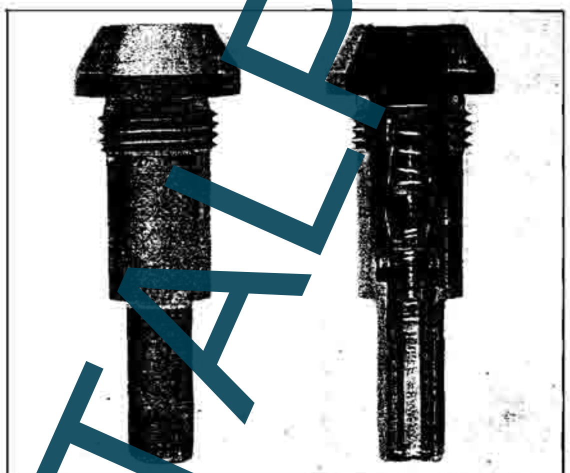


FIG. 59.—Detonating delay fuze, Mark IV. Exterior view and section.

Mark III fuze, safety device.-A partial bore safety device has been added to the Mark III fuze. This consists of a plunger operated by centrifugal force and set at an angle so that linear acceleration tends to oppose the centrifugal force and holds the plunger in a safe position. This plunger is located in the fuze body between the front and rear detonators. While the projectile is being accelerated in the bore, this plunger remains in a safe position and shuts off any premature action from the front cletonntor, or primer, making the fuze bore safe to that extent. After linear acceleration ceases, the centrifugal force throws the plunger out and opens the channel between the two detonators. This device is shown in the diagram of the Mark III fuze on the preceding page.



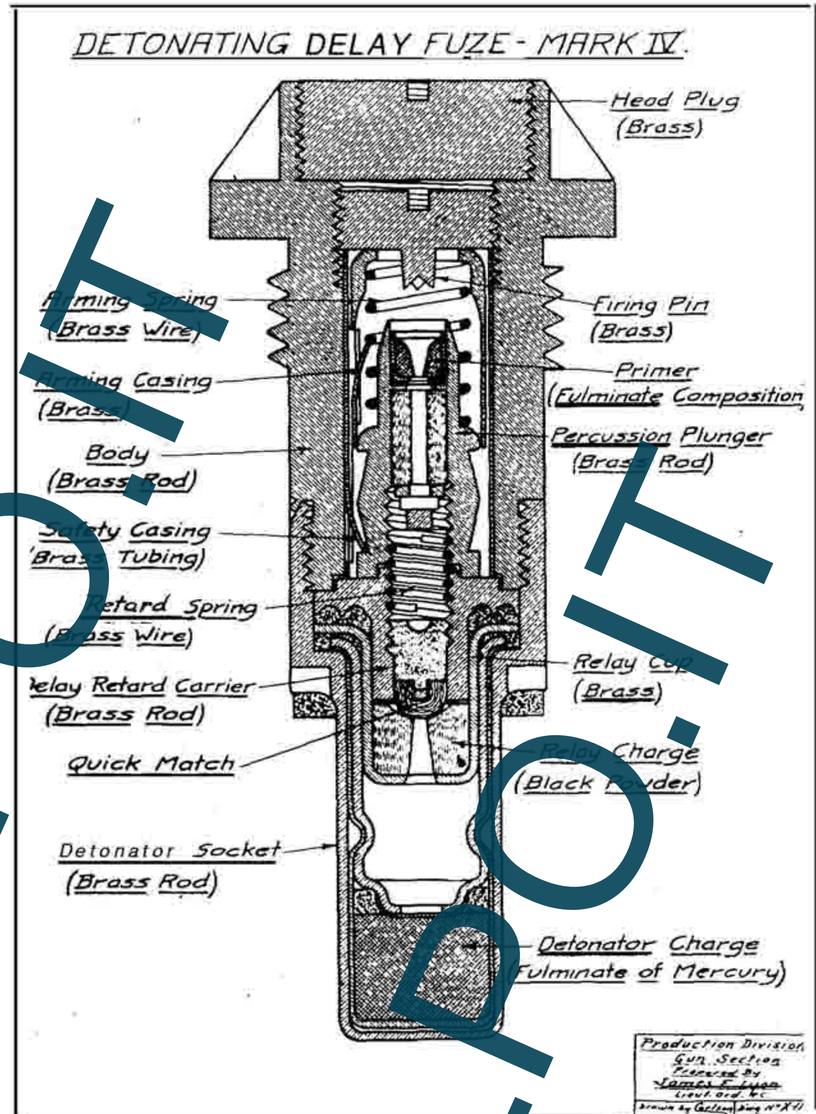
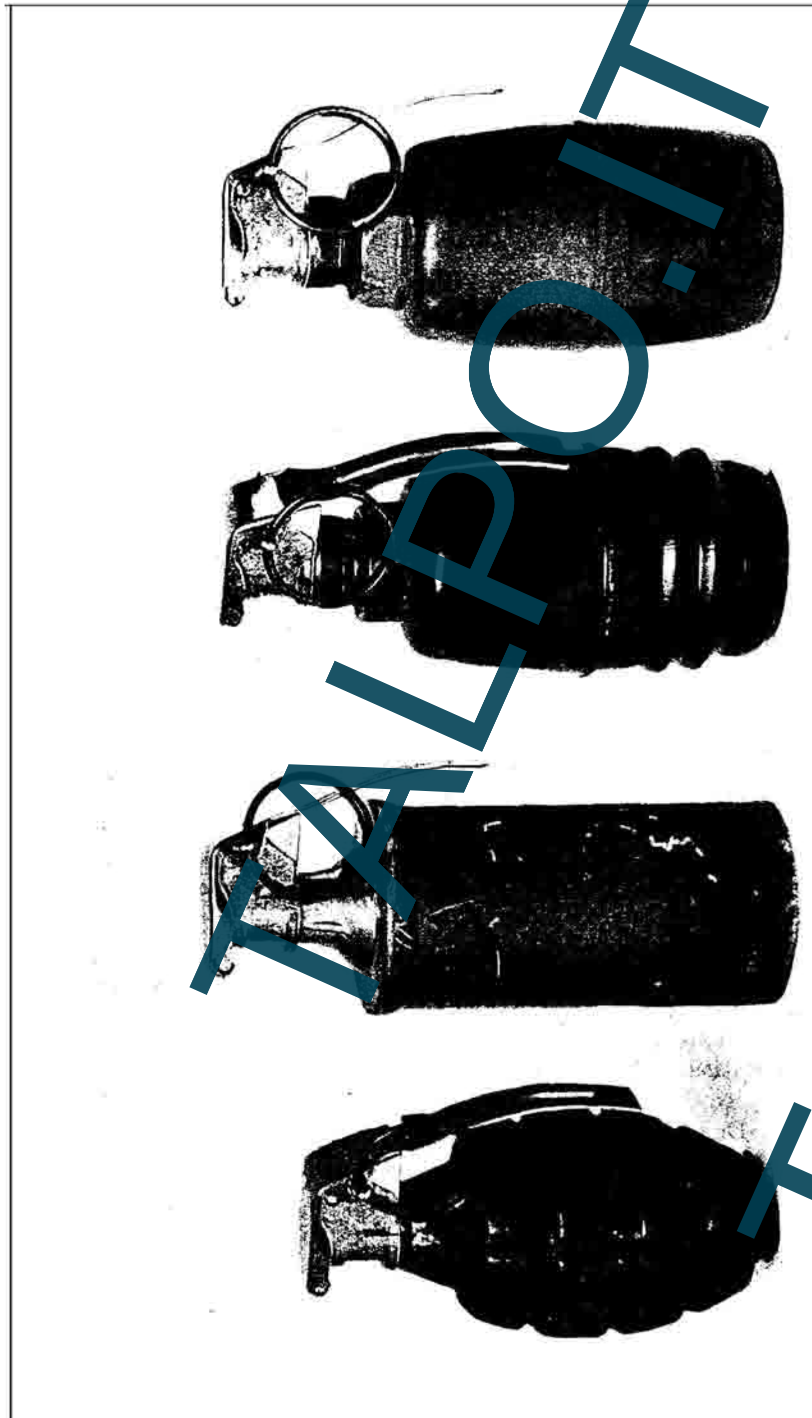



FIG. 60.—Point detonating fuze, Mark IV.

Mark IV and V fuzes.—The Mark IV and V fuzes are essentially copies of French designs. These, together with the Mark III, are the three types which the French high commission considered essential for the United States to adopt for manufacture in this country in order to obtain all the advantages of the French fuzing system, which includes a considerable additional number of types. These three fuzes fit the same adapter and booster and can be used



Defensive hand grenade, Mark II. Offensive hand grenade, Mark III. Gas hand grenade, Mark II. Phosphorus hand grenade, Mark II.

FIG. 84.—Types of hand grenades.





TABLE 20.—*Grenades.*

| Type. | Total weight. | Charge. | Material of body. | Automatic bouchon assembly. | Characteristics. |
|---|---|---|---|---|---|
| | *Ounces.* | | | | |
| Defensive hand grenade, Mark II. | 22 | 2-ounce Trojan grenade explosive. | Cast iron... | Primer—5-second fuze No. 6 detonator. | Thrown from cover: value depends upon fragmentation of body. |
| Offensive hand grenade, Mark III. | 12 | 4-ounce Trojan grenade explosive. | Laminated paper. | Primer—5-second fuze No. 8 detonator. | Thrown in open effect from detonation of the high-explosive charge. |
| Gas grenade, Mark II. | 22 | 5-ounce chemical filler. | Sheet steel. | Primer—5-second fuze No. 8 detonator. | Used to clean out dugouts, etc. |
| Phosphorus grenade, Mark II. | 20 | 4-ounce phosphorus. | ....do...... | ....do........ | Used to create smoke clouds for screen. |
| V. B. rifle grenade, Mark I. | 17 | 1.75-ounce Trojan grenade explosive. | Malleable iron. | 8-second fuze...... | Thrown from V. B. discharger to range 200 yards. |
| Incendiary hand grenade, Mark I. | [1] 24 | Thermit and oil. | Paper...... | 5-second fuze...... | To fire ammunition dumps, etc. |
| Thermit hand grenade, Mark I. | [1] 30 | Thermit ...... | Tin...... | ....do.......... | To fuze breechblocks in cannon (captured). |

[1] Approximately.

Defensive hand grenade, Mark II-This was modeled on the lines of the Le. Blanc and is similar in type to the well-known Mills grenade. The body is made of gray cast iron, and is of about the size and shape of a large lemon. It is scored longitudinally and transversely with deep grooves which provide for proper fragmentation.

Into&he upper end of the body is screwed the bouchon assembly, consisting of the bouchon. the operating lever, and a sheet - metal sealer. The bouchon is a die casting composed of a tube which holds a standard Bickford fuze and a detonator, and a projecting head which

FIG. 85.—Defensive hand grenade, Mark II, leaving the hand—handle released.

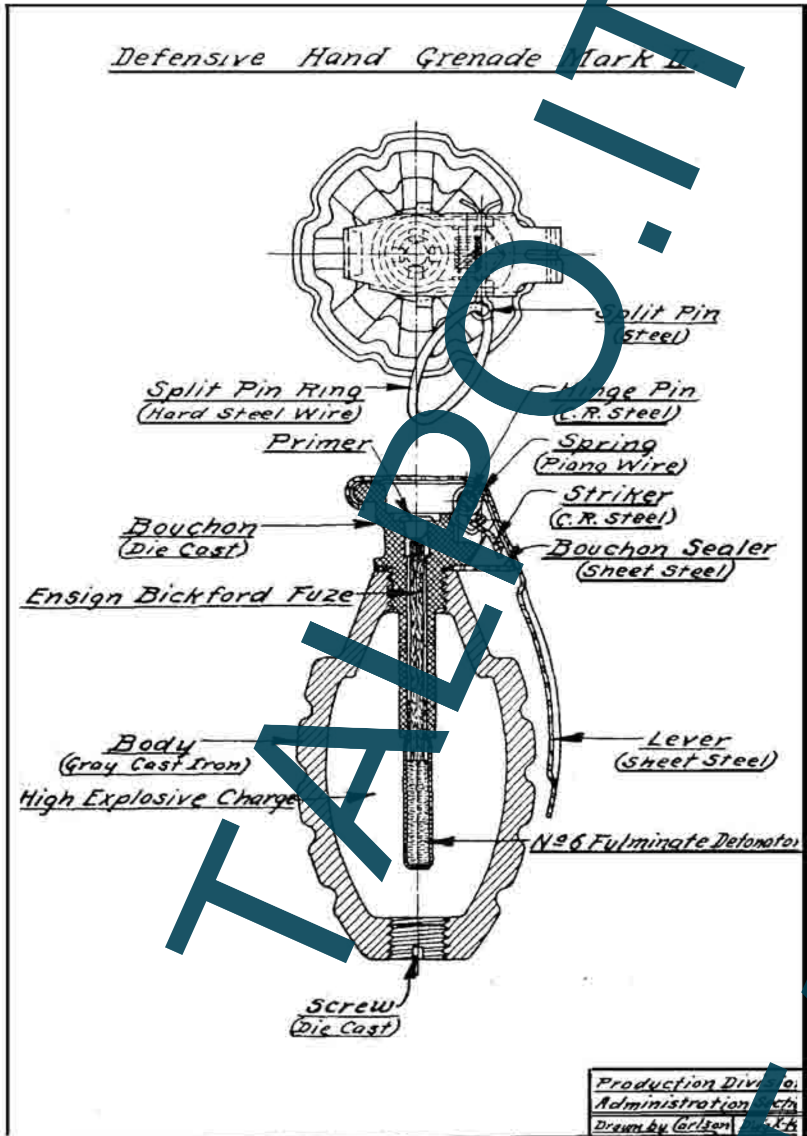



FIG. 86.—Sectional view of defensive hand grenade, Mark II.

holds the priming cap, the firing spring, and the striker. The operating lever fits over the head of the bouchon and is held in place by a safety pin with a ring attached to it. When this safety pin is pulled out, and the lever released from the hand of the thrower, the firing pin at once throws off the lever and drives the striker against



the priming cap. In other words, the grenade can not function as long as the lever is held in position against the body of the grenade.

After release, there is a delay of about 5 seconds before the fuze explodes the detonator, with the consequent explosion of the charge of $2\frac{1}{3}$ ounces of Trojan powder which fills the body of the grenade. The effective radius of dispersion is about 80 feet, although fragments may be thrown a much greater distance. The defensive grenade must therefore always be thrown from cover. It weighs, when loaded, approximately 22 ounces, and, following the French practice, is painted battleship gray.

Change of design.-In the first United States defensive grenades, an attempt was made to overcome the dangerous features of the Mills type of grenade in fixing the lever upon a pivot. The sidemays thrust of the thumb, as the grenade left the hand, threw the lever to one side and allowed the functioning of the release mechanism. This device was abandoned.

Dummy hand grenade, Mark I.-The dummy grenade is made of cast iron, and resembles the defensive hand grenade, Mark II, in size, weight, and contour. It is used for practice and is painted bright red.

Method of marking.-The method of marking live and practice grenades has been taken from the French practice in order that no confusion will arise from our troops using grenades of American and French manufacture interchangeably. In general the bodies of all live grenades are painted gray while the bodies of practice grenades are painted red.

Packing for shipment and subsequent assembly.-Note should be made of the method of packing hand grenades and components for shipment, and the subsequent assembly of these components. Hand grenade bodies are packed 24 to a box. These bodies are loaded with high explosive and have in the bouchon hole a wooden plug. Packed in a separate box are 384 complete bouchon assemblies. These two boxes go forward to the place of assembly, ordinarily the regimental dump, where the wooden plug is removed from the body and the bouchon assembly secured into place. The completely assembled grenade is then replaced in the box in which the bodies were received and sent forward to the front-line trenches for issue to the various troops stationed there.

Testing grenades.-For grenades, no special facilities for testing are necessary, but experimental tests were conducted at Aberdeen, where perfectly adequate arrangements for this purpose are available. Regular practice drills with different types of hand grenades under instructors who had seen service in the trenches were held at a number of the large encampments in the United States before the troops were ordered overseas.

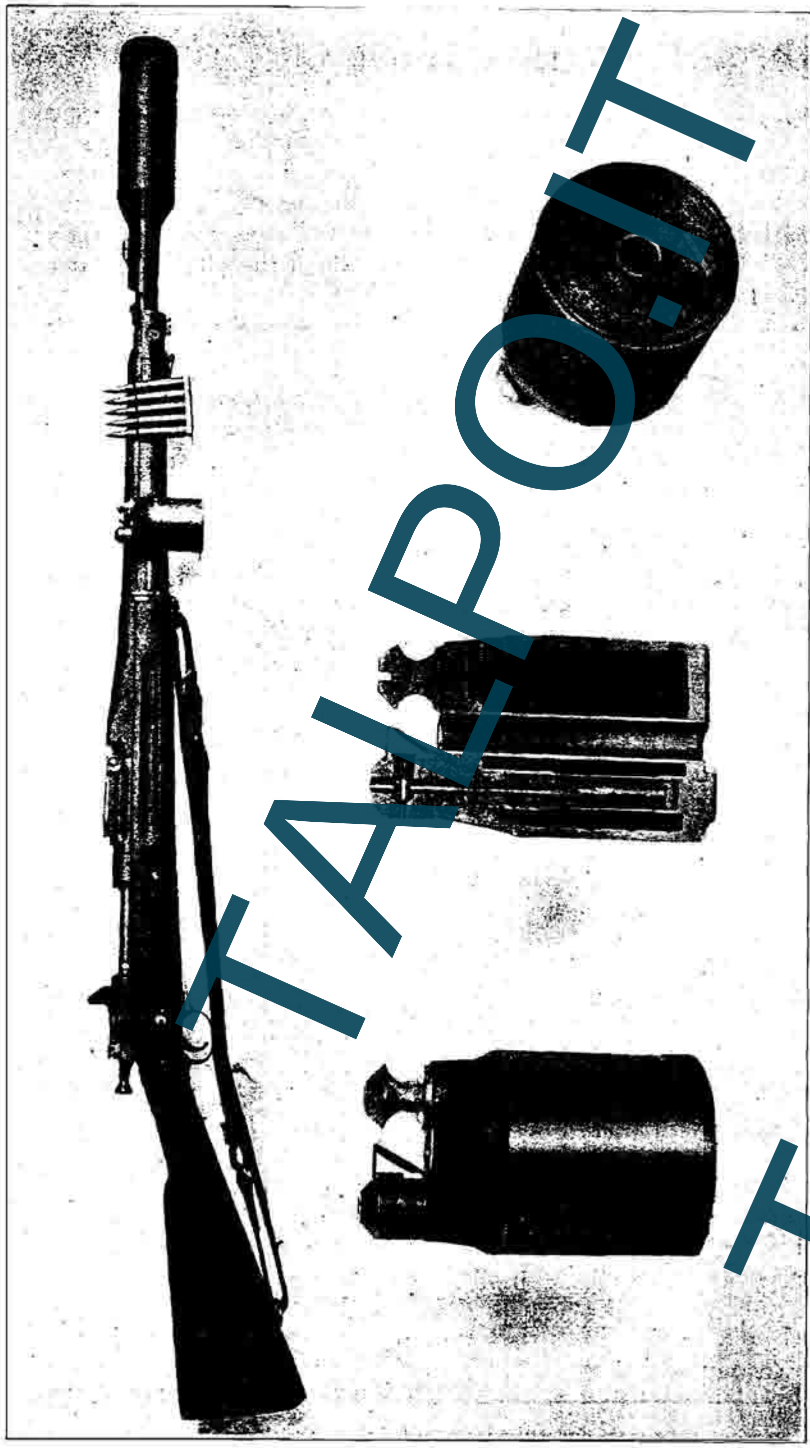


FIG. 9[illegible].—V. B. rifle grenade. Discharger mounted on rifle, together with grenade and cartridges. Side view of grenade. Sectional view of grenade. End view of grenade.





V. B. rifle grenade, Mark I.-This grenade is copied from the French V. B. grenade. It is cylindrical, of malleable instead of cast, iron—the French is cast-with rounded top and flat base, grooved on the inside to secure proper fragmentation. It is pierced longitudinally by a central tube through which the bullet from the rifle cartridge passes. The fuze container carries the primer at its upper end, with the striker projecting obliquely over the end of this bullet tube. When the bullet from the rifle cartridge has passed through the tube it hits the striker and thus fires the primer; from the primer the flash is transmitted to the fuze, which runs longitudinally through the center of the fuze container into the interior of the grenade, and is timed to burn 8 seconds. The fuze in turn fires the detonator attached to its lower end, which bursts the walls of the detonator tube and detonates the main charge. The grenade is fired from a discharger by the gases behind the bullet from the rifle cartridge, which exert their pressure on the flat base of the grenade. The normal range when the rifle is aimed at 45 degrees is about 200 yards. The weight of the grenade when loaded is about 17 ounces.

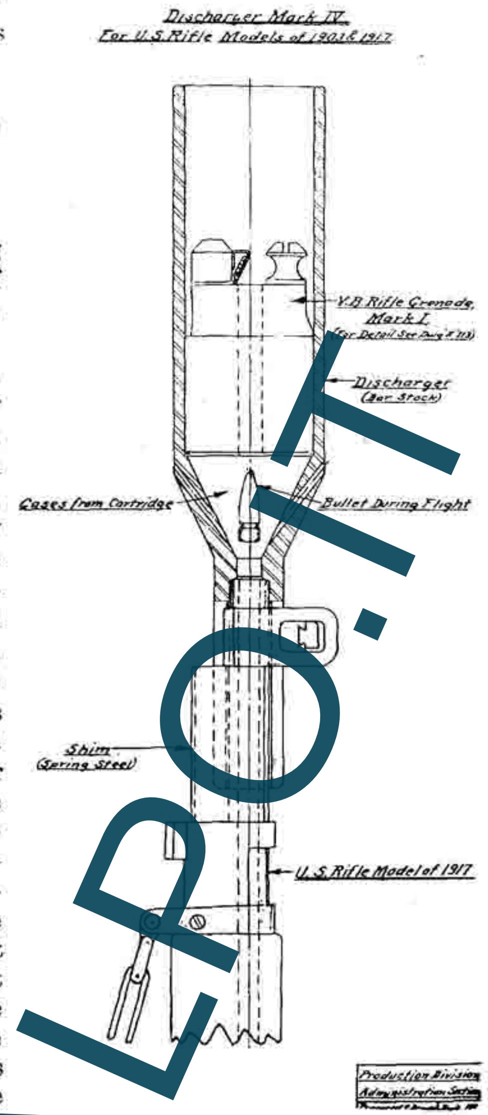



FIG. 91.—Rifle grenade discharger, Mark IV

The V. B. rifle grenade discharger, Mark IV.-This consists of two parts-the discharger proper and the shim. The former is a steel cylinder tapering below the middle to less than half of its largest diameter. This portion of the discharger has two slots, running its entire length, and it is fastened securely over the rifle barrel by means of the shim. The United States rifle model of 1917 requires a discharger of slightly different design from the one used with the model of 1903.

Adaptation to United States rifle ammunition.-The V. B. grenade fired from the discharger has apparently been very satisfactory for use in the trenches. Considerable difficulty, however, was experienced in adapting this article for use with the United States rifle. The American rifle ammunition is more powerful than the French, the result being that the pressure exerted in the discharger was excessive, thereby causing the rifle stocks to split as a result of continuous firing of the grenades. The American V. B. grenade has a larger bullet than the French grenade, and this excessive pressure is vented through the bullet tube of the American grenade. In view of the fact that the supply of rifle grenades of the French and Americans are pooled for issue, it was found necessary to drill two ventholes in the American discharger to permit venting of the excess pressure in the discharges when French grenades are fired. The net result of this practice is that 30 yards less range is obtained with the American grenade than with the French. It was directed that all dischargers manufactured in the United States have the two ventholes referred to above drilled in them.

The dummy rifle grenade.-This grenade resembles the V. B. rifle grenade, Mark I, in contour and weight, but contains no ignition device or explosive charge.

## TRENCH MORTARS AND AMMUNITION.

Nature and use.-Although the trench mortar was a weapon comparatively unknown before the present war began, it has proved to be of the first importance. None had been used by our Army except in an experimental way before we engaged in the conflict, and the entire field had to be developed by the Ordnance Department. The only weapon of the sort in existence in the United States Army was the 3.2-inch, which had never been in active service. None of the mortars designed by the allies, moreover, had been manufactured in this country before the declaration of war. It was, therefore, necessary for the military authorities to decide what type of mortars the American troops should use before the Ordnance Department could develop a source of supply. It was August, 1917, before the first definite decision was received from abroad, which was to adopt the British type of 3-inch Stokes mortar. Sixty of these mortars were thereupon imported from England for training purposes and were distributed among the camps. Subsequently other types were adopted, until now the five designs mentioned in the table were in regular production and others were being developed experimentally.



TABLE 21.—*Trench mortars and trench-mortar bombs.*

| Type and caliber. | Weight of shell. | Weight and kind of charge in shell. | Fuze. | Maximum range. | Characteristics. |
|---|---|---|---|---|---|
| | *Lbs. oz.* | | | *Yards.* | |
| 3-inch Stokes T. M., Mark I. | 11 11 | Trojan shell explosive 2 pounds 6 ounces. | Mark V I . | 750 | An infantry weapon; total weight of mortar, about 150 pounds: muzzle-loading shell and propellant. |
| 4-inch Stokes T. M., Mark I. | [1] 15 | Gas, smoke, incendiary, high-explosive. | Mark VI and fuze to be developed. | 950 | A weapon used only by troops of chemical warfare service: muzzle-loading shell and propellant. |
| 6-inch T. M., Mark I. | 52 | Trojan shell explosive 11 pounds. | Mark VII, delay and nondelay. | 1,800 | Artillery weapon: muzzle-loading shell and propellant. |
| 240-mm. T. M., Mark I. | 156 | Trojan shell explosive 76 pounds. | Mark VII, delay.. | 2,400 | Artillery weapon: muzzle-loading shell, breech-loading cartridge case. |
| 11-inch Sutton... | 205 | 100 pounds....... | Mark VII, delay... | 4,500 | Experimental; loading same as for 240 mm. |

[1] Approximately

*Trench mortar bombs* (European. manufacture).

| Bomb. | Propellant. | Fuze. | Packing. | Remarks. |
|---|---|---|---|---|
| 3-inch Stokes (English manufacture). | One, 95 grain ballistite cartridge, four 110-grain cordite rings. | Pistol head or No. 146 (The All-ways). | Three rounds complete or three rounds with propellant separate. | Note carefully if cartridges and rings present. |
| 58 - mm. (French manufacture). | Bags with igniters base charge 60 grams, ballistic compound, B Z, and two "appoints" of 25 grams weakened ballistite, "A TT." | 10 per cent railway, 20 per cent P. R. 1916 nondelay, 30 per cent P. R. 1916 delay, 40 per cent 1899-1915. | Two L. S. bombs in crate, one P. L. 8¾ crate, charges and accessories except fuzes 50, 57, and 60, box. | Furnish 110 per cent simplified obturating primers. |
| 6-inch *Newton* (English manufacture). | Four 1 oz. bags guncotton yarn, two 1¼-ounce bags flaked cordite. | 100 per cent No. 110. | Bomb in crate, 20 charges one box, 20 sets accessories one box. | |
| 240-m. (French manufacture). | In 155-mm. brass cases; charge I 1,300 grams ballistite; charge II 900 grams ballistite. | 100 per cent P. R. 1916, delay. | Bomb in crate, 10 charges in box, 30 fuzes in box. | |

FIG. 95.—3-inch Stokes trench mortar. Loading for firing. The nature of the projectile can be seen by the shell held by the soldier on the left.

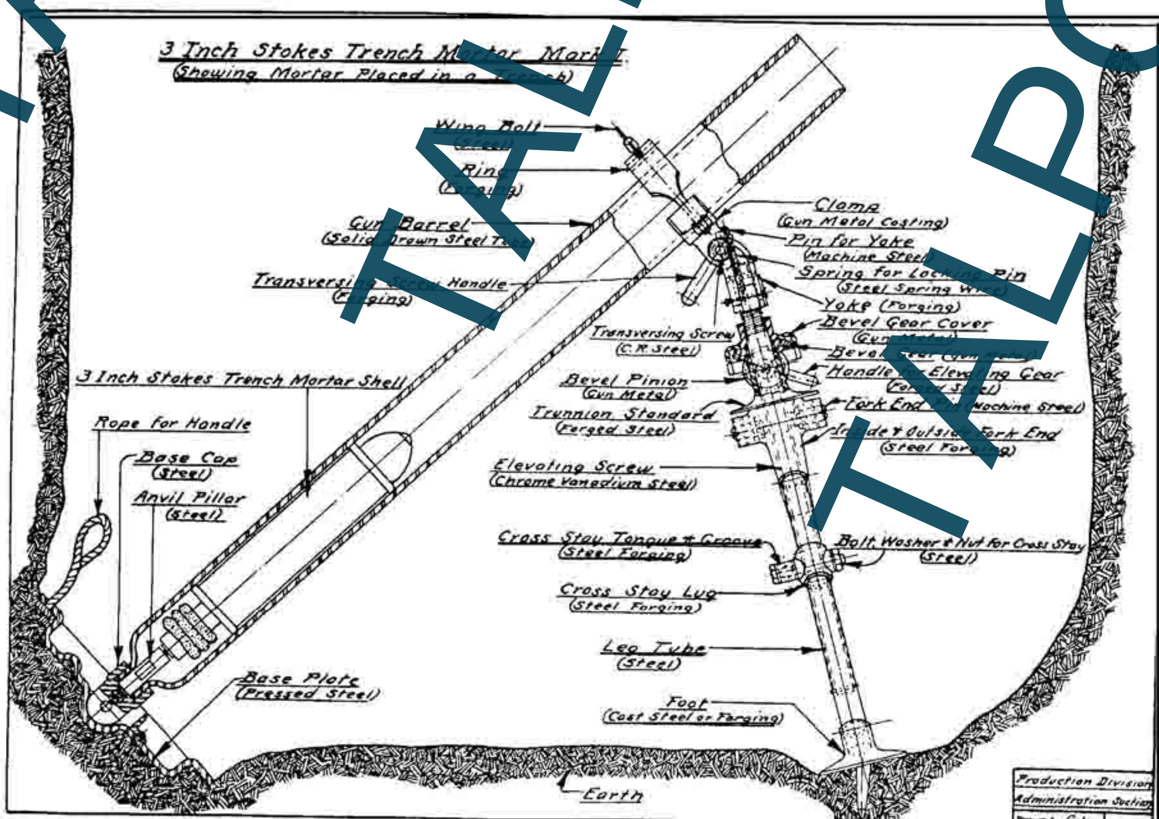





FIG. 96.—Method of placing 3-inch Stokes mortar in trench.

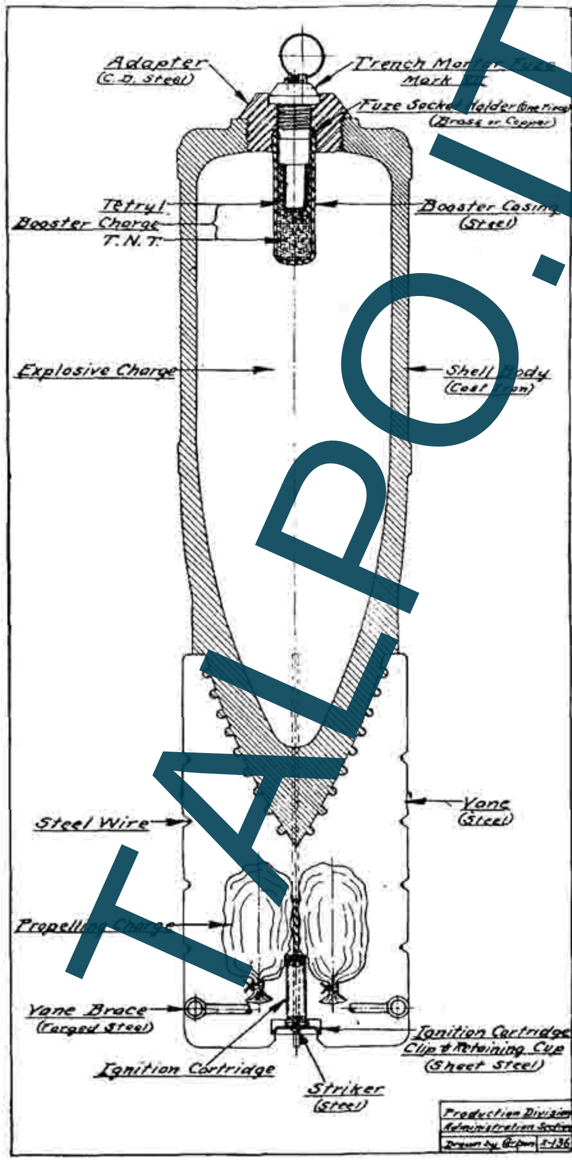



FIG. 100.—Detail of 6-inch trench mortar shell, Mark 1.

**6-inch trench mortar shell, Mark I.**—The shell or bomb is made of gray iron with its front end threaded for an adapter, and the rear end fitted with steel vanes which serve to keep the bombs steady in flight. Steel wire is wrapped around the vanes to hold the powder bags in position. The rear ends of the vanes are strengthened by connecting vane braces of forged steel. The bomb weighs 39½ pounds and the explosive charge is about 13 pounds of TNT.



FIG. 101.—Three craters formed by explosion of 6-inch Newton projectiles fired at same angle with delay fuze.

**Propelling charge.**—The propelling charge consists of 1-ounce bags of guncotton yarn and similar bags of ballistite tucked between the vanes in the wire wrapping according to the number used with the range desired. Four guncotton bags and two ballistite bags constitute the maximum charge and the range varies from 100 to 1,600 yards. The propelling charge is ignited by an igniting cartridge which contains 12½ grains of guncotton yarn dusted with as much meal and black powder as it will hold.

**Operation.**—In firing this mortar a fuze of the Mark VII type shown on page 243 is screwed into the adapter, powder bags pushed between the wire vanes of the cartridge clip, and cartridge put into place after proper laying of the mortar, in which process a clinometer of special form is employed, and the shell is dropped into the muzzle of the barrel, fuze first, sliding down until it strikes the anvil, which is kept tight by a long-handled socket wrench. Contact with the anvil sets off the percussion element in the cartridge, which in turn ignites the powder and guncotton bags. After each round the gas ejector is pushed down the bore to force out the hot gas.

**Bed.**—The bed consists of a cast steel base plug secured to the platform by a boss on the inside of the plug. The base plug is prepared on the other side with a socket for the reception of the rounded end of the barrel. The lifting or traversing guys are arranged on the right end. Left and right upper sides, respectively, of the bed, secured at one end with eyebolts. The other ends of the guys are attached to the loops on the barrel when the latter is mounted in position on the bed. For the purpose of transportation hooks are placed on the bed, to which the ends of the guys are engaged and the barrel dismounted. Four wire handles are provided on the side of the bed to facilitate transportation.

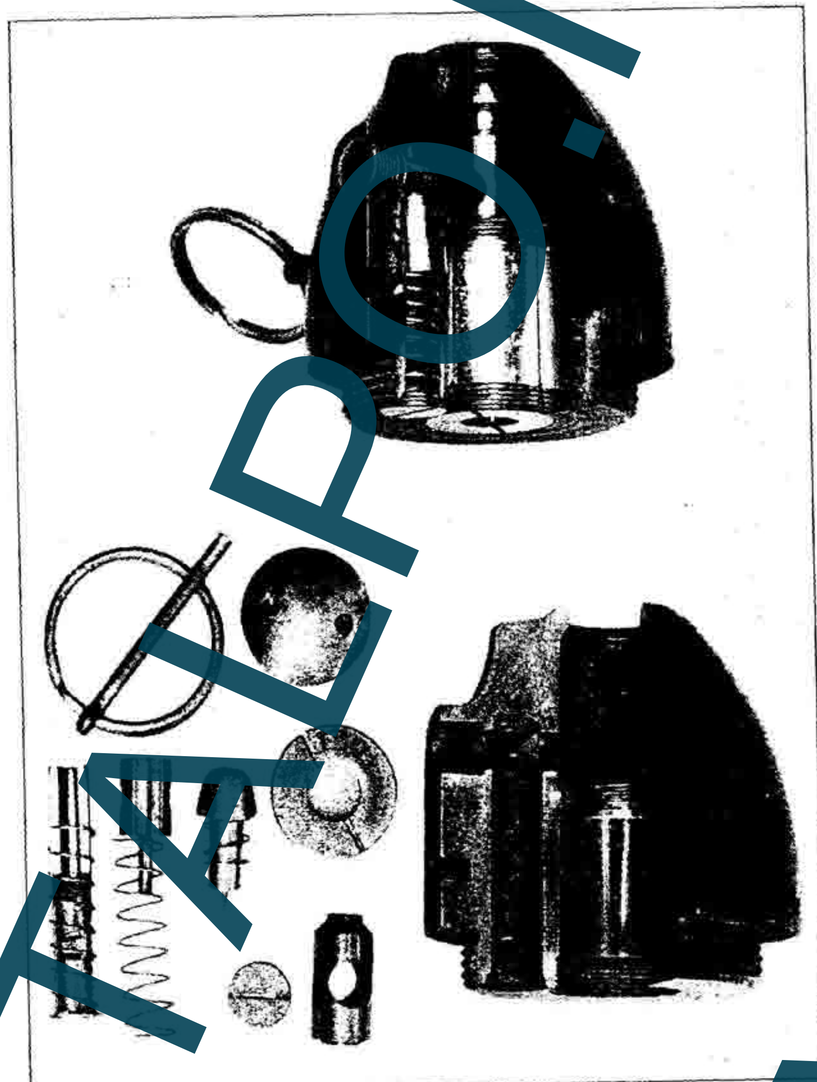


FIG. 106.—Trench mortar fuze, Mark VI. Assembly and section.

**Mark VI trench mortar fuze.**—Used with the 3-inch and 4-inch Stokes trench mortar shell, this fuze has a double percussion element which functions positively irrespective of the position in which the shell strikes on impact. It was designed by Lieut. F. A. Sutton, R. E., and improved by Lieut. Col. E. J. W. Ragsdale, U. S. A. The safety pin and ring must be removed before firing, leaving the set-back pellet supported by friction until the shell leaves the barrel. As acceleration of the shell starts the safety fork is ejected and the striker is



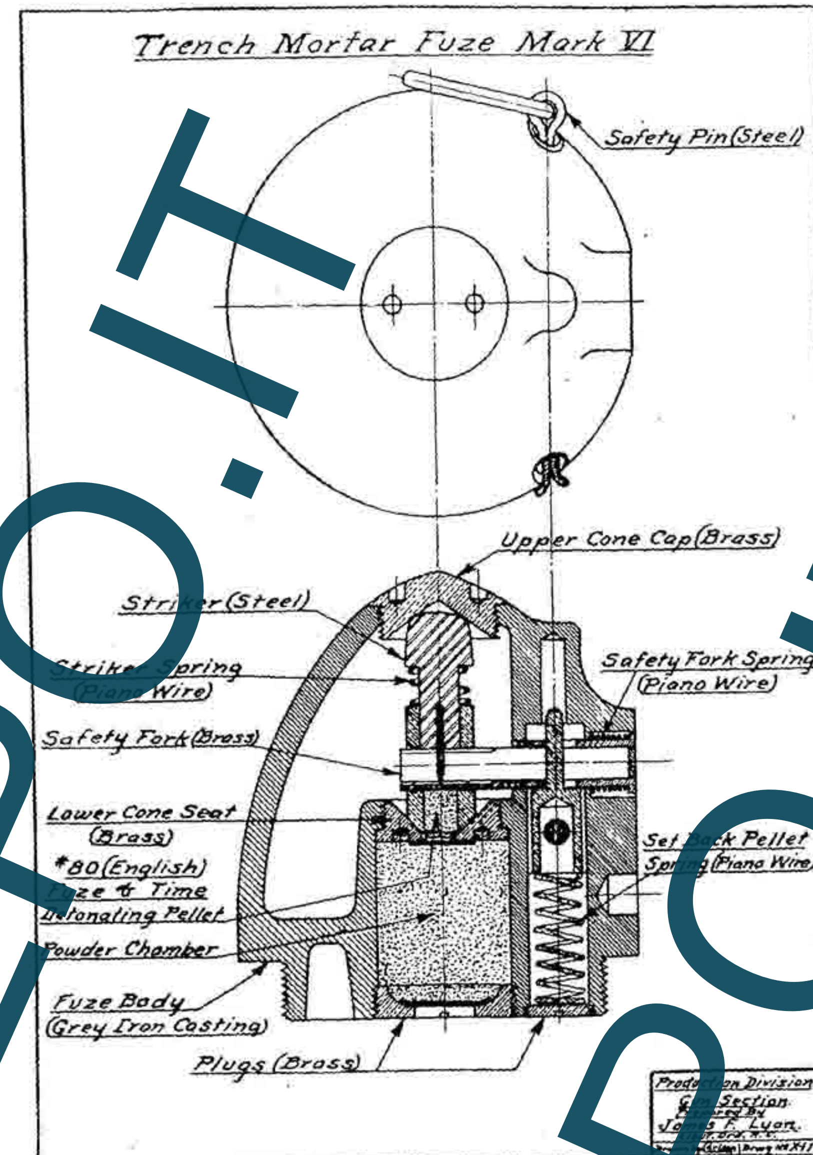



FIG. 107.—Detail of trench mortar fuze, Mark VI.

free to reach the detonating pellet or percussion element when impact takes place. This ignites shrapnel powder in the powder chamber and the flash then passes to the detonator and booster. The booster charge is contained in a cardboard tube and consists of two pellets of tetryl which fit around the detonator and one pellet of TNT below the detonator. The tube is closed with felt discs.

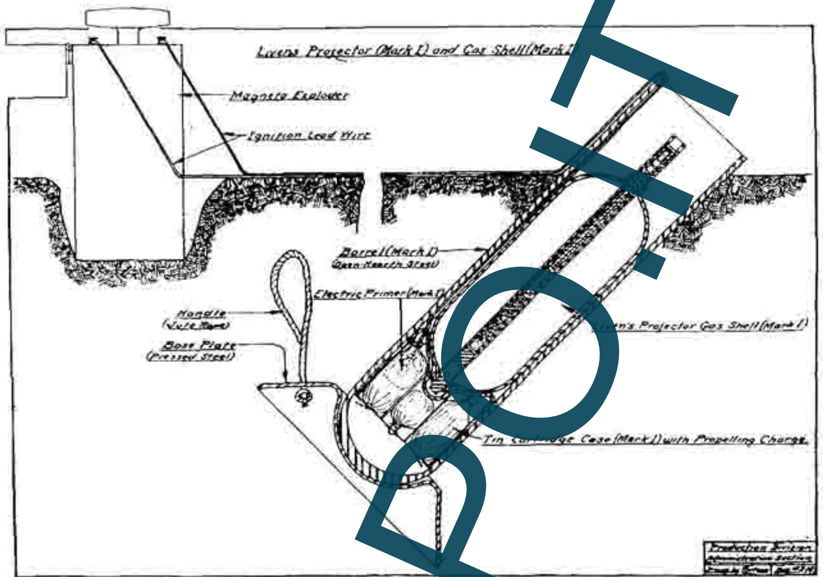



FIG. 108.—Method of placing Livens projector.

**Livens projector.**—The Livens projector is a mortar of the simplest type, which is used to discharge gas and incendiary shells. It consists of a straight cylindrical barrel of steel and a pressed-steel base, in the center of which is a concave recess shaped to receive the rounded breech of the mortar. The base is placed at the bottom of a hole dug to the proper depth some distance in front of the trenches. The barrel is placed therein and inclined at the proper angle; the earth is then replaced to support the projector and at the same time effectually conceal it from hostile observation. The muzzle alone remains uncovered. A cartridge case containing a number of bags of powder is dropped into the bottom of the projector with suitable wire connections leading from the electric primer in the powder to the point of operation. The shell is placed in the mortar over the cartridge case, the top of which is shaped to fit the base of the shell. The shell is provided with a length of Bickford fuze, which is ignited when the shell leaves the projector, and a standard type of detonator. A bursting charge of TNT is generally used with the gas shell, which contains a large charge of toxic materials. Black powder is usually employed to secure ignition of the incendiary materials in the incendiary shell, which may consist of cotton-waste balls or jute strands soaked in oil of some spontaneously inflammable mixture.

A large number of Livens projectors are usually placed in the ground, loaded and wired up ready for firing, being covered over with waterproof pieces or paper to keep out water or dust while others are being prepared. When as many have been set up as desired they



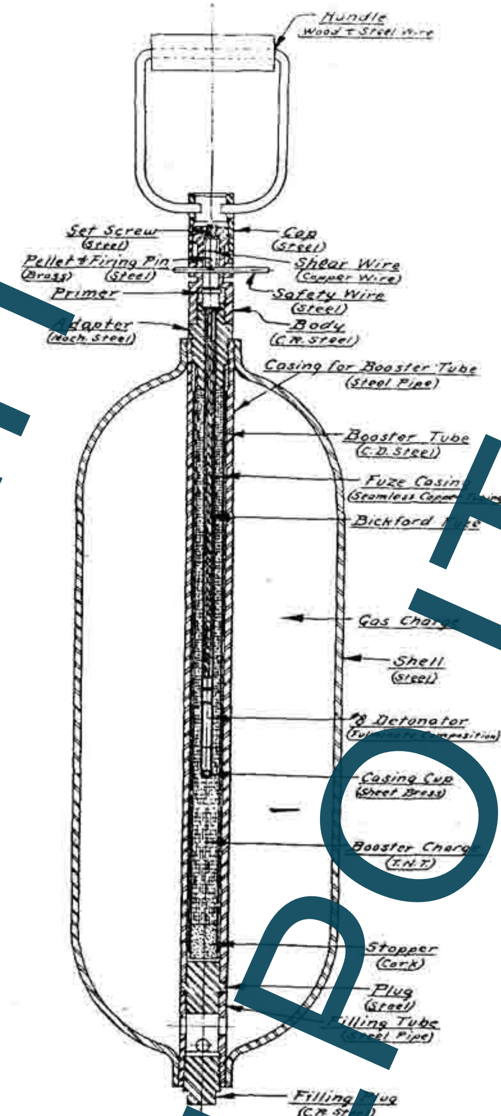



FIG. 109.—Livens projector shell, Mark I—section.

are fired by a blasting machine, the various projectors being connected in parallel and sufficient machines being used to secure proper functioning of the charges. As many as 6,000 or 7,000 of these bombs have been fired at once with but one or two malfunctions. The maximum range is about 2,200 yards with a wide dispersion, but since gas bombs are fired the object is to produce a large volume of gas in certain sections, and a wide dispersion is advantageous.

mounting on planes. All D. H. 4 planes were equipped with Marlins as fixed guns. Arrangements were made to have Spads and Salmsons altered so that Marlins could be mounted on them, and production on these types was taking place toward the end of the war. The rate of fire of the Marlin is much faster than the Vickers. Other planes were being prepared for the Marlin installation also, and it was expected to use primarily Marlins as fixed guns.

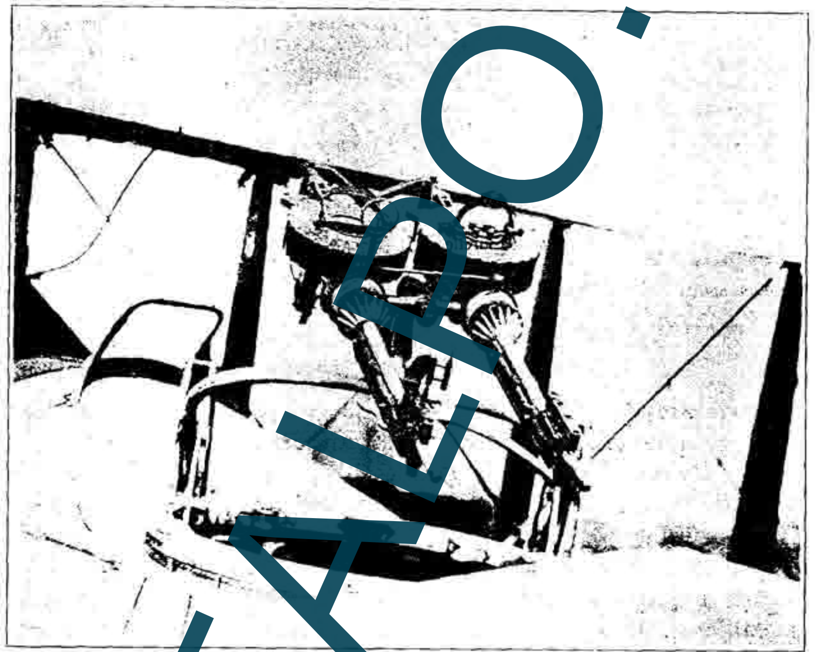


FIG. 116.—Two Lewis Guns mounted in jumellage in a tourelle or turret.

**Lewis aircraft.**—The Lewis gun, owing to the fact that it can not be readily synchronized, is used entirely as a free gun. At first it was necessary to modify the ground gun to adapt it to air use, but later a standard aircraft type was developed. It is mounted over the observer's seat in biplace planes by means of a scarf ring or tourelle. Two guns are mounted together in a yoke or jumellage, and the rotary action of the tourelle, combined with a joint permitting the perpendicular action of the jumellage, makes possible the aiming of the guns in all directions. Both guns are fired at once by means of a Bowden control. A recoil reinforcer is designed for the Lewis gun also, to make its action more positive and to increase its rate of fire a small extent.

**Browning aircraft.**—Tests of the Browning aircraft gun were made in England with a view toward determining the efficiency of its action under all conditions of flight. Barring certain malfunctions, due to a fault in the workmanship on the gun, which could be easily remedied, it met all conditions with greatest success. No gun heater was found necessary after cold tests. It synchronized exceedingly well, as was shown by a comparative test with the Vickers on the same mounting. The shots grouped in an angle 14 degrees less than that of the Vickers. More tests later were to be made to subject the gun to the most severe conditions imposed in action. It was hoped that ultimately all pursuit planes could be armed with this gun.



**11-mm. Vickers.**—The 11-mm. Vickers gun is used in the same manner as the .30-caliber Vickers. Only a few were in use near the end of the war, but more were expected from the United States to be mounted on pursuit planes. They are especially desirable for use with incendiary ammunition as balloon destroyers.

**Working-in plants.**—The acceptance parks installed plants for the working in of all machine guns before they were mounted on planes. In these tests the guns are cleaned thoroughly and fired at the butts. After a maximum of 500 rounds is fired the guns are disassembled and inspected for signs of wear. All parts showing burrs or roughness left in machining are stoned and smoothed up. Any parts showing defects are replaced by new ones. The guns are then oiled and turned over to the installation department for mounting. This working-in plant serves to put guns in the condition of ones which have been fired 20,000 rounds, making them smoothly functioning pieces and removing all possibility of their failing to function through defects in workmanship.

**Synchronization tests.**—After the gun has been mounted on the plane and the synchronizing gear adjusted the plane is taken to the firing butts, where the gun is operated with the motor running. This serves as a check on the adjustment of the synchronizing gears and prepares the plane for immediate service on its arrival at the front.

**37-mm. motor cannon.**—The 37-mm. semiautomatic cannon is mounted in the V of a motor with the barrel extending through the hollow propeller hub. The propellers of most airplanes are directly connected to the crank shaft of the motor, which would prevent the installation of the cannon. A plane such as the Spad 13, with the motor driving the propeller through reduction gears, is therefore used in connection with the cannon. This permits the muzzle of the gun to project through the hub of the reduction gear, which drives the propeller. The cannon is semiautomatic; that is, the recoil ejects the empty case and cocks the gun. The gun is loaded and the breech is closed by the pilot. The breech mechanism consists of a block sliding with a vertical motion in the breech housing and a catch to hold the block in its upper position. As the gun returns to battery a cam raises the catch, allowing the block to drop until it strikes

## AERIAL DROP BOMBS.

**Nature and use.**—The perfection of the airplane engine, and the corresponding increase in the carrying capacity of the plane have resulted in the rapid development of bombing operations into a most active and efficient arm of modern warfare. The tactical advantages of bombing are limited only by the number of planes and bombs available and the degree of accuracy with which the targets are covered.

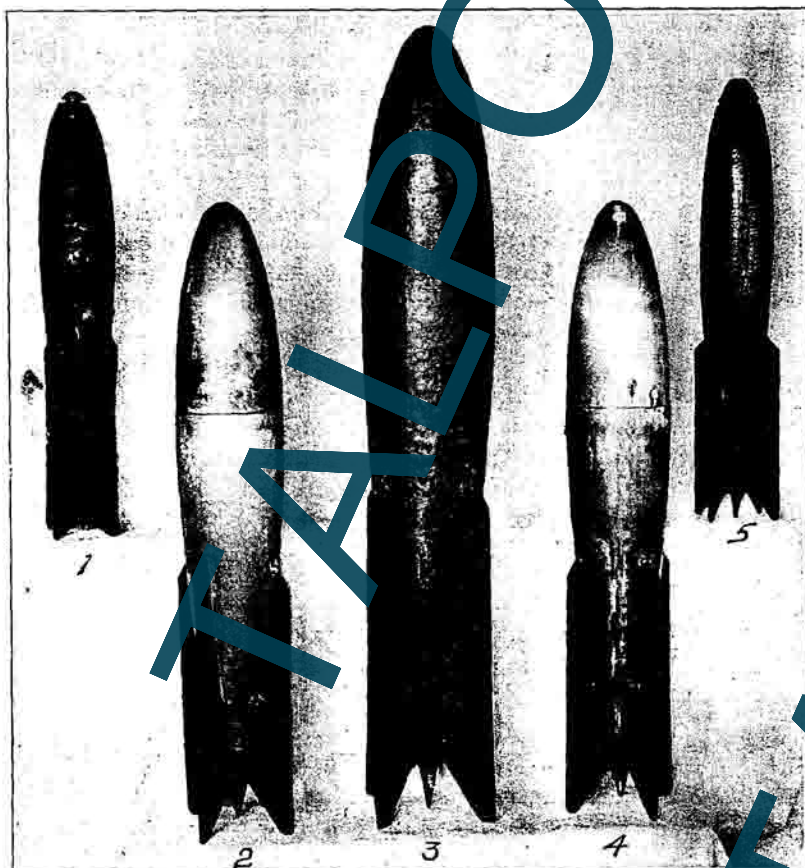



FIG. 112.—Types of aerial drop bombs. 1. Mark II, demolition drop bomb. 2. Mark II, incendiary drop bomb. 3. Mark I, demolition drop bomb. 4. Mark I, incendiary drop bomb. 5. Dummy drop bomb.

**Types.**—Aerial drop bombs are of three general types, viz:

High capacity (demolition).
Fragmentation.
Incendiary.



The various types brought out by the Ordnance Department in the United States have been designed and equipped to conform to requirements abroad; changes were constantly being made in details, such as the method of suspension, to make possible the use of the bombs in the new release mechanisms and planes. Only one type, the high capacity, was under quantity production up to the summer of 1918. Therefore, in the following description, only such details are given as apply to the accepted designs of 1918.

High-capacity drop bombs, so-called because of the large ratio of the weight of the explosive to the weight of the container, are used for general demolition purposes. The targets engaged include fortified positions, railroad terminals and lines, heavy structures of all kinds, supply depots, ammunition dumps, etc.

Fragmentation bombs carry a relatively small charge of explosive in a heavy steel shell, and depend for their effect upon the fragmentation of the shell. They are used against personnel, such as troops in the field or on the march, or wherever the protection afforded is slight.

Incendiary bombs are used for incendiary purposes against ammunition dumps, aerodromes, grain fields, etc. Two types were under manufacture—the scatter and the intensive type.

**Safety features.**—All American bombs are equipped with a safety device whereby they may be dropped to explode or not to explode, in accord with the will of the bomber. This is accomplished through the use of a safety pin, which is withdrawn from the bomb at the moment of release if the bomb is to explode or is allowed to remain if the bomb is to fall safe. The movement of the pin is controlled by a safety wire engaging a hook which is moved to the operating position or withdrawn to the nonfunctioning position just before the bomb is released.

In the older type of firing mechanisms the detonators are carried outside the main charge until the bomb has left the plane. Accidental explosion of the detonator will not explode the bomb in this condition. In the new types other safety features are provided to make the bombs safe from accidental discharge. The bombs are loaded with a high explosive, which requires a powerful detonator to set them off. The charge can not be detonated by penetration of rifle bullets.

## HIGH-CAPACITY DROP BOMBS.

**High-capacity drop bomb, Mark II.**—This bomb is modeled after the 120-mm. French bomb, having a light sheet steel stream-line body 4¾ inches in diameter and 28¼ inches long. The front half of the shell is five thirty-seconds of an inch thick, the rear half one-sixteenth of an inch thick. Its weight is 22 pounds, of which 9½ pounds repre-

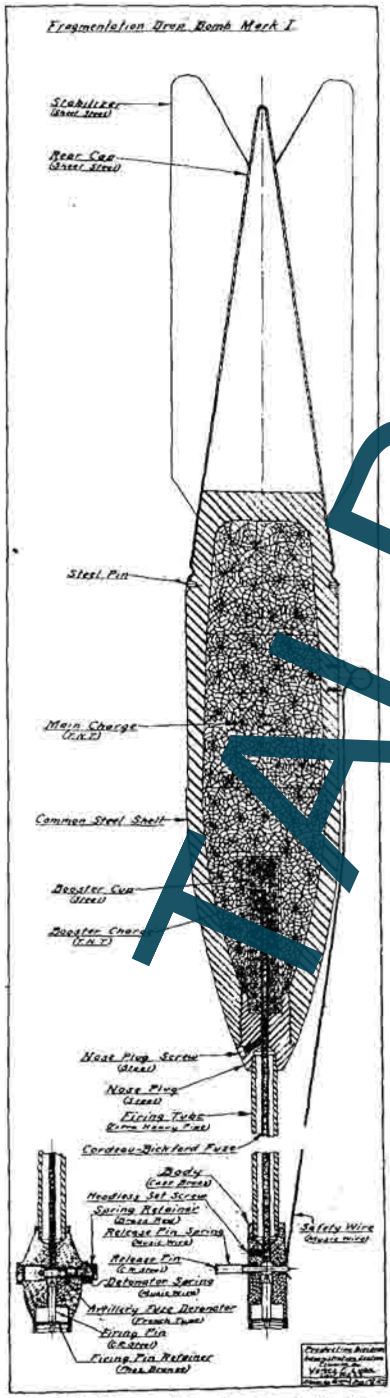



FIG. 117.—Fragmentation drop bomb, Mark I.

**High-capacity drop bomb, Mark IV–A.**—This type also has a heavy casing, and in all details except the firing mechanism is a duplicate of the French 100-kilogram bomb. It closely resembles the Mark IV in size and weight, the shell proper being 49 inches long and 10.18 inches in diameter, with a thick casing. It is provided with two vane-type firing mechanisms and the same means of suspension as are provided for the Mark IV.

NOTE.—The new types of firing mechanism designed for the larger bombs are provided with an adjustable fuze arrangement that will provide for delay action up to 15 seconds.

## FRAGMENTATION BOMBS.

**Design and action.**—In bombing operations against personnel, it is necessary that the explosion of the shell occur before it is buried in the earth to secure an efficient disperson of the fragments. To meet this requirement bombs have been designed in which a common steel shell is used in connection with a very rapid detonating device protruding from the nose of the shell. Designs of four sizes were prepared, Mark I, II, II–A, and III, using the 6-inch, 75-mm., 3-inch, and 4.7-inch artillery shell, respectively. Only the Mark II–A, using the 3-inch shell, was put into production, as advices from abroad indicated that the larger sizes would not be required. The firing mechanism is carried in a brass casting at the forward end of a short length of steel pipe, the rear end of which is screwed into the nose of the shell. A detonator in the body of the firing mechanism is arranged to slide into firing position when the bomb leaves the plane. On impact a firing pin is driven into the detonator, which now lies between the firing pin and a length of detonating fuze running into the booster cup of the shell. The action is very rapid, and explosion occurs well above the ground, insuring a lateral dispersion of fragments over a space 40 yards or more in diameter. The weights and dimensions of this type are as follows:



| | Overall length. | Diameter. | Total weight. | Weight of charge. |
|---|---|---|---|---|
| | *Inches.* | *Inches.* | *Pounds.* | *Pounds.* |
| Mark II | 30.1 | 2.925 | 19 | 1½ |
| Mark II–A | 30.2 | 3 | 19 | 1½ |
| Mark III | 50.38 | 4.7 | 49 | 6 |
| Mark I | 58.3 | 6 | 94 | 13½ |

All of the above are intended for horizontal release. The Mark II and Mark II–A are also provided with a loop at the tail, by means of which they may be carried in the British release mechanism for the Cooper bomb.

**Barlow heavy drop bomb.**—This is another type of fragmentation bomb. It consists of a forged steel war head or shell 6 inches in diameter and 18 inches long, which contains 16 pounds of high explosive. To this is connected a compressed-air mechanism of pressed steel and brass tubing, giving a total length of 80 inches in the safe or normal position. The mechanism consists of a forward extrusion rod carrying the firing device and a sliding stabilizer mounting which moves to the rear. On release from the plane the compressed air in the air chamber is released and drives the stabilizer tube back and the firing mechanism forward until the latter extends about 6 feet in front of the war head. Thus the bomb measures 15 feet over-all in the firing position. On contact a service cartridge, carried in the front end of the extruded tube, is discharged. The bullet passes up the tube and strikes a primer, which explodes the fulminate detonator, and explosion of the war head is thus produced when it is between 4 and 5 feet above the ground. The bomb was to be used against personnel in the field wherever adequate cover is lacking. As this bomb was designed to explode equally well above the water or on land, it was thought it could be used against landing parties and small boats.

Some difficulties arose in the manufacture of this bomb as well as in the method of handling it in the field. Advices were received from abroad that a fragmentation bomb of this size was unnecessary, and production was accordingly stopped until a thorough field test could be made. The bombs for this test were shipped.

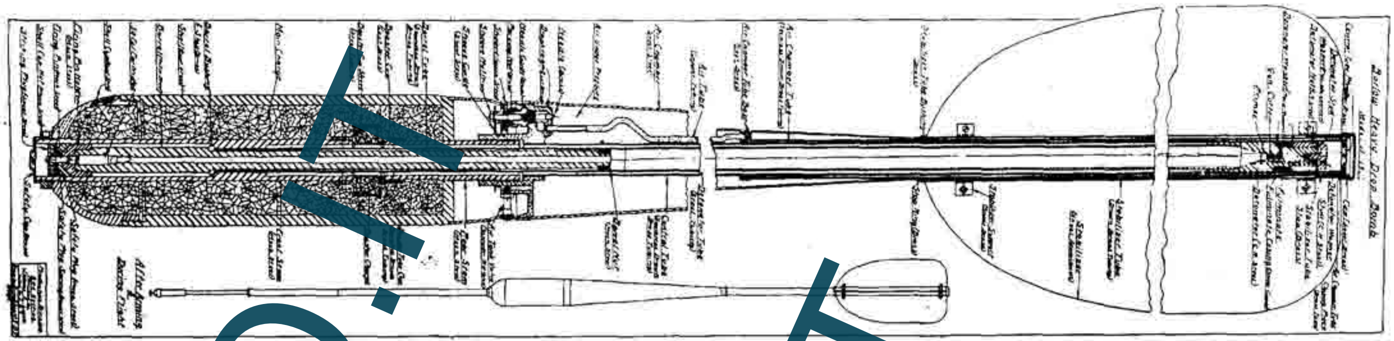


Fig. 118.—Barlow heavy drop bomb, model of 1917.



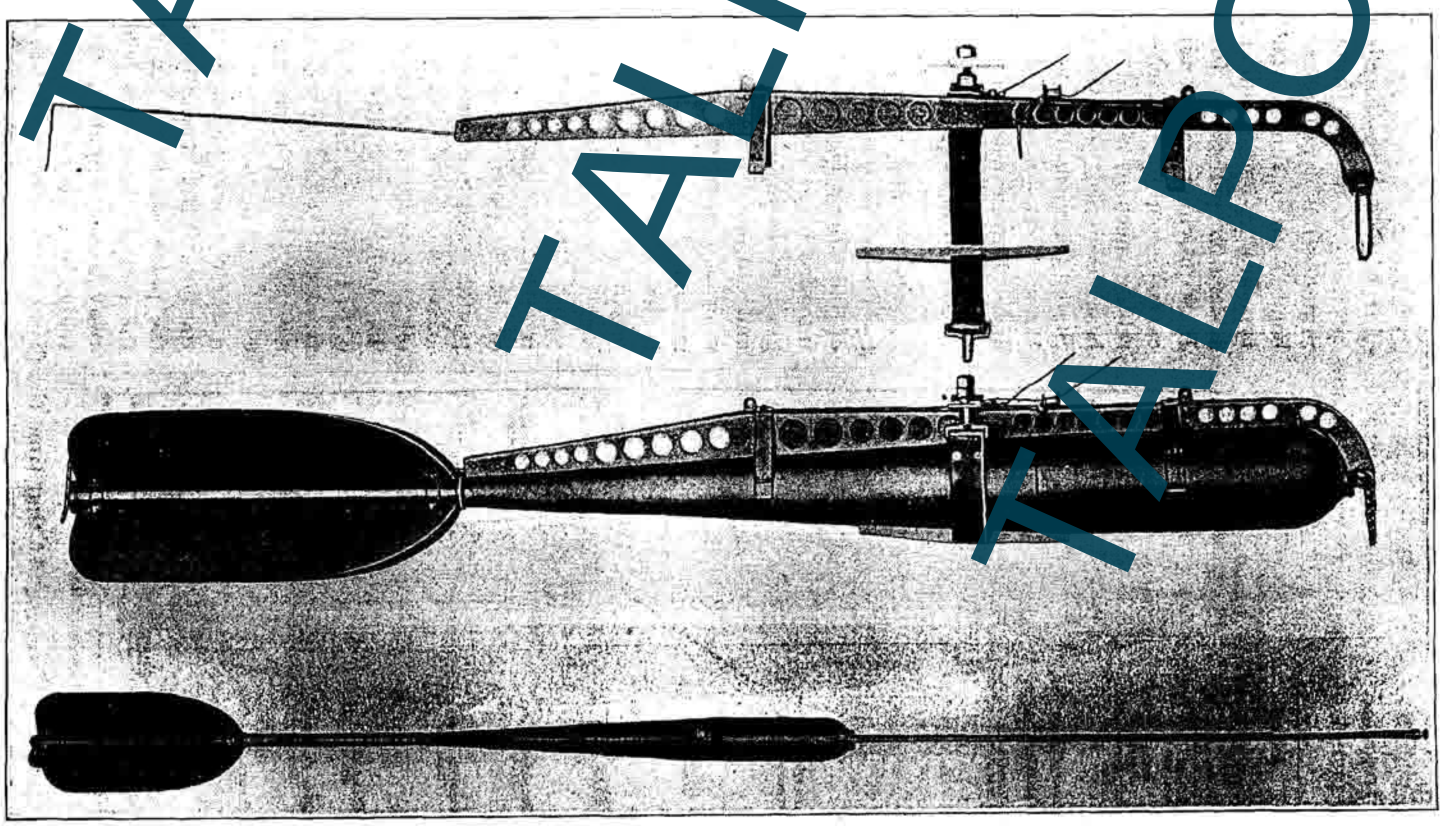


Fig. 119.—Barlow heavy drop bomb with release mechanism. Below—Barlow heavy drop bomb with rod extended.

In accordance with instructions received from abroad, the English 20-pound Cooper bomb was put into production in the United States. It is a pear-shaped bomb with a simple vane-type arming mechanism and a sensitive percussion fuze. It is provided with a tail-carrying loop for the British release mechanism and has been designed as United States fragmentation bomb, Mark II-B. (See below, under European bombs.)

## INCENDIARY BOMBS.

**Incendiary drop bomb, Mark I.**—This is the "scatter type" of incendiary bomb and is intended for use against grain fields, light structures, ammunition dumps, etc., where no great amount of igniting power is necessary. It has a diameter of approximately 6 inches and a length of 36 inches, with a weight of about 40 pounds. It carries a $1\frac{1}{3}$-pound charge of black powder and 19 pounds of cotton-waste balls soaked in turpentine, or solid oil balls wrapped in burlap. The body is of pressed steel 0.187 of an inch thick at the front and 0.03 of an inch at the rear. It is provided with two firing mechanisms—one in the nose and the other in the tail. After release from the plane the firing pin in the rear mechanism is held away from the igniting cartridge by means of a spring until contact occurs. At that time the firing of the service cartridge drives the bullet through the central tube and ignites both powder

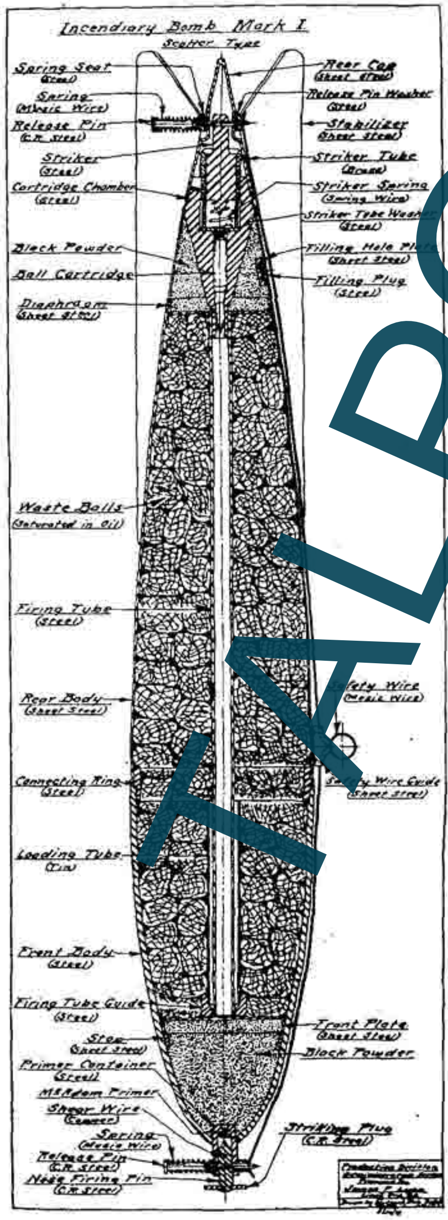


FIG. 120.—Incendiary drop bomb, Mark I.


FIG. 121.—Incendiary drop bomb, Mark I.


FIG. 122.—Incendiary drop bomb, Mark II.

might use incendiary ammunition. The Signal Corps had requested 1,000 caliber .433 Marlin aircraft machine guns for use with the incendiary ammunition, and a sample gun of this type was modified and prepared for test. As it was found necessary practically to redesign the entire Marlin gun for this purpose, experiments were conducted with the Russian Vickers gun, one of which was bored and chambered for 11-mm. French ammunition, and necessary minor changes were made in the lock. The test of this gun was so successful that the Control Bureau was requested to secure from the Colt's Patent Fire Arms Manufacturing Co. the 800 Russian Vickers guns, either completed or in process, to obviate the difficult and expensive work of redesigning and producing 1,000 Marlin guns.

**Vickers aircraft model.**—An aircraft model was designed by the Vickers Co., in which the water jacket was replaced by the skeletonized tube which supports the barrel, decreasing the weight of the

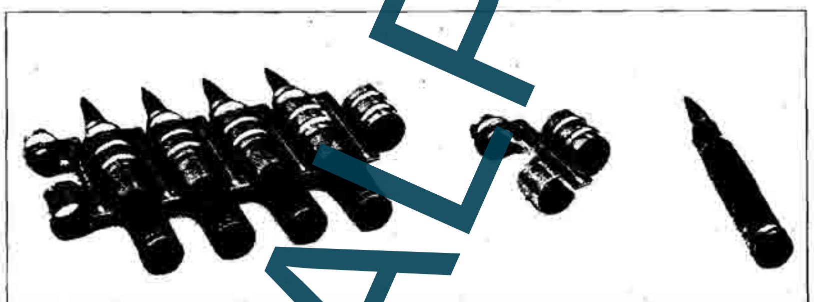


Fig. 137.—Metallic disintegrating feed belt for Vickers aircraft machine gun.

gun considerably. The mechanism is the same as in the gun supplied to the mobile army, except that there is no muzzle attachment, the feed box is made of aluminum, and when firing is suspended, the lock stops in the rearmost position so that the chamber remains open until the trigger is pulled, thus preventing a cartridge being exploded by a hot barrel. The gun is fed by a disintegrating metallic link belt similar to the Prideaux link, made up in 250 to 500 round lengths, and is fitted with a loading handle by means of which the complete loading operation can be accomplished with one hand.

A water-cooled model is also used in aircraft work, with the water-jacket mechanism arranged for the free circulation of air. This gun is also equipped with a loading handle and with a mechanism which permits the aviator to adjust the recoil-spring tension from the rear end of the gun.

A left-hand feed box has also been designed for the Vickers gun, to allow two guns being placed close together with just enough space between them for the ejection of the belt links, the belt being fed from opposite sides.



The Vickers aircraft gun can be used with a synchronizing attachment to fire through the propeller.

**Hotchkiss machine gun.**—The Hotchkiss machine gun, model 1914, caliber 8 mm., uses French (Lebel) ammunition, model 1886, and is of the gas-operated, air-cooled type, firing 400 shots per minute. This gun was invented by an Austrian, Capt. von Odkolek, in 1897, and was developed by the French for use in Africa, where water cooling would not be practical. It was used by the Japanese with great success in the Russo-Japanese War, and at present is the standard machine gun of the French Army, more than half of the heavy machine guns on the allied western front having been Hotchkiss guns.

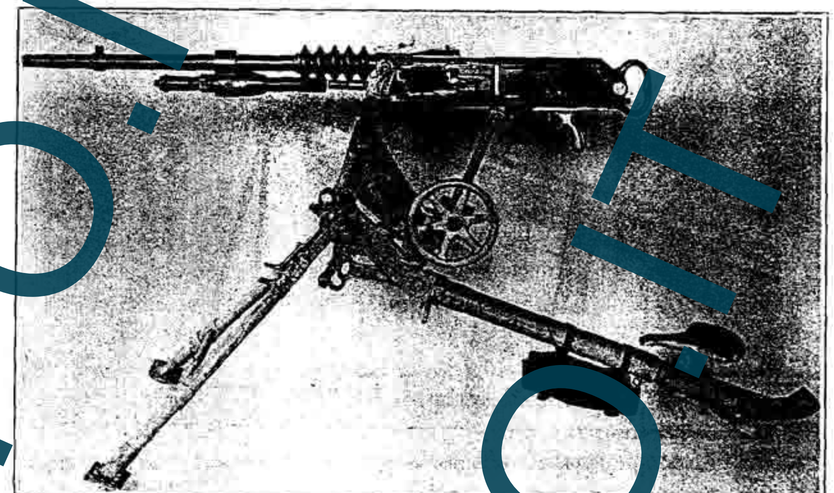


Fig. 138.—Hotchkiss machine gun and tripod.

The heavy type is fired from a tripod, and is fed from a rigid metallic strip holding 24 rounds or from a flexible metallic band holding 250 rounds. The gun weighs 54 pounds, the tripod 54 pounds, and a loaded strip 1 pound 12 ounces. It is manufactured by the Hotchkiss Co., St. Etiene, France. A complete outfit consists of one gun, one tripod, one flash hider, one spare barrel, one spare parts case, one gunner's pouch, one resizing tool outfit, and six ammunition boxes holding 10 strips each. The complete outfit is transported in the field on a machine-gun cart, very similar to the American standard cart.

A lighter type, weighing 30 pounds, was developed by an American, Lawrence Benet, about 1900, and is known in England as the light Hotchkiss, and in America as the Benet-Mercie automatic machine rifle, having been adopted in 1909 as the standard automatic

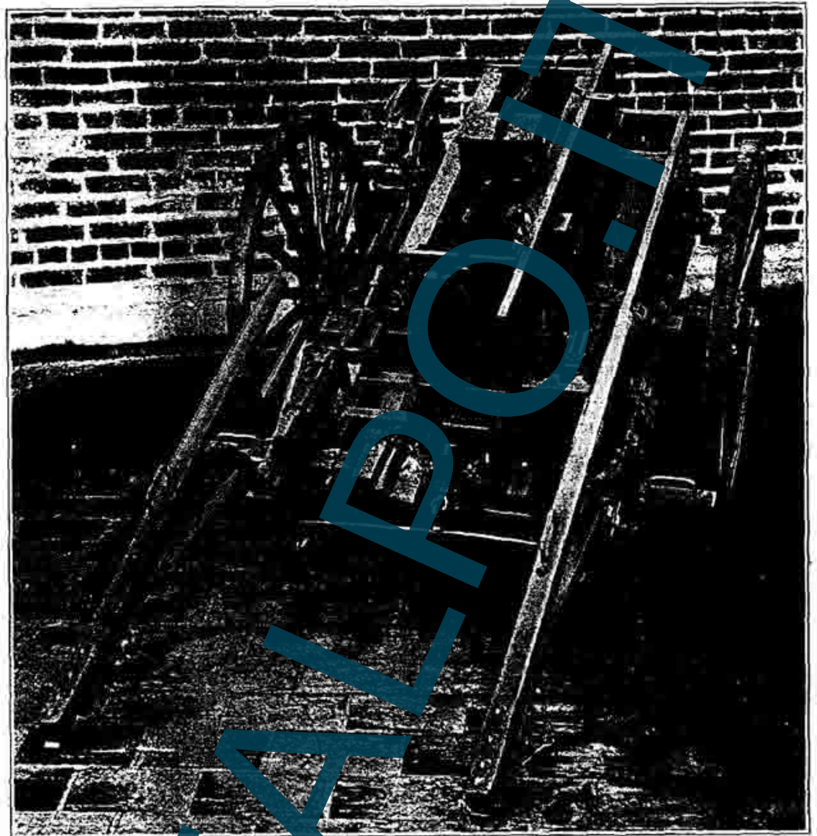


Fig. 141.—Machine gun cart.

**Special aircraft ammunition.**—Special .30-caliber armor-piercing incendiary and tracer ammunition was developed for use in the machine guns mounted on airplanes and was in quantity production before the war ended. These special types are discussed under Ammunition on pages 345 et seq.

**Mounts for machine guns.**—For machine guns, heavy type, a tripod conforming to the weight of the gun is found more satisfactory for field service. The tripods vary in strength and size with the type of gun and requirements of portability. For the Browning Machine Rifle, the Engineering Division of the Ordnance Department contemplated providing a light bipod. Such a bipod had proven very satisfactory in tests, but had not been officially adopted. An emergency bipod mount also was provided for the Browning Machine Gun, as well as a light tripod for both the Browning machine gun and Browning tank gun.



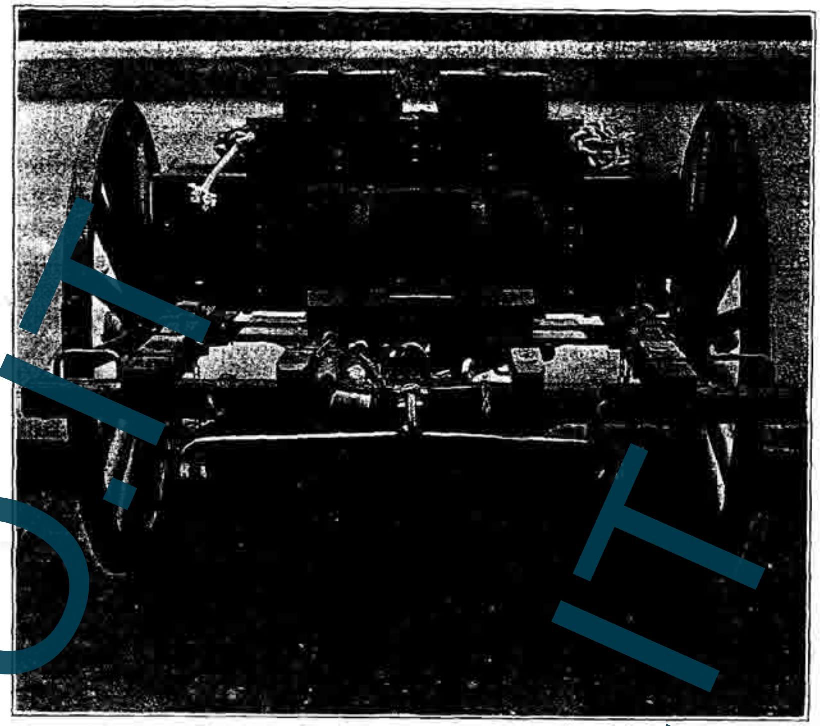


Fig. 142.—Machine gun ammunition cart.

## MACHINE-GUN UNIT EQUIPMENT.

**Machine-gun organization and supply.**—To each infantry machine-gun company equipped with machine-gun carts are issued 16 water-cooled machine guns, 16 tripods, 12 gun carts, and the other items as indicated in Part VIII of Ordnance Department Handbook on Machine-Gun Cart, Model 1917, with such necessary changes and amendments as field experience and other considerations have found necessary. To each division 168 active and 56 spare machine guns are issued. Machine-gun organizations for France are equipped with machine-gun carts which are similar to the French voiturettes. Each machine-gun company has 12 active machine-gun carts, 12 ammunition carts, and 2 spare gun carts, though up to September 1, 1918, the two spare gun carts had not been authorized for issue to the American Expeditionary Forces. The active one carries a heavy gun tripod and 7 boxes, except in the case of carts arranged for the Lewis gun, where there are accommodations for but 6. In this way 5 ammunition boxes, with 1,250 rounds, in addition to the tool box and the water box, may be carried on a machine-gun cart. Each ammunition cart will provide for 3,000 rounds, while each spare cart will carry

2 spare guns and tripod. The machine-gun carts, ammunition carts, and spare gun carts or voiturettes are two-wheeled carts, drawn by one mule, and take an ordinary load of approximately 400 pounds, which in an emergency can be increased to 600 pounds.

The same general type of cart, with but minor modifications, has been designed to carry all of the machine guns used in the United States service, including the water-cooled Browning machine gun, model of 1917; the Vickers machine gun, model of 1915; and the air-cooled Colt machine gun, caliber .30, and the Lewis gun. These carts are of French pattern and were made by the International Harvester Co., of Chicago, Ill.; the Velie Carriage Co., of Moline, Ill.; and the St. Louis Car Co., of St. Louis, Mo. Full description of them and of the matériel carried is given in the Ordnance Department Handbook on Machine-Gun Carts, model of 1917, War Department Document No. 778, A. G. O. (In connection with this handbook it should be borne in mind that certain changes in reference to fire-control instruments have been required, and the list of articles shown in Part VIII should not be relied upon to give the correct information in reference to these instruments as conditions of field service demanded additions to equipment and the elimination of unnecessary articles.

**Automatic rifles, organization and supply.**—Sixteen automatic rifles are issued to each infantry company, or 768 automatic rifles to each division. In the American Expeditionary Forces no distinction was made between active and spare automatic rifles issued to each company in 1917–1918, the total number (16) being considered active weapons. All spare automatic rifles, however, may be used as active automatic rifles where conditions warrant. Automatic rifles are carried by the men to whom they are issued, but to relieve them of carrying part of their personal equipment, this is loaded on company combat wagons. Each automatic rifle is served by a rifle squad, consisting of one automatic rifleman, one first assistant, and one second assistant. The rifleman and first assistant are armed with pistols or revolvers and the second assistant with a caliber .30 rifle. Each man of the squad wears a belt about his waist in which ammunition is carried. The belts of the rifleman and first assistant are identical. The rifleman may carry in his belt 120 rounds of ammunition for the automatic rifle and two clips of pistol or pistol-ball cartridges. Since the first assistant does not carry a spare parts case he is enabled to carry 40 additional rounds of ammunition for the shoulder rifle. In addition to these belts the first and second assistant have each been provided with two bandoleers, each designed to carry 120 rounds of ammunition for the automatic rifle. All ammunition for the automatic rifle carried by the rifle squad is carried loaded in magazines, each magazine containing 20 cartridges, the total carried by the squad



being 20 rounds. In case the spare parts case is not carried, 20 additional rounds of ammunition may be carried.

**Sights.**—On the Browning machine gun, model of 1917, water-cooled, and on the Vickers machine gun, model of 1915, the rear sight is graduated in meters from zero to 2,800. On all automatic rifles the rear sight is graduated in yards. On the Browning Automatic rifle, model of 1918, air-cooled, the rear sight leaf is identical with the rear sight leaf of the United States rifle, model of 1917.

## FIRE-CONTROL INSTRUMENTS.

**Plane table.**—The plane table is of wood construction, 40 centimeters square, with 3-inch compass, set in flush with the board. It is fur-

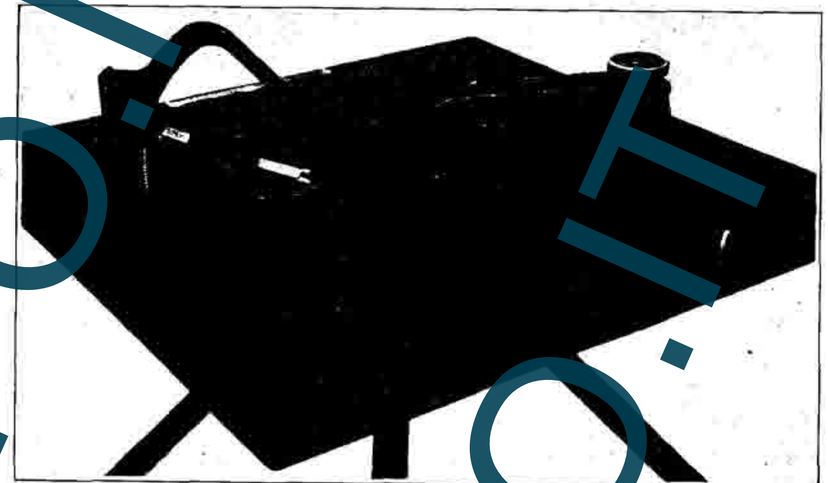


FIG. 143.—Plane table with clinometer and angle of site instrument.

nished with a canvas carrying case. It is attached to a wood tripod provided with extension legs, weighing approximately 5 pounds.

**Machine gun panoramic sight, model of 1918.**—The panoramic sight early was requested by headquarters American Expeditionary Force. The type adopted is similar to the French aiming circle, attached either to gun mount or tripod.

**Machine gun clinometer, model of 1918.**—The clinometer, used to lay the machine gun to any desired angle of elevation, is not attachable to the gun. The type adopted consists of a brass quadrant with a straightedge base and a radial arm carrying level bubble. The quadrant is graduated for each 20 mils up to 840 mils. The radial arm can be swung to any position through the arc and is provided with a micrometer scale, which makes the instrument accurate to 1 mil. This has a leather clip for attaching to the belt.

**Brunton compass, machine gun type, model of 1917.**—The Brunton compass is used to obtain direction and to measure horizontal angles. It consists of a magnetic needle inside of an aluminum case. The instrument is aimed by glancing at a mirror on the inside of the hinged lid. The azimuth circle is graduated for each 20 mils from zero to 6,400. The transit is furnished with a metal tripod having telescopic legs, and both the instrument and the tripod are provided with a leather case.

**Prismatic compass and clinometers.**—The prismatic compass and clinometer is used in the same way as the Brunton compass and is supplied to units not equipped with the Brunton compass. It consists of a metal case, magnetic needle and dial. The instrument is used by sighting through a prism, by which the line of sight is deflected to the dial, enabling the operator to read the dial at a fixed index. Used as a clinometer vertical angles may be measured.

FIG. 144.—Brunton compass.

FIG. 145.—Prismatic compass.

**Lensatic compass, model of 1918.**—The lensatic compass was designed to supersede both the Brunton compass and the prismatic compass, and employed for the same uses. It consists of an aluminum case with a magnetic dial floating in a liquid. It has a fixed azimuth scale, and also a single leveling bubble. The outside of the case is graduated and is used as a protractor. All scales are graduated in units of 20



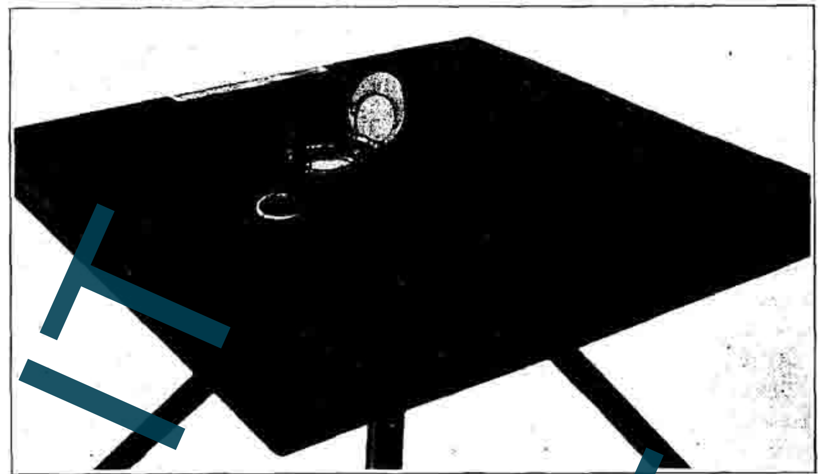


FIG. 146.—Lensatic compass and case.

mils from zero to 6,400 and illuminated to provide for night reading. The instrument is provided with front and rear sights for aiming. The front sight is a hair line on glass; the rear sight a slot, cut in the magnifier. After the instrument is aimed reading can be obtained by glancing at the indicator through the magnifier and noting the reading of the dial. A leather carrying case is provided.

**Angle of site instrument, model of 1917.**—The angle of site instrument is used to measure vertical angles. An aluminum frame carries the sight tube at the base and above this the bubble carrier. The sight tube is provided with an eyepiece and horizontal cross wire. The bubble carrier is in the form of a lever, with pivot at the front end and adjusting screw and graduation plate at the rear end. The graduation plate is fixed to the frame and is graduated in units of 20 mils, from zero to 180, both above and below the horizontal. The adjusting screw provides a micrometer, which gives the instrument an accuracy of 1 mil. On the inside of the sight tube an inclined mirror gives the observer a view of the bubble and enables him to level up the bubble carrier. When the sight tube is on the object and the bubble carrier is level, the instrument may be lowered from the eye and reading taken.

**Other instruments.**—In addition to those mentioned above the following instruments are also included in fire-control equipment for machine guns: Semicircular protractor, alidade protractor model of 1918 Abaque, Corcelli's graph, zinc rule, zinc square, Hitt's-Brown rule, night-firing box, aiming stake, and 80-centimeter base range finder. The last named is a special self-contained optical instrument specially designed for range finding for machine guns.

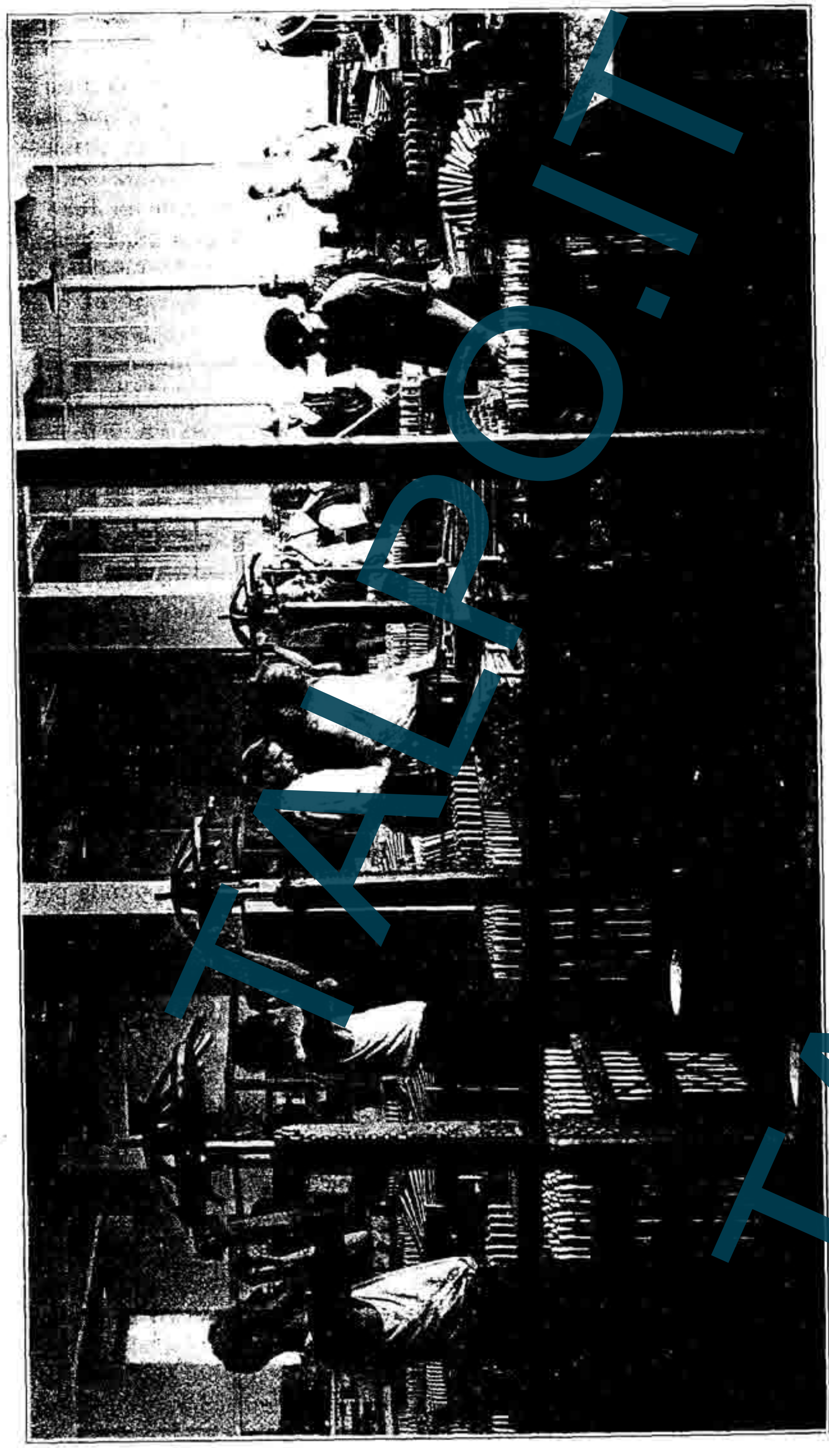


FIG. 14[illegible].—Examining and straightening rifle barrels at Rock Island Arsenal.





**Source.**—This rifle is manufactured at the Springfield Armory and at the Rock Island Arsenal. The rate of production is some 1,200 per day at the former, and at Rock Island 400 per day can be made when the plant is not engaged upon repair work.

TABLE 33.—*Principal dimensions and weights of United States rifle, caliber .30, model of 1903.*

[From Ordnance Pamphlet No. 1923; revision Jan. 22, 1917.]

DIMENSIONS.

| | Inches. |
|---|---|
| Barrel: | |
| Diameter of bore | 0.30 |
| Exterior diameter at muzzle | .619 |
| Exterior diameter at breech | 1.14 |
| Length of chamber and bore | 23.79 |
| Length of travel of bullet in bore | 21.697 |
| Diameter of chamber, rear end | .4716 |
| Diameter of chamber, front end | .442 |
| Diameter of neck of chamber, rear end | .3425 |
| Diameter of neck of chamber, front end | .3405 |
| Length of body of chamber | 1.793 |
| Length of shoulder of chamber | .16 |
| Length of neck of chamber | .396 |
| Length of chamber, total | 2.3716 |
| Rifling: | |
| Number of grooves, 4. | |
| Twist, uniform, one turn in | 10.00 |
| Width of groove | .1767 |
| Width of lands | .0589 |
| Depth of grooves | .004 |
| Height of front sight above axis of bore | 1.05 |
| Distance from top of front sight to rear side of leaf, leaf raised | 22.1254 |
| Stock: | |
| Length, with butt plate | 40.166 |
| Crook, i. e., distance from axis of bore to heel of butt | 2.089 |
| Distance from trigger to butt plate | 12.74 |
| Length of gun complete | 43.212 |
| Sight radius | 22.1254 |
| Sight radius (battle sight) | 21.5404 |
| Width of single division on windage scale | .0267 |

WEIGHTS.

| | Pounds. |
|---|---|
| Barrel | 2.79 |
| Barrel, with rear-sight base and front-sight stud | 3.00 |
| Butt plate | .26 |
| Receiver | .98 |
| Bolt mechanism | 1.00 |
| Magazine and trigger guard | .44 |
| Magazine mechanism, including floor plate | .17 |
| Bayonet | 1.00 |
| Stock | 1.58 |

| | Pounds. |
|---|---|
| Hand guard | 0.13 |
| Front and rear bands, including swivels | .25 |
| Rear sight, not including base | .20 |
| Total weight of metal parts | 7.30 |
| Oiler and thong case | .19 |
| Total weight of arm, including oiler and thong case, with bayonet | 9.69 |
| Total weight of arm, including oiler and thong case, without bayonet | 8.69 |
| Weight to compress mainspring | 16 to 18 |
| Trigger pull (measured at middle point of bow of trigger) | 4 to 5 |

MISCELLANEOUS DATA.

| | | |
|---|---|---|
| Initial velocity | feet per sec | 2,700 |
| Powder pressure in chamber | lbs. per sq. in | [1] 51,000 |
| Weight of ball cartridge | grains | [1] 395.5 |
| Weight of bullet | do | 150 |
| Weight of powder charge | do | [1] 50 |

**United States rifle, caliber .30, model of 1917.**—This rifle is derived from the British Enfield, pattern of 1914, caliber .303, which was remodeled with the least possible change to adapt it to use the United States cartridge caliber .30 model of 1906, mounted in clips, holding five cartridges each, this being the same ammunition used in the U. S. rifle caliber .30, model of 1903. It is a magazine rifle of the bolt type. The sear interlocks with the bolt and prevents pulling the trigger until the bolt is locked. The magazine is situated under the bolt, is loaded from the top, and the capacity is six cartridges. The barrel is 26 inches in length as compared with 23.79 inches for the 1903 model. The rifling is one turn in 10 inches, left hand. The distance between the sights is 31.76 inches, but the sight is not compensated for drift nor adjustable for windage. The rear sight is mounted in the rear end of the receiver instead of on the barrel, as in the 1903 model. It is adjustable from 200 to 1,600 yards. The muzzle velocity of the piece is 2,700 feet per second. It is provided with a safety lock, but no magazine cut-off. The last forward motion closes the bolt and locks it. The total weight without the bayonet is 9 pounds 3 ounces, and the total length without the bayonet is 46.3 inches. The same cleaning rod is used in the 1917 model as in the 1903 rifle.

**Breech mechanism.**—The bolt is locked by a turning movement which causes lugs on the bolt to engage in recesses just in the rear of the chamber. A camming action of locking lugs seats the cartridges firmly and continues throughout the locking action. To preclude the possibility of the bolts unlocking under powder pressure, a safety stud is mounted on the sear and rises as the trigger is pulled to lock the bolt against the turning. This serves also to preclude pulling of the trigger unless the bolt is fully locked.

[1] About.

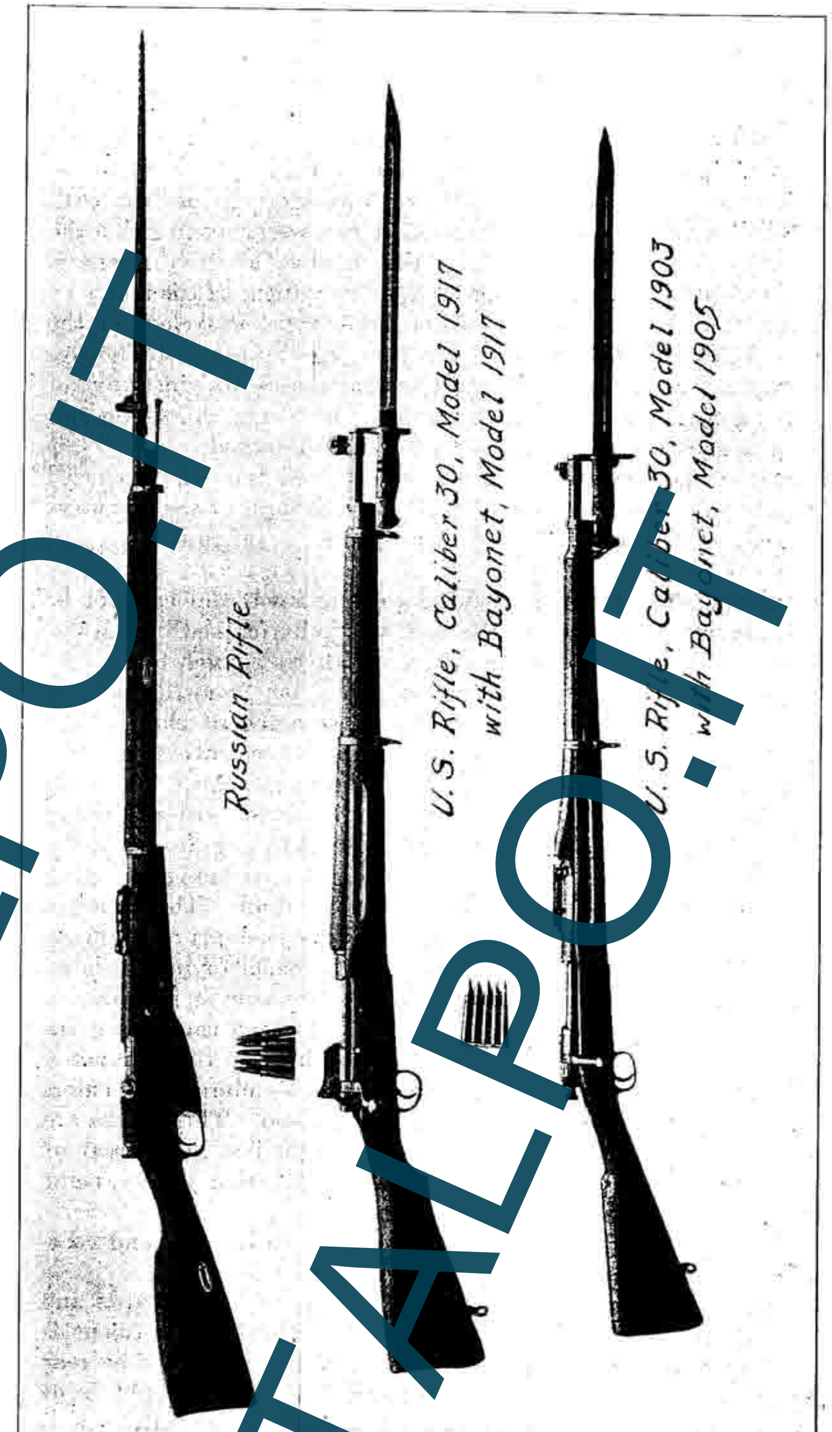



FIG. 148.—Service rifles manufactured in the United States, 1917 and 1918.

the firing position. The slide, which has a longitudinal movement carries both the front sight and the rear sight. There is a safety lock which locks the hammer and also a grip safety which locks the trigger whenever the handle of the pistol is released.

**Operation.**—The loaded magazine, which carries up to seven cartridges, is placed in the handle, and the slide is drawn back and released so that the first cartridge is introduced into the chamber. The hammer is thus caught and the pistol is ready for firing. By first inserting the cartridge into the chamber of the barrel and then inserting the loaded magazine the pistol may be prepared for instant use and for firing without the least possible delay the maximum number of shots.

**Magazine.**—The magazine has a charge of any number of cartridges from one to seven, and when exhausted may be readily released from the handle to be replaced by a loaded magazine.

**Miscellaneous data.**—The following items give the essential data concerning the automatic pistol:

| | |
|---|---|
| Weight | 2 pounds 7 ounces. |
| Trigger pull | 6 to 7½ pounds. |
| Total length | 8. 593 inches. |
| Barrel: | |
| Length | 5. 025 inches. |
| Diameter of bore | 0. 445 inch. |
| Rifling: | |
| Grooves— | |
| Number | 6 |
| Width | 0. 1522 inch. |
| Depth | 0. 003 inch. |
| Lands, width | 0. 072 inch. |
| Twist, one turn in 16 inches, left handed. | |
| Front sight above axis of bore | 0. 5597 inch. |

**Exterior ballistics.**—The automatic pistol has been fired 21 times in 12 seconds, beginning with pistol empty and loaded magazines on a table beside the operator, firing at 25 yards distance at a target 6 by 2 feet Under such conditions 21 shots were fired in 28 seconds, making 21 hits with a mean radius of 5.85 inches. The drift or deviation due to the rifling of this pistol is more than neutralized when pulling the trigger if the pistol is fired from the right hand. The muzzle velocity is 802 feet per second and striking energy 329 pounds, which at a range of 250 yards diminish to 666 feet per second velocity and a striking energy of 226 foot-pounds. With a 25-yard range the penetration is 6 inches of pine, and in moist loam 9.95 inches, and in dry sand 7.8 inches. At 25 yards the penetration of 1 inch in white pine corresponds to a dangerous wound.

The trajectory is very flat up to 75 yards, at which range the pistol is accurate. With the angle of departure equal to 45 degrees the range

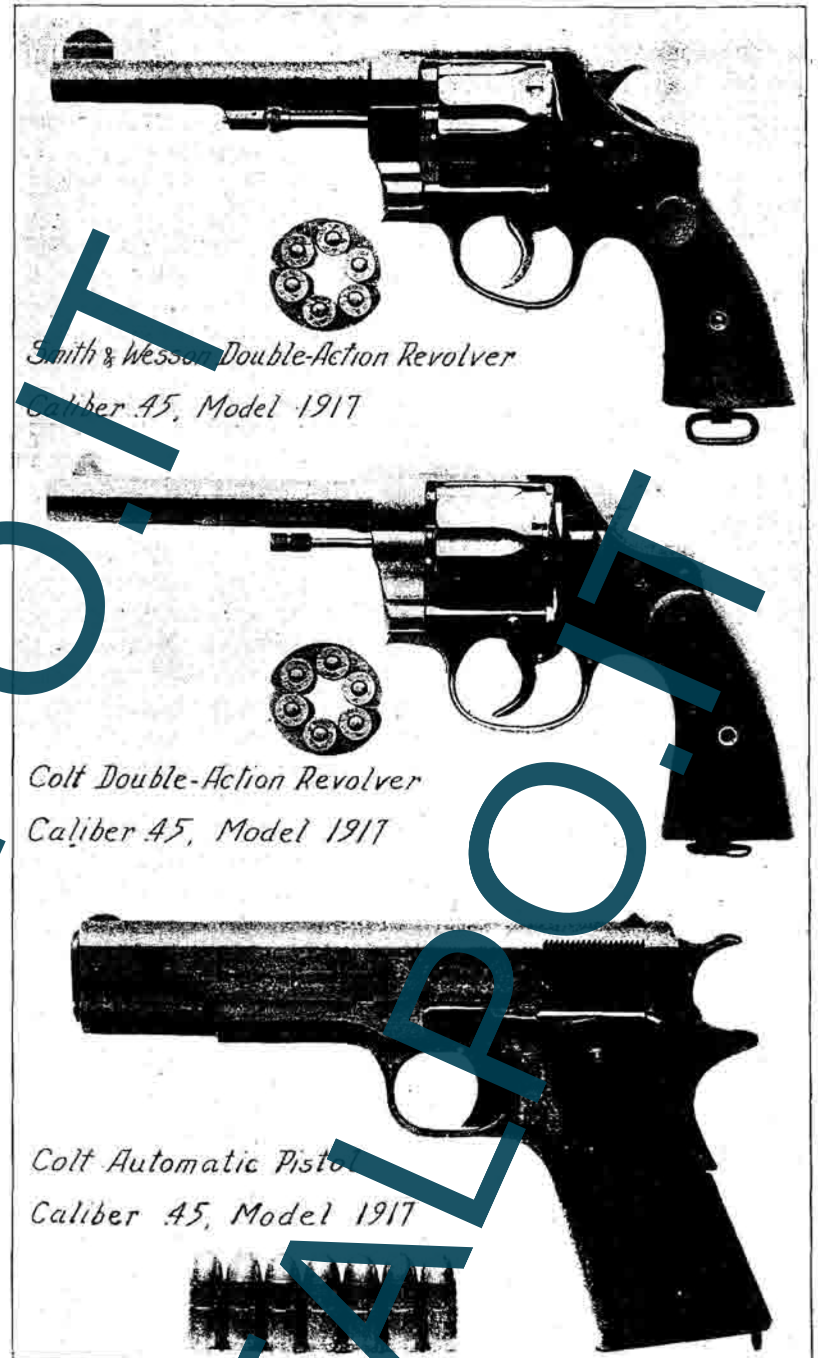



FIG. 53.—U. S. service revolvers and pistol, models 1917.

is approximately 1,955 yards. The automatic pistol, model of 1911, has full description in Ordnance pamphlet No. 1866.

**Extension magazine for automatic pistols.**—A straight extension magazine, feeding as many as 30 cartridges, has been developed. The follower is positively guided, and two springs are used, one telescoping inside and the other outside a tubular guide.

**Improved automatic pistols.**—Various improvements in automatic and semiautomatic pistols have been brought to the attention of the United States Army Ordnance Department and have received careful consideration. Some of the more notable and important are discussed below.

**Jolidon pistol.**—This pistol is the same as the service automatic (automatic pistol, caliber .45, model 1911), except that the barrel rotates to lock with and unlock from the slide, instead of dropping at the breech to perform this function. Test pistols were constructed to ascertain the value of this mechanism.

**Grant Hammond automatic pistol (sometimes called the "Liberty" pistol.**—This is a recoil-operated pistol using P. B. cartridges, caliber .45, model 1911, and having a bolt similar to the Mauser pistol. Unlike the Mauser pistol, however, the magazines are inserted in the grip, as in the Colt. This pistol was very favorably regarded at Springfield and at Camp Perry after tests at each place, but at the end of the summer of 1918 was not considered then available for adoption. It has two novel features—when the last cartridge is fired the bolt lock opens and the magazine catch is released; and insertion of a loaded magazine automatically releases the bolt, which is moved forward by the recoil spring, chambering the first cartridge from the new magazine.

## REVOLVERS.

**Service revolvers, model of 1917.**—The Colt double-action revolver, model of 1917, and the Smith & Wesson double-action revolver, model of 1917, are commercial types of revolvers modified to accept pistol ball cartridges, caliber .45, model of 1911, mounted in clips of three cartridges to a clip. The modification consists of increasing the head space to give room for the clips. These cartridges may be fired without clips, but in this case the shells must be picked out of the cylinder one by one.

These types of revolvers are made by the Colt's Patent Fire Arms Co. and the Smith & Wesson Co., and are issued mainly to artillery units, serving as an emergency, in case of shortage of automatic pistols. Up to November 9, 1918, the Colt's Patent Fire Arms Co. had delivered 134,300, while the Smith & Wesson Co. had delivered 134,051, maintaining a daily average production of about from 500 to 700 revolvers each.



**Colt's double-action revolver, caliber .45, model of 1917.**—Colt's double-action revolvers, caliber .45, model of 1917, are marked on the butt "U. S. Army, Model 1917," and are serially numbered. They consist of a barrel having a bore of 0.445 inch, firmly screwed into a frame which contains the lock mechanism. The front sight is brazed on the barrel, while the rear sight is merely a longitudinal groove in the upper surface of the frame. The lock mechanism is contained in the frame proper, which also supports the crane carrying the cylinder. There is a safety device which may be moved up in front of the hammer by a safety lever. The cylinder has six chambers and rotates upon and is supported on the central arbor of the crane. The crane fits in a recess in the frame below the barrel and turns on its pivot arm, which rotates in a hole in that part of the frame below the opening for the cylinder. There is an ejector with appropriate spring and rod which operates after the latch is pulled to the rear and the cylinder is swung to the left out of the frame. Pressing the ejector rod head to the rear will cause the ejector to engage the clips of the cartridges and carry them and the cartridges free of the cylinder, which may be reloaded with two clips and swung back into the frame. These clips may be saved and may be reloaded by hand.

**Operation.**—This revolver may be used either single or double action. In firing double action the pressure upon the trigger causes its upper edge to engage the hammer strut and thereby raises the hammer until nearly in full-cock position, when the strut will escape from the trigger and the hammer, under action of the mainspring, will fall and strike the cartridge. In firing single action the hammer is first pulled back with the thumb until the upper edge of the trigger engages in the full-cock notch in the front end of the lower part of the hammer. Pressure on the trigger will release the hammer, which under the action of the mainspring will fall and strike the cartridge.

DIMENSIONS.

| | |
|---|---|
| Weight | 2 pounds 7 ounces. |
| Total length | 10.8 inches. |
| Barrel: | |
| Length | 5.5 inches. |
| Diameter of bore | 0.445 inch. |
| Rifling, number of grooves | 6 grooves. |
| Grooves: | |
| Width | 0.1522 inch. |
| Depth | 0.0033 inch. |
| Twist, one turn in | 16 inches. |
| Lands, width | 0.0772 inch. |
| Cylinder: | |
| Length | 1.595 inches. |
| Diameter | 1.695 inches. |

Chambers:

| | |
|---|---|
| Number | 6 chambers. |
| Diameter—Maximum | 0. 480 inch. |
| Minimum | 0. 473 inch. |
| Front sight, above axis of bore | 0. 732 inch. |

**Exterior ballistics.**—The Colt revolver, caliber .45, model of 1917, has been fired 18 times in 34 seconds, using clip ammunition, and beginning and ending with the cylinder closed and the chambers empty. At 25 feet the velocity is 780 feet per second. The drift of the bullet is to the left and is more than neutralized by the pull of the trigger when firing from the right hand. The drift is negligible at the short range at which this weapon is ordinarily used.

**Smith & Wesson double-action revolver, caliber .45, model of 1917.**—The Smith & Wesson double-action revolvers, caliber .45, model of 1917, in service are marked on the butt "U. S. Army, model, 1917," and are serially numbered. They consist of a frame to which the barrel is firmly screwed and held in position by a barrel pin. This barrel has a bore of 0.445 inch and to it is brazed, as an integral part, the front sight. The rear sight is a longitudinal groove in the upper part of the frame. The lock mechanism is contained in the frame.

**Operation.**—This revolver may be used either single or double action. In firing double action, pressure on the trigger causes its upper edge to engage the hammer strut and raises the hammer until the trigger nose itself comes into contact with the hammer. After this the trigger continues to raise the hammer until the hammer is nearly in its full-cock position, when the hammer will escape from the trigger nose, and, under action of the mainspring, will fall, causing the firing pin to strike the cartridge. In firing single action, the hammer is first pulled back with the thumb until the upper edge of the trigger engages in the full-cock notch in the front end of the lower part of the hammer. The pressure on the trigger will then release the hammer, which, under action of the mainspring, will fall and cause the firing pin to strike the cartridge.

**Cylinder and ejector.**—The cylinder has six chambers. It rotates upon and is supported by the central arbor of the crane. The crane fits into a recess in the frame below the barrel and turns on its pivot arm, which rotates in a hole in that part of the frame below the opening for the cylinder. The ejector, of which the ratchet of the cylinder is a part, consists of a rod and a star-shaped ejector head which engages the clip to cause ejection of the shell. It is forged in one piece. By means of a latch the cylinder can be released and swung outward to the left from the frame for ejecting the fired cartridges. The revolver can not be cocked until the cylinder is back in position in the frame and latch.



DIMENSIONS.

| | |
|---|---|
| Weight | 2 pounds 4 ounces. |
| Total length | 10.79 inches. |
| Barrel: | |
| Length | 5.5 inches. |
| Diameter of bore | 0.445 inch. |
| Rifling, number of grooves | 6 |
| Grooves: | |
| Width | 0.157 inch. |
| Depth | 0.003 inch. |
| Twist, one turn in | 14.659 inch. |
| Lands, width | 0.075 inch. |
| Cylinder: | |
| Length | 1.537 inches. |
| Diameter | 1.708 inches. |
| Chambers | 6 |
| Diameter— | |
| Maximum | 0.480 inch. |
| Minimum | 0.4795 inch. |
| Front sight above axis of bore | 0.794 inch. |

**Exterior ballistics.**—The Smith & Wesson, caliber .45, model of 1917, revolver has been fired 18 times in 35 seconds, using clip ammunition, and beginning and ending with the cylinder closed and chambers empty. At 25 feet the velocity is 806 feet per second. The drift of the bullet is to the left and is more than neutralized by the pull of the trigger when firing from the right hand. The drift is negligible at the short range at which this weapon is ordinarily used.

**Caliber .38 revolver ball cartridges.**—Caliber .38 revolver ball cartridges are used in the old type of .38 caliber revolver. The ammunition is made from a brass case with a lead bullet and a charge to give a velocity of 750 to 800 feet per second, by developing a pressure not in excess of 15,000 pounds per square inch. Practically all of this type of ammunition recently procured is of the commercial type.

8-mm. Lebel cartridge — 7.62-mm Russian ammunition — 11-mm. incendiary cartridge

FIG. 160.—Ammunition for rifles and machine guns.

**Gallery practice cartridges, caliber .22.**—This ammunition is used in a model 1903 rifle, chambered to take an adapter which holds these small cartridges. The .22 caliber cartridges are of commercial grade known as the .22 caliber short. As the name implies, this ammunition is used for gallery practice.

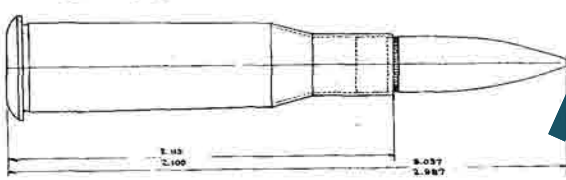


FIG. 161.—Caliber 7.62-mm. cartridge for Russian rifle.

**Caliber 7.62 mm. ammunition for the Russian three-line rifle.**—Ammunition for the Russian rifle consists of a cartridge case of brass, of the rim type, which is loaded with a charge of from 48 to 50 grains of powder, giving a maximum pressure not exceeding 45,500 pounds



per square inch, and producing a muzzle velocity of 2,866 feet per second. The bullet is made of a cupro-nickel jacket filled with a lead slug and having a weight of about 150 grains.

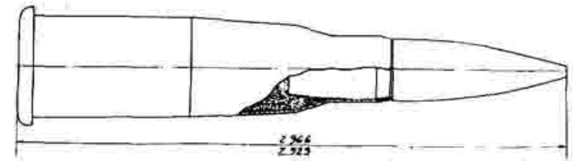


FIG. 162.—French 8-mm. Lebel cartridges.

**French 8 mm. Lebel cartridges.**—8 mm. cartridges have been made in this country, principally by the Remington Arms-Union Metallic Cartridge Co. and the Western Cartridge Co. The cartridge case, which is of brass, is loaded to produce a velocity of 692 meters per second, at a distance of 25 meters from the muzzle of the gun. The bullet is of copper, hardened with about 10 per cent zinc, and has a mean weight of 197.6 grains. The charge is usually 46 grains of Du Pont No. 22 or Hercules No. 20 powder. The French cartridge had an equivalent charge of $BN_3F$ smokeless powder consisting of small square grains. The pressure developed does not exceed 45,000 pounds per square inch. The ammunition manufactured was for use in the 8 mm. French Chauchat rifle and the Hotchkiss machine guns, both of which were used by the first of the American Expeditionary Forces in France.


FIG. 163.—Incendiary catrtridge, caliber 11-mm.

**11 mm. ammunition.**—Tracer-incendiary ammunition, caliber .11 mm., has been developed for use in the machine guns of this caliber adopted as part of aircraft armament. This ammunition has a muzzle velocity of about 2,000 feet per second, and the bullet differs from other types in that it is made of brass and is hollowed out to hold a charge of tracing composition, which consists of barium nitrate, magnesium, and a binder with a priming charge of red lead and magnesium. This charge of tracing composition is so large that the bullet not only traces but has excellent incendiary properties. It will trace its path for at least 1,000 yards. It is principally used against kite balloons and dirigibles.

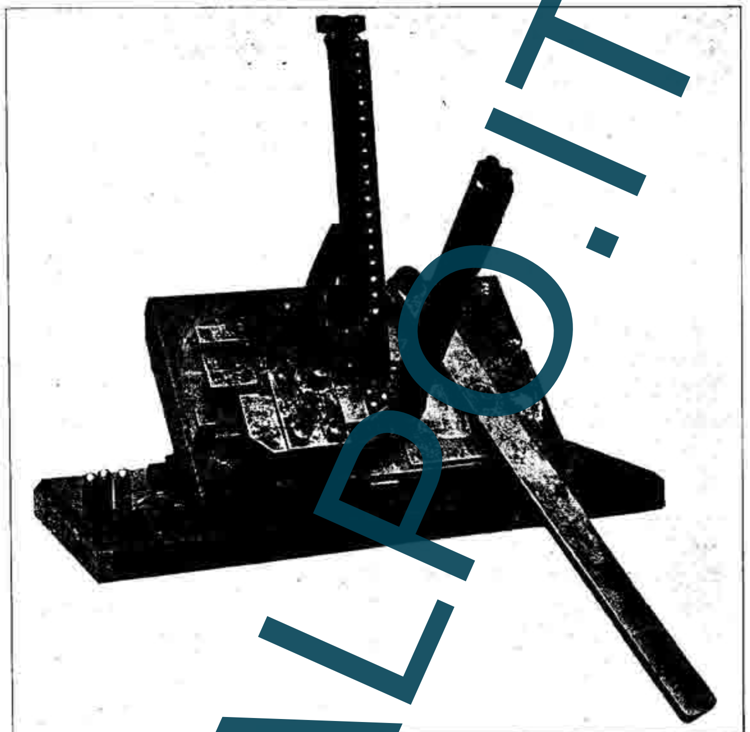


FIG. 164. Clip-loading machine, model 1918, caliber .45, for revolver ball cartridges.

**Clip-loading machine for caliber .45 revolver ball cartridges.**—The clip-loading machine, model of 1918, for caliber .45 revolver ball cartridges, model of 1911, is designed to clip these cartridges for use in revolvers. The illustration indicates the nature and construction of the machine clearly and affords a good idea of how it functions. The magazine to hold the clips is not shown in the picture, as this addition was made after the construction of the model illustrated. The cartridge magazine opening at the top is fitted with a tool-steel gauge to detect cartridges which are too large to be clipped.

**Small-arms repair and cleaning outfits.**—The various repair chests and cleaning outfits for use in the field as issued are as follows:

**Armor-repair chests, model 1910.**—This chest contains tools and spare parts for the United States rifle, model of 1903. It is intended for use by the company's mechanics.

**Armor-repair chests, model 1917.**—This chest contains tools and spare parts for the United States rifle, model 1917. It is intended for use by the company's mechanics.

**Tool roll for United States rifle, model 1903.**—This contains taps, reamers, etc., for adjusting front sights on United States rifle, model 1903.

| Caliber. | Model. |
|---|---|
| .22 | Gallery practice. |
| .30 | Armor-piercing, 1 |
| .30 | Armor-piercing, 1 |
| .30 | Multiball, 1898... |
| .30 | Service, 1898..... |
| .30 | Multiball, 1903... |
| .30 | Service, 1903..... |
| .30 | Service, 1906..... |
| .30 | Incendiary, 1918. |
| .30 | Tracer, 1917..... |
| .38 | Revolver ball.... |
| .38 | Revolver blank.. |
| .45 | Revolver ball, 19( |
| .45 | Pistol ball, 1911.. |
| .45 | .....do........... |
| .45 | Multiball, 1873... |
| .45 | Revolver blank, 1 |
| .45 | Dummy, 1918... |
| .45 | High-pressure... |
| .303 | British, Mark VI |
| .303 | British, Mark VII |
| 8-mm. | French Lebel.... |
| 7.62-mm. | Russian......... |
| 11-mm. | United States inc |
| .30 | Blank, 1898...... |
| .30 | Blank, 1906...... |
| .30 | Blank, 1909...... |
| .30 | Blank, 1903...... |
| .30 | Dummy, 1898.... |
| .30 | Dummy, 1903.... |
| .30 | Dummy, 1906.... |
| .30 | Gallery practice, 1 |
| .30 | Gallery practice, 1 |
| .30 | Gallery practice, 1 |
| .30 | Guard, 1898...... |
| .30 | Guard, 1906...... |
| .30 | High-pressure... |
| .30 | .....do........... |
| .30 | .....do........... |
| .30 | Incendiary, 1917.. |

templated is considered and the fact that the leather supply was early affected by the war, it is obvious that leather will continue to become more difficult to secure. One regiment of medium heavy Field Artillery requires 125 sets of wheel harness and 333 sets of lead harness, the leather for which would make 11,720 pairs of shoes.

**Supply of tractors unlimited.**—The manufacturing plants in America had greatly enlarged their floor space with a view to greater output. This meant that the supply of tractors and trucks was unlimited, whereas the supply of horses was limited and becoming more so.

**Ease of concealment.**—Tractors are far more easy to conceal and camouflage than horses and are, therefore, seldom destroyed by air raids.

**Sanitary conditions.**—Animals, dead or alive, under conditions existing at the front, are a source of disease and are highly obnoxious. The tractor can not create these conditions.

**Motorization of Field Artillery—75-mm. gun.**—The motorization of 75-mm. guns and 155-mm. howitzers was early begun for the American Expeditionary Forces with the matériel in France. The first motorization of the 75-mm. gun was done by use of the 3-inch field gun trailers drawn by F. W. D. or Nash trucks. The 75-mm. gun regiments (French matériel) were converted in shops in France and drop-forge lunettes specially designed for the conversion of French matériel were ordered and delivered. By cutting the wooden pole furnished with the matériel and fitting the lunette with the necessary tie-rods this conversion was perfected with very little delay. The horse-drawn batteries as constituted in the summer of 1918 did not have a sufficient number of French limbers for motorization, and as a result special connecting poles had to be fabricated in France for each motorized battery until standard connecting poles were received from the United States.

**Motorization of 155-mm. howitzer.**—In order to convert the 155-mm. howitzer horse-drawn artillery to motor draft, the same procedure applied to the ammunition limbers as to the 75-mm. limbers referred to and all necessary matériel was early put under manufacture. The carriage limber for the 155-mm. howitzer required a special connecting pole, which in the case of the first group of howitzers was purchased from the Schneider Co.

**Motorization of the 4.7-inch gun.**—The 4.7-inch gun matériel arrived in France ready for motorization and no changes were necessary in the carriages, limbers, or other accessories.

**Number of vehicles.**—In a 75-mm. artillery regiment motorized, in accordance with the requirements of table of organization No. 30, series A, there are 264 vehicles, exclusive of the actual fighting material. These vehicles are trailers, tractors, trucks, artillery-repair



trucks, supply trucks, etc., and with the actual fighting material make a total of 393 vehicles. The fighting matériel proper for such a regiment consists of:

24 guns.
36 caissons.
60 limbers.
3 reel carts.
6 reel and fire-control carts.

**Motor transport for one army, five corps.**—The theoretical initial requirements of motor-conveyers for one army, as submitted May 11, 1918, were as follows:

| | |
|---|---|
| Ammunition trucks | 16,388 |
| Artillery-repair trucks | 815 |
| Artillery-supply trucks | 1,955 |
| Equipment-repair trucks | 124 |
| Reconnaissance cars | 414 |
| Light repair trucks | 428 |
| Staff observation cars | 386 |
| Machine-gun cars | 1,296 |
| 1-ton supply trucks | 131 |
| 2½-ton artillery tractors | 763 |
| 5-ton artillery tractors[1] | 3,468 |
| 10-ton artillery tractors | 468 |
| 20-ton artillery tractors | 360 |
| 3-inch field-gun trailers | 300 |
| 3-inch antiaircraft trailers | 260 |
| 4.7-inch antiaircraft trailers | 40 |
| 4-ton trailers | 368 |
| 10-ton trailers | 450 |

**Initial requirements.**—The above estimates only include initial requirements; the motor vehicles necessary for replacements, reserves, training troops in the United States, etc., have been omitted. The motor equipment which is required in connection with the tank service has also not been included.

**Repairs and replacements.**—In the spring of 1918 the control bureau of the Ordnance Department decided upon the following percentages for replacements, reserves, etc., of motor equipment, and requirements were figured upon this basis:

25 per cent of the initial requirements as a fixed reserve in France.
20 per cent of the initial for repair shops.
8 per cent of the initial at the port of embarkation in the United States.
4 per cent depreciation per month.
10 per cent loss in overseas shipment.

[1] Substitution of tractors.—A board of officers appointed by paragraph 69, S. O. No. 242, W. D., Oct. 17, 1917, recommended on Jan. 25, 1918, the use of 5-ton artillery tractors in certain organizations in which the tables of organization called for 10-ton tractors. The 5-ton tractor will replace the 10-ton tractor in these organizations in the ratio of 2 to 1.

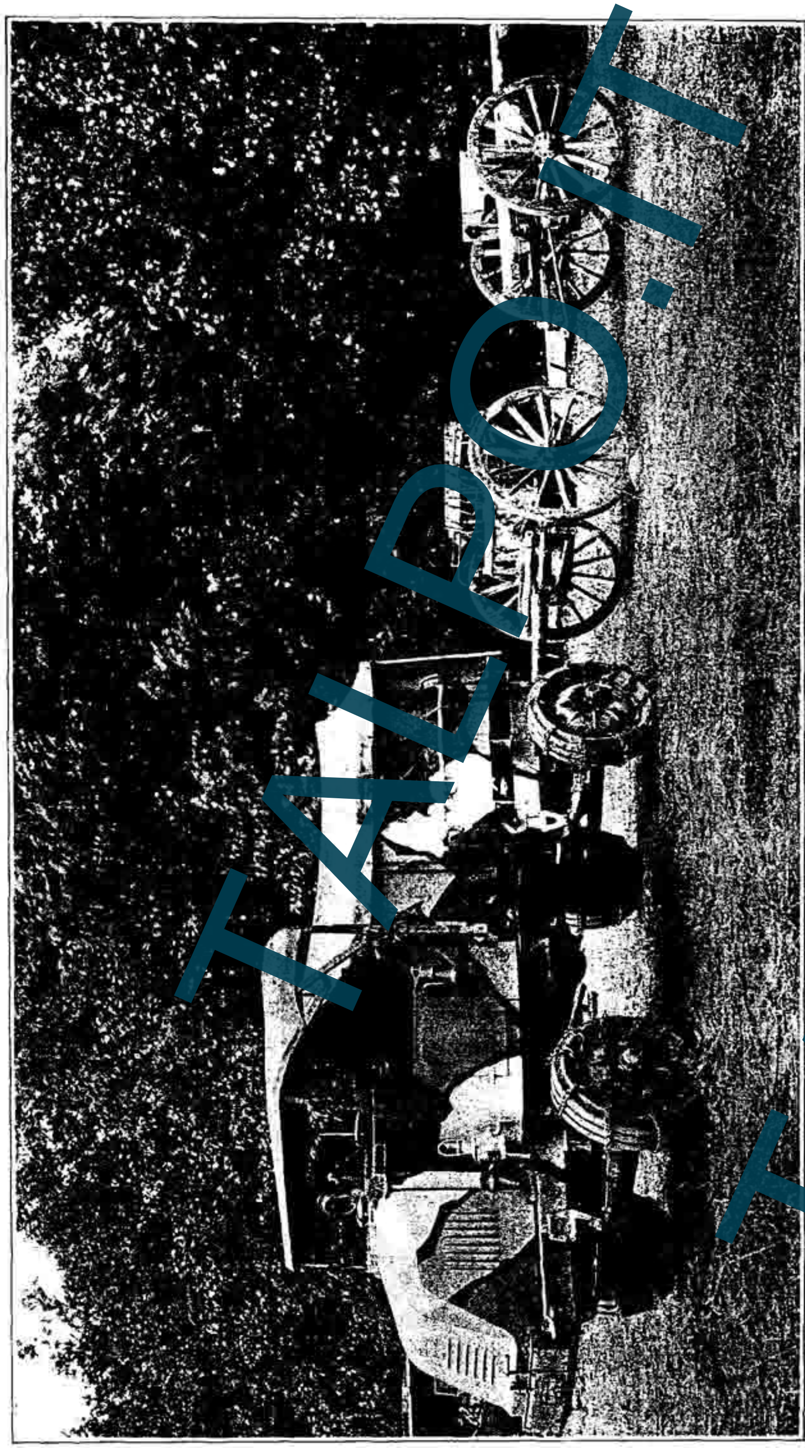


FIG. 167.—Ammunition truck used as a tractor for hauling field guns.





TABLE 39.—*Motor trucks supplied by Ordnance Department.*

| Body or type of truck. | Purpose. | Chassis. | Motor. |
|---|---|---|---|
| Ammunition truck has a steel box body. | Transportation of ammunition, passengers, wireless equipment, telephone switchboards, fuel oil, water, baggage, and rations. | Bodies interchangeable on Nash 2-ton truck chassis; both chassis drive on all four wheels and have speed of about 15 miles per hour; Nash chassis is being made by Nash Motors Co., Hudson Motor Car Co., National Motor Car & Vehicle Corporation; F. W. D. chassis being made by F. W. D. Auto Co., Mitchel Motors Co.; Premier Motors Corporation and Kissel Motor Car Co. | |
| Equipment repair truck has a steel body containing bins and drawers for parts and materials for repair of personal equipment, small arms, leather equipment, etc.; sewing machines for leather and canvas and hand tools are carried. | Three of these trucks used in each mobile ordnance repair shop, for repair of personal equipment, small arms, leather equipment, etc. | | Motor used in Nash is Buda 4-cylinder, 4½ by 5½ inches; motor rated at 28.9 horsepower at 1,100 revolutions per minute; motor used in F. W. D. is 4-cylinder, 4¾ by 5½ inches, at 36 horsepower at 1,000 revolutions per minute. |
| Artillery repair truck body is a complete small-arms machine shop having separate gas-motor generator which supplies power for motor-driven machine tools, which include a 9-inch lathe, a drill press, and a grinder, etc. | Issued to ammunition-train motorized artillery, and mobile ordnance repair shops for repair of artillery and motor materials. | | |
| Artillery supply truck special steel body equipped for carrying spare parts, etc. | Takes place of old battery and store wagon; carries spare parts and supplies for artillery and motor material. | | |
| Reconnaissance car steel body with seats for 12 men and chests for fire-control instruments. | Battery commander's car and also carries fire-control instruments. | White 1-ton truck chassis; speed 50 miles per hour, rear drive only. | 4-cylinder 45-horsepower White motor, 4¼ by 6¾ inches. |
| Light repair truck small steel box body. | Carries carpenters', machinists', and automobile tools and supplies for emergency pair work. | Dodge commercial car chassis speed is about 40 miles per hour. | Standard Dodge engined 4-cylinder, 24 horsepower, 3⅞ by 4½ inch motor. |
| Staff observation car, large size, 9-passenger touring car body. | Used for transport of officers, also instruments and other special work. | White 1-ton truck chassis, 50 miles miles per hour, rear drive only. | 4-cylinder 45-horsepower White motor, 4¼ by 6¾ inches. |

**Steering.**—The steering column and all control levers are mounted on the right side of the driver's seat.

**Clutch.**—The clutch, consisting of 11 steel and 10 bronze V-notched disks running in oil, is bolted to the flywheel as a unit and is provided with a clutch brake.

**Transmission.**—Although cast in one piece, the transmission is made of two sections divided by a cast web to permit a difference in oil levels of these sections. The forward section contains a constant mesh type three-speed transmission gear set, gear shifting being accomplished by shifting dog clutches between the different gears. Power is taken from the main transmission shaft in the rear section through a link belt silent chain drive to the subtransmission, which consists of a large chain spur gear inclosing a hand locking bevel gear differential, in which are mounted the jack shafts which drive the front and rear propeller shafts through universal joints.

**Brakes.**—On the cross channel supporting the rear of the transmission, the service brake is mounted, which consists of a drum supported by the brake skein on two roller bearings, and connected to the transmission shaft by a combined cap and shaft (bolted to the brake drum) and a shaft collar. As this brake acts directly on the duction indicate that it should be considered in any program for rapidly advancing an army over country that has been subjected to the effects of modern warfare.

**Caterpillar attachments for trucks.**—Extensive experiments have been made with caterpillar attachments to replace the wheels of trucks, and it is possible that there is a place for attachments of this type. In general, the results have not been as successful as hoped for, the reason being that important structural changes are necessary in the case of most existing trucks; the increased mobility over that of the four-wheel-drive type of truck is not so great as might be anticipated, and the bearings in the rollers are subjected to such high pressures that their life is short.

**Needs of cross-country mechanical transport.**—In this connection it is interesting to note the following extract from the minutes of the meeting on June 5, 1918, of the inter-allied tank committee.

> General Capper explained that the British commanders were convinced that in order to make a rapid advance the forces must be supplied with some sort of cross-country mechanical transport. Experience had shown that an advance was generally brought to a standstill owing to want of supplies. The importance of having some arrangement to get wheeled transport across country was fully recognized. It was thought that the general question of the supply of cross-country mechanical transport was closely connected with the question of fighting tanks. Gen. Estienne had then rightly remarked that this was a question which belonged to the artillery. But he would point out that all these questions relating to the carriage of infantry and carriage of munitions, supplies, etc., were closely connected, and the more uniform the type of vehicle obtained, the better it would be. He was convinced that no army could be complete, no army could exploit with success, unless it was made independent of roads.

## TRACTORS.

**Two-and-one-half-ton artillery tractor, model 1918.**—The $2\frac{1}{2}$-ton artillery tractor which has been developed by the Ordnance Department is a caterpillar type of tractor, weighing about 5,810 pounds. It has a range of speed from 2 to 12 miles per hour under normal motor speeds. The tractor should normally be run at 7 to 8 miles per hour, but when greater speed is necessitated the tractor may be run at 12 miles per hour for short duration of time over fairly smooth ground. Protection is secured against shrapnel and splinters of shell fragments by the provision of $\frac{1}{4}$-inch armor over motor, radiator, and reserve gasoline tank. The tractor is most satisfactory at high speeds for a caterpillar type, and runs fairly quietly. The track extends sufficiently forward to enable tractor to climb steep banks and shell holes.

**Operation.**—The tractor is easy to operate, and two men ride comfortably on a spring-cushion seat without the aid of straps to hold them in place. The operator may easily crank the motor by rising

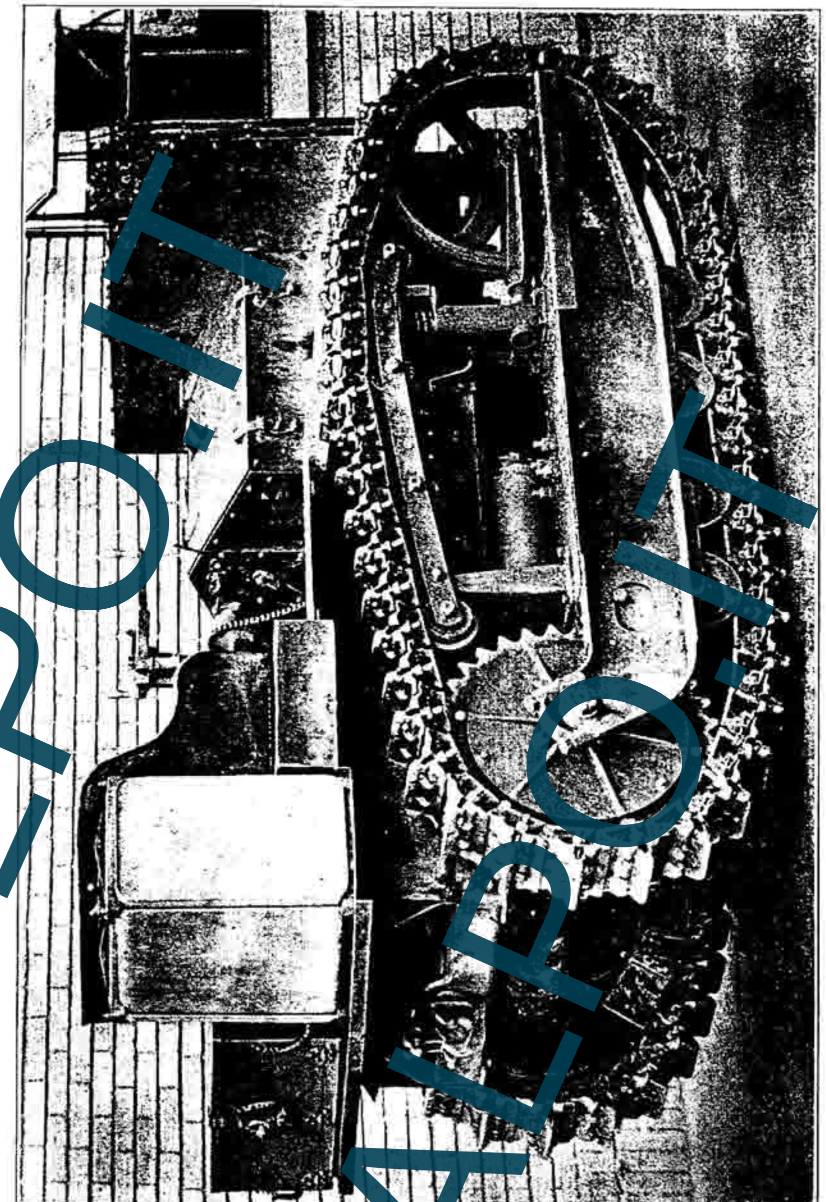


FIG. 178.—$2\frac{1}{2}$-ton artillery tractor.

from his seat and leaning forward sufficiently to grasp a starting device handle. An emergency crank is provided for cranking motor from the front in the usual way. The tractor may be brought into place and hooked to trailed load much quicker than in the case of trucks or the larger tractors.

**Description.**—The main gasoline tank of 20 gallons and standard ordnance tool box are supported at rear of operator's seat. This tank is not armored. Quick detachable grousers are supplied for each track link, and may be carried when not in use in a box compartment under the driver's seat. The track link has 50 per cent surface in contact with ground and will not injure the roads when grousers are removed. The unit ground pressure when truck is sunk 3 inches in mud is 5.4 pounds per square inch. The tractor is supplied with artillery-vehicle equipment tools and oil lamps. Ordnance pintles provide quick hook-up at the rear end and towing hooks are provided at front end.

**Engine.**—The unit power plant, including 8-cylinder engine, clutch, and transmission, is practically the same as used in the Cadillac pleasure car, except minor changes in oiling system, carburetor, and ignition, which are necessitated to enable tractor to ascend grades of 45 degrees without loss of power. The engine is capable of developing 70 B. H. P. at a speed of 2,600 R. P. M. The standard Cadillac ignition has been replaced with a K. W. high-tension magneto with impulse starter attachment.

**Use.**—This tractor is supplied to brigade, regimental, and battalion headquarters of motorized artillery to pull reel and cart. Tractor will easily pull loads of 5,000 pounds. As this tractor has great mobility, sufficient power, and may readily be produced in quantities due to the number of standard parts used, it is proposed to motorize the 75-mm. gun regiments, each tractor releasing a six-horse team, and the manufacture of 5,000 units for this purpose was authorized.

**Five-ton Artillery tractor, model 1917.**—The 5-ton Artillery tractor which has been developed by the Ordnance Department, is a 4-cylinder caterpillar type of tractor, weighing about 9,000 pounds. It has a normal speed range of 1½ to 6 miles per hour. The tractor should be normally run on fair roads at 5 to 6 miles per hour. Protection is secured against shrapnel and splinters of shell by the provision of a ¼-inch armor over the engine, radiator, and reserve gasoline tank. As these pieces are employed with divisional artillery, they must be able to cross temporary pontoon bridges, where the maximum load is usually set at 9,000 pounds. This tractor is the result of extended study, experiments, and tests, and represents the most modern type of mechanical transportation for field artillery.

The tractor is easily operated and has ample room on the seat for two men to ride comfortably. An efficient starting device, easily ac-

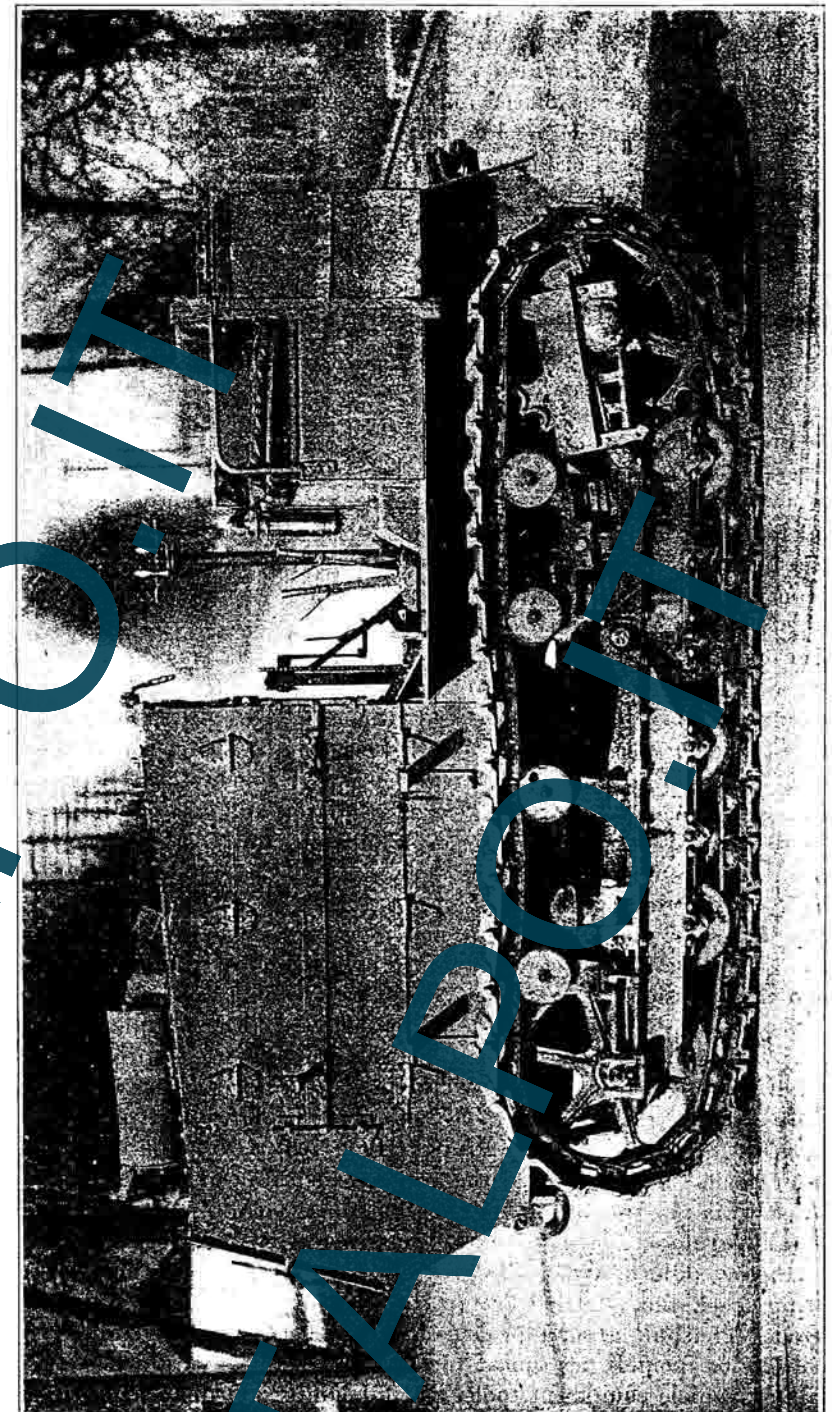


FIG. 179.—5-ton artillery tractor.

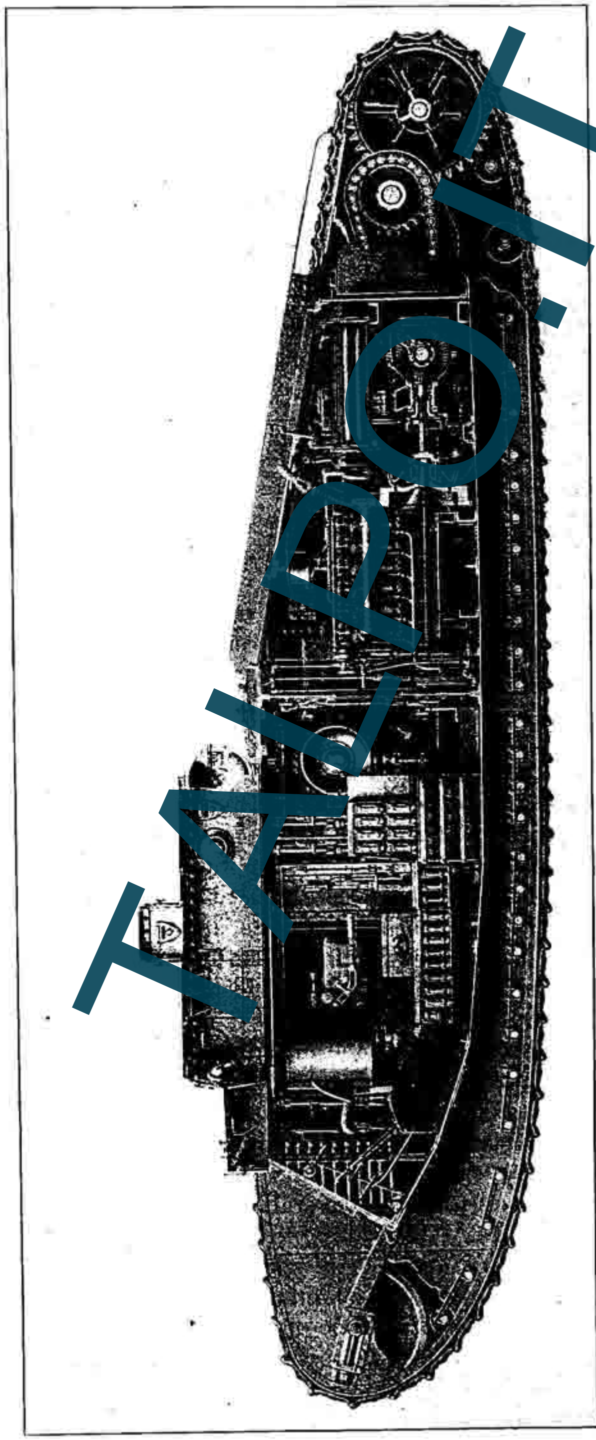


Fig. 183.—U. S. tank, Mark VIII (weight 35 tons, crew 11 men, armament 2 6-pounders, 7 machine guns).





guns, approximately 10 per cent of this being smoke shells. Of the machine-gun ammunition there is carried about 18,000 rounds.

**Personnel.**—The personnel carried by the machine will be 10 men and 1 officer. One of these men is the driver, who operates the machine, while the officer in command directs the movements and in addition can cooperate with other machines of the squadron from the officer's lookout, which is a small turret projecting above the main turret at the top of the tank.

**Power.**—The power in the Mark VIII tank is supplied by a 12-cylinder Liberty tank engine. The cooling is by a copper tube radiator mounted horizontally. Air is drawn into the engine compartment by a large 20-inch Sirocco type fan, which discharges through the radiator and out again through another armored screen.

**Transmission.**—The power from the engine is transmitted through a two-speed epicyclic transmission at the rear of engine compartment. Reverse speed is provided by a shifting dog which throws into operation a bevel gear located on the opposite side of the driving pinion from a forward speed bevel gear. The engine can be disconnected from the epicyclic transmission by a clutch.

**Controls.**—The engagement of the clutch and the shifting of the reverse dog is accomplished by levers mounted at the sides of the driver's seat, which is in the forward part of the tank. The epicyclic bands are operated by two levers, one for either side. These levers work in a gate; when in the inside of the gate a powerful spring pulls the lever and also the epicyclic gears into low speed. When levers are pushed down and outward the spring pulls the epicyclic gears and the lever into high speed, the lever on either side being independent. The track brakes are operated by one foot pedal and when both epicyclic gear levers are in neutral the foot pedal operates on both track brakes, but when epicyclic gear is driving on one side the track brake is prevented from operating on that side by a system of connecting levers in the control.

**Engine room.**—In the design of the machine, the engine room, which contains the engine, transmission, and all fittings incidental to driving the machine, is separate and distinct from the fighting compartment, which contains the turrets, 6-pounder guns, machine guns, and all the personnel. This is separated by a bulkhead, and ventilation is supplied by a small fan independent from the cooling fan, which throws air from the outside through the protected screens discharging into the fighting chamber. Access to the engine room is obtained through three sliding doors, one on either side of a horizontal trapdoor, which gives access to the electrical connections on the engine which would otherwise be rather inaccessible because they are so close to the bulkhead. The general arrangement of the engine room as well as of the fighting compartment is indicated in figure 183.

**Fire control.**—Control of the machine by the commanding officer is accomplished by speaking tubes which lead to the driver and to the 6-pounder gun sponsons. In addition there is a fire-control instrument operated by the commanding officer which directs the fire to a given point for each 6-pounder gun. Cooperation with other tanks can be accomplished by means of a signaling semaphore which is mounted at the back end of the turret. In addition, a few of the tanks (one of each, perhaps) will accompany each squadron of tanks with wireless signaling apparatus of a new type adapted for use in the noise accompanying the operation of a tank.

**Summary.**—To sum up, Mark VIII tank is a 35-foot long machine of the rigid-hull type, weighing approximately 35 tons, carrying two 6-pounder guns and seven machine guns. It is driven by a 300-horsepower engine and a two-speed epicyclic transmission, giving a speed maximum of approximately $5\frac{1}{2}$ miles per hour on level terrain, or approximately 4 miles per hour on average going.

## SIX-TON TANK.

**Model.**—The 6-ton tank, model 1917, is the Americanized Renault. The Renault was designed and first built by the Renault Co. in France. Four sample machines were sent to the United States, the first one arriving on December 1, 1917.

**Plan.**—Standard ordnance drawings were made, keeping the machine a Chinese copy of the French machine, except that all metric measurements were changed to inches and screw threads and gear teeth changed to American practice. An American engine was substituted for the Renault engine, the American engine being the Buda type H. U. with certain modifications of crank case and timing gear to fit the hull of the tractor. The 6-ton tank, Mark II, is practically the same as the model 1917, except that the 6-cylinder Hudson engine is used.

**General character.**—The six-ton tank, model 1917, has no wheels of any sort directly bearing on the ground, but is completely supported and propelled by two endless-chain tracks, one on each side. Each track works on a side frame called a longeron. The track runs on two wheels, one propelling it by means of the engine and the other keeping up the tension and aiding it in the return of the track. Traction is obtained by the lower part of the track being forced into the ground by the weight of the machine, which weight is supported by rollers on the back of the lower part of the track. The axles of these rollers are fixed to two rockers, called the front and rear chariots, placed inside the lower frame of the longeron.

**Front chariot.**—The front chariot has two trains of rollers, each train articulated to it by an axle. The forward train carries three rollers, the rear two rollers. The chariot is attached to the lower

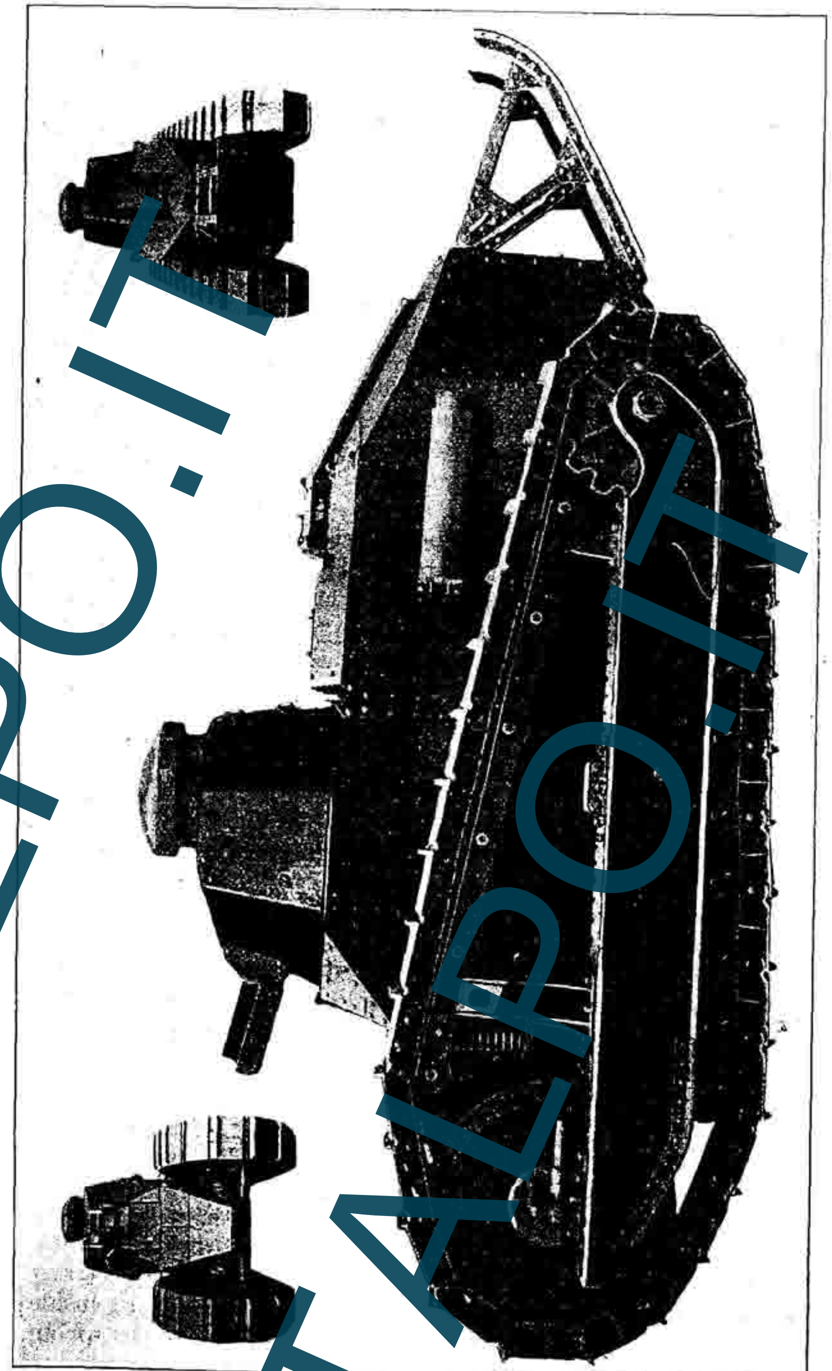


FIG. 181.—U. S. 6-ton tank.

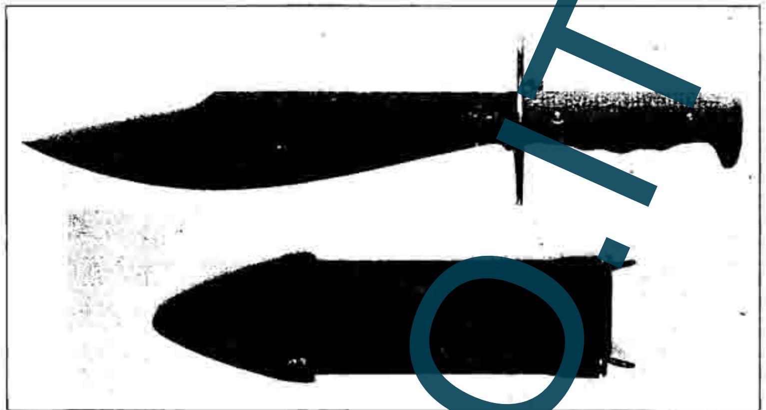


FIG. 186.—Bolo and scabbard.

**Bolos, model of 1917 and model of 1917 C. T.**—The bolo, as issued in the service, is a heavy brush knife, useful for clearing brush, sharpening pegs, or valuable for personal combat in extreme cases. Both models are similar to the model 1910, but lack the scabbard catch. In the model 1917 C. T. the pommel is integral with the tang, and the guard is welded. In the model 1917 the guard is slipped into place from the tang and the pommel is brazed on. Both use the same grips, therefore the grip and spare parts are interchangeable. They are manufactured by Fayette R. Plumb, American Cutlery Co., Bartlett Edge Tool Co., and others.

**Miscellaneous equipment.**—Miscellaneous, personal, horse, and other equipment, aside from weapons and munitions, supplied by the Ordnance Department, comprises many articles which are listed and described in various handbooks such as those in which the nature, construction, and care of infantry and cavalry equipment are discussed. These various articles, however, are so many and so diversified that lists, not to mention descriptions, are out of place in these pages, particularly as many changes were found necessary and desirable in view of developments in European warfare. Special or improved appliances such as trench knives, wire cutters, and other devices were adopted according to new designs of special efficiency to meet special conditions. In much of the new equipment there was a tendency to recognize the shortage of leather and to adopt webbing in its place. One development of the war, however, in which the Ordnance Department was concerned, and which represented entirely new conditions for the United States, was the necessity of manufacturing steel helmets. Experimental work on helmets and armor was carried on from the entrance of the United States into the war, and is discussed briefly in the following pages.



## HELMETS AND BODY ARMOR.

**Value of body armor.**—The protective value of body armor in the recent war, and the advisability of providing certain types of this equipment early were recognized as a subject of considerable importance, and helmets of steel soon became regulation for the forces on the western front. The importance and value of such protective devices were shown by the statement of Gen. Adrian that 80 per cent of the hospital beds were tenanted by men wounded by missiles of low and middle velocities, whom armor might have saved. He further comments: "If I had made my helmets for a hundred instead of a million men, in my experimental lot, I might never have demonstrated their great protective value."

Front. Rear.

FIG. 187.—Light laminated armor.

**Armor experimental work of equipment section.**—The experimental work of the equipment section, engineering division, of the United States Ordnance Department in armor had for its aim the development of whatever body defenses seemed practicable or desirable for modern use. Since the outbreak of the war models of helmets and body armor to the number of 19 were considered. Of this number, 12 are new models from designs furnished by Maj. Dean.

**Types of armor proposed.**—The accompanying diagrams show the types of armor proposed and designed in the equipment section, as follows:

Figure 188.—A light body defense which shall not hamper movement, yet shall be proof against missiles of low and middle velocity, and be so cushioned with sponge rubber as to absorb shock appreciably.

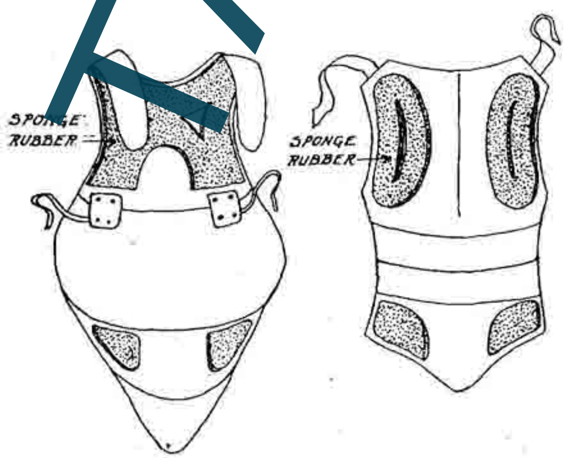



Figure 189.—View of inside of laminated body armor, showing sponge rubber cushions designed and so placed as to absorb shock through contact at points of the bony structure.



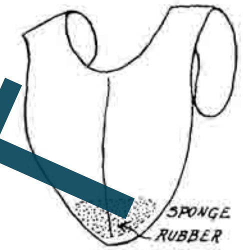



FIG. 190.

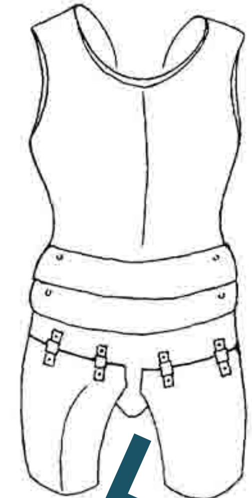


FIG. 191.

Figure 190.—A necklet, weighing 1½ pounds, for the protection of the upper chest, to be worn under the tunic or shirt.

Figure 191.—A body armor for sentinels, designed to protect the wearer from chin to knees, with breastplate proof to a service rifle bullet at 40 yards, 2,750 foot-seconds. The weight of this armor, without thigh guards, is 24½ pounds, but this is evenly distributed.

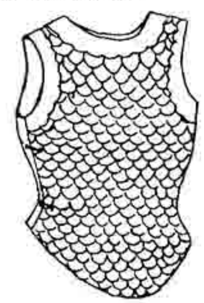


FIG. 192a.

FIG. 192b.

Figure 192 (a–b).—A jazeran, a flexible light body defense, to be worn over or under the tunic, fitting more closely than the device shown in figure 188. Of this three types are proposed, one of which has withstood an automatic pistol shot at 10 feet 800 foot-seconds.

Figure 193.—An eye and face shield, outlined by Dr. Wilmer, weighing 7 ounces, of French helmet steel, rubber cushioned.

FIG. 193.

Figure 194.—A sentinel's or sniper's helmet, designed to protect the wearer from machine-gun fire.


FIG. 194.

**Summary of experiments.**—The helmet and armor project was somewhat modified by evidence obtained abroad by an officer of this section, but by the middle of August, 1918, the equipment section had about completed its series of helmets and body armor, and in nearly every case ballistic examples had been forwarded to headquarters, American Expeditionary Forces. Experimental lots of helmets submitted had been reported upon unfavorably; but it was also stated

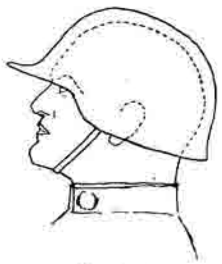


FIG. 195.

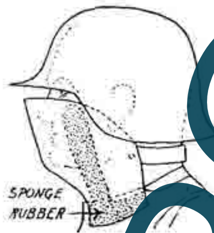



FIG. 196.

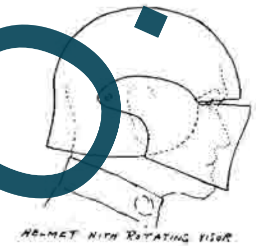



FIG. 197.

Figure 195.—A helmet which will give greater protection to the head than the British model, and shall fit more comfortably as well as be stronger. Developed as helmet No. 5.

Figure 196.—A face guard to be worn with various types of helmet, weighing 1½ pounds and especially designed to withstand heavy shock.

Figure 197.—Helmet with rotating visor.

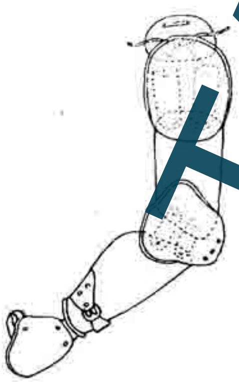


FIG. 198.

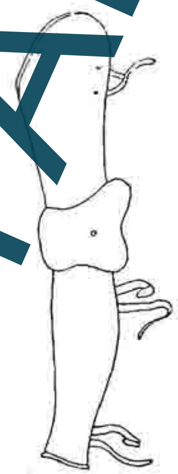


FIG. 199.

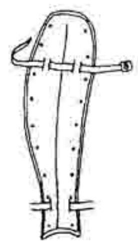


FIG. 200.

Figure 198.—An arm defense to weigh about 3 pounds.

Figure 199.—A complete leg armor, to weigh 4 pounds.

Figure 200.—A shin guard, weight, 1 pound.

(The above three proposed in view of the fact that over 50 per cent of wounds occur on the extremities.)



FIG. 201.—The jazeran as worn under the tunic conforms to the movements of the wearer and protects the vulnerable thoracic cavity.

FIG. 202.—The sentinel's armor is combined with the gun proof helmet for protection against sniper's fire.

FIG. 203.—Helmet No. 5 worn with face guard, showing the small degree of exposure notwithstanding there is perfect freedom of movement.

FIG. 204.—The greater protection afforded by the helmet No. 5 is here shown in contrast with the British Helmet which sits higher on the head. The figure to the right is wearing the British helmet.

that the British helmet in use was unsatisfactory. The experiments included:

(*a*) The preparation of helmets of various models.
(*b*) Face and eye guards of two types.
(*c*) Body defense of six types.
(*d*) Necklet and shoulder guards.
(*e*) Armor for the extremities.

mean 10 times 6,000 or 60,000 master gauges for artillery ammunition. Estimating the cost per gauge at $20, the cost is $1,200,000 for master gauges for artillery ammunition. Perhaps 10 times as many inspection gauges and 20 times this number of working gauges would be required by the manufacturers. Assuming that the inspection and working gauges cost one-third as much as the master gauges, the total cost of gauges for artillery ammunition alone would be $13,000,000.

**Estimates.**—Gauges for cannon, for mobile gun carriages, railway, seacoast carriages, trench warfare material, machine gun small arms, motor equipment, etc., would each cost approximately the same amount, so that a conservative estimate of the amount of money spent for gauges would in round numbers be about $91,000,000. Plainly this is a very rough estimate. The sum might easily reach twice this magnitude indeed, but would hardly fall below it.

**Conference with allies.**—The matter was further complicated by the fact that much of the material ordered had to be interchangeable either with the English or the French, for which tolerances were not always available. By the summer of 1918 tolerances for most of the principal components had been worked out and master gauges provided for them. The number of inspection and working gauges required was naturally greatly increased as production was speeded up.

One of the main obstacles encountered by the allies was the impossibility of securing an adequate supply of gauges of the required accuracy, and this lack was never really overcome. The entrance of the United States into the war only increased the difficulty.

## TYPES OF GAUGES.

**Types of gauges.**—The following paragraphs describe briefly the leading types of gauges employed in the manufacture and test of ordnance.

**Screw-thread gauges.**—To determine whether a screw thread is within limits as to effective diameter and lead, and at the same time to insure that the desired thread form has been maintained, the following gauges are necessary:

A. To test a male thread—

1. A "go" thread ring.
2. A "not go" thread ring.
3. A plain "go" ring.
4. A plain "not go" ring.

1 and 2 are to insure that the pitch or effective diameter are within the specified limits, while 3 and 4 check the tops of the threads.



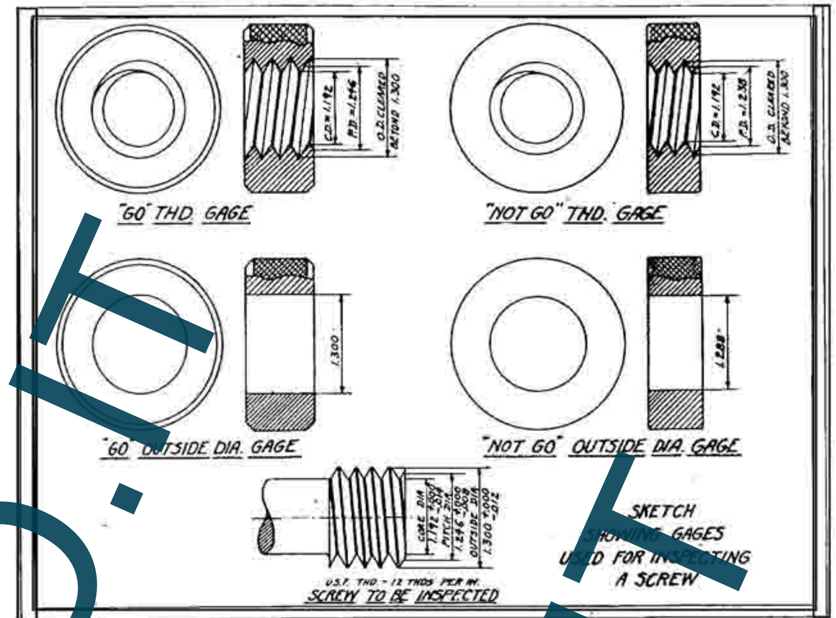



FIG. 216.—Gauges used for inspecting a screw.

B. To test a female thread—

The same number of gauges is required, the only difference being that instead of rings, thread and plain plugs are used.

Gauges made in accordance with the above plan for testing a screw are shown in the diagram above figure 216, while on the following page in a similar diagram, figure 217, are shown a corresponding set for testing a nut.

**Caliper gauges.**—The standard caliper gauges found in the market are carefully hardened and ground, and accurately lapped to size. By their use mistakes in the setting of calipers and variations in measurements by different workmen are in a great measure avoided. The measuring surfaces are amply large to insure accurate measurements and the maintenance of gauge sizes. As furnishing convenient and reliable standard sizes for every-day use in the workshop they are of great advantage, and their use contributes to uniformity in the production of the working parts of the machinery.

These gauges are furnished with both ends finished, one end for internal and the other for external measurements, in sizes to 3 inches. They are also furnished to these sizes with one end only finished and provided with handles, either for internal or for external measurements.

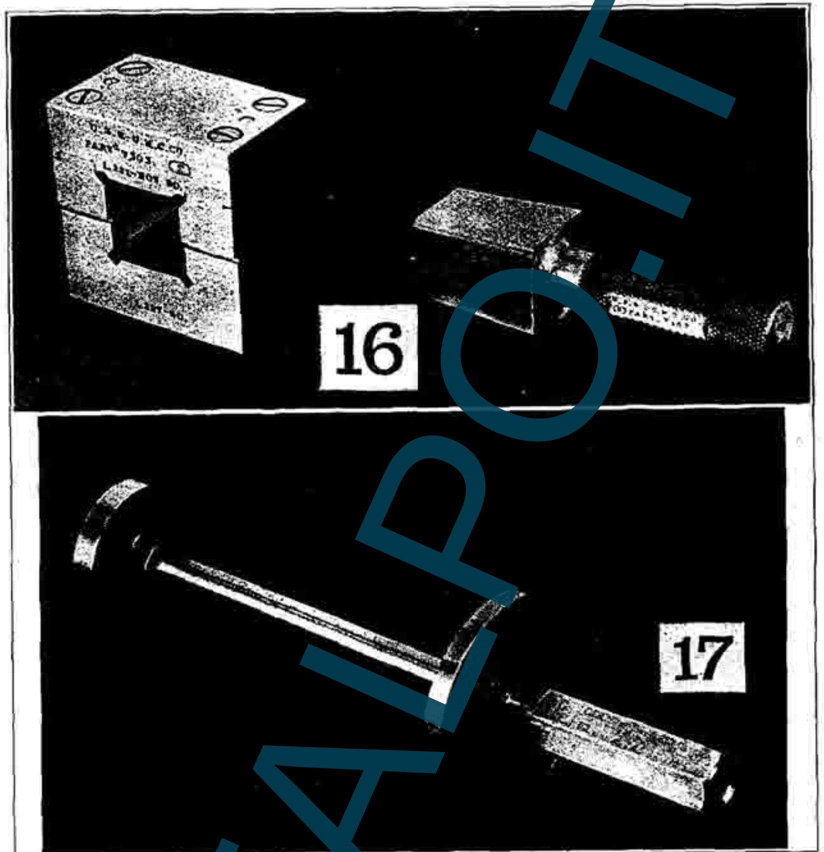



FIG. 220.—Gauges for testing holes or cavities. 16. Square taper gauge and check. 17. Cavity diameter gauge.

and the importance of its general adoption has been persistently urged by the engineering profession. Its universal adoption as the standard of all Government work in the United States and the continental European countries, also by all railroads and practically all the other manufacturing industries in the United States, is largely due to the fact that it is the only form of thread by which interchangeability in manufacturing is possible. This was appreciated by the manufacturers of ordnance in America who were called upon to adopt the various screw threads employed on foreign munitions to American conditions of manufacture.

**A. S. M. E. gauges for machine screws.**—The A. S. M. E. standard, so called to distinguish it from the United States standard thread, is the outcome of the efforts of the American Society of Mechanical Engineers to place the manufacture of machine screws and taps upon a more practical basis. The form of thread is the same as the United States standard.



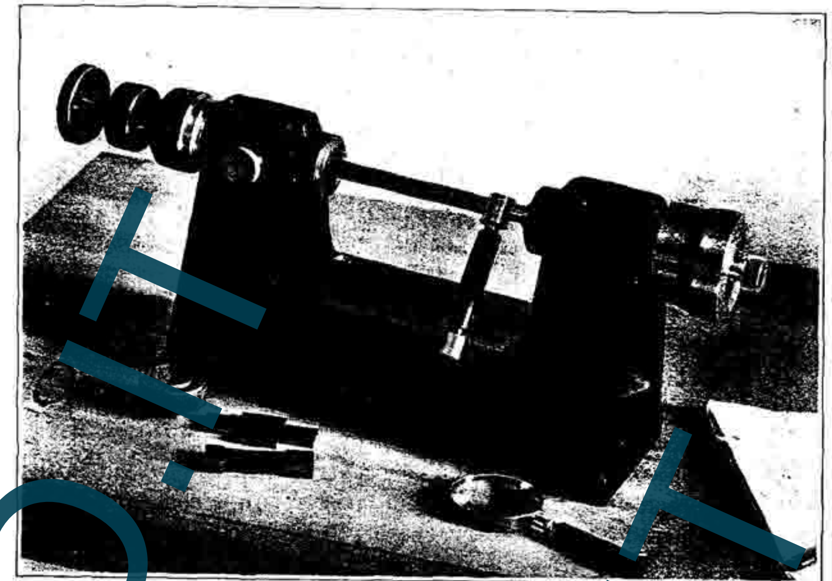


FIG. 221.—Micrometer for testing diameter of plug gauges.

**Thread plug limit gauges.**—The thread plug limit gauges have the minimum or "go" end made longer than the maximum or "not go" end. This not only takes care of the greater amount of wear borne by this end but also helps readily to distinguish it from the other. The gauge ends are inserted in the handle. Threaded ends when worn can be replaced, and, both limits being on the same gauge, there is no danger of their being separated and either plug misplaced.

**Limit snap gauges.**—The limit snap gauge is for testing the diameter of round or cylindrical surfaces, or any external diameter, within specified limits. The first, or upper, pair of contacts is set to the maximum limit. The second, or lower, pair of contacts is set to the minimum limit. The article being measured should pass the first points, but should not pass the second. To provide against wear from long-continued use, the contacts are adjustable by means of set and locking screws. Recesses back of the set screws can be filled with wax with a seal impression on same to prevent tampering.

**Rapid inspection limit gauges.**—The rapid inspection limit gauge is designed especially for rapid inspection of external diameters or sizes. The solid extension jaw facilitates use by guiding same to the measuring points at right angles thereto. For measuring cylindrical work while on the machine it is only necessary to invert the gauge, laying the extension jaw on the work, and sliding the gauge forward.

**Concentricity gauges.**—To determine whether two assembled parts of a component are not eccentric to such extent as to interfere with

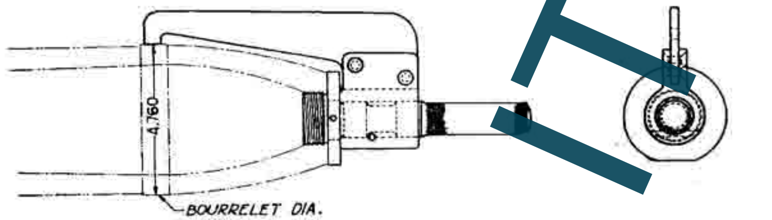



Fig. 222.—Sketch showing type of gauge used to inspect concentricity of fuze thread and bourrelet diameter in shells.

their proper functioning, they are tested with what is termed a concentricity gauge.

A good example of the need of such a gauge is the booster, the exterior thread of which must be sufficiently concentric with the body to insure its entrance into the cavity provided for it in the shell. It is obvious that if the cavity is not concentric with the thread in the nose of the shell and the body of the booster is not concentric with the outside thread on the booster, there will be interference at certain positions as the two are screwed together, provided, of course, that the eccentricity is sufficiently great. The same interference would take place between the interior of the booster and the fuze if the threads involved are not concentric within the certain required limits.

In order to take care of the inevitable lack of concentricity and to divide it between the two parts which may be made by different contractors, the following rule for computing the dimensions of such gauges has been established:

For gauge to check the inner component add 40 per cent of the clearance, viz, the space between the smallest outside component and the largest inside component to the maximum inside part permitted by the tolerance.

For gauge to check the cavity dimensions subtract 40 per cent of the clearance from the minimum dimension of the cavity.

The gauge for the inner component will be a chamber gauge, while the gauge to check the cavity will be a plug gauge.

The above distribution of clearance is entirely arbitrary and is not always adhered to. If the relative difficulty of manufacturing one component is much greater than that of the other, the distribution of the clearance between the gauges for the two components should be such as to take care of this condition.

An example of the foregoing method of computing the dimensions of concentricity gauges is shown on the following sketch. The maximum dimension of the inner component can be 1.235+0.005=1.24. The minimum dimension of the outer component is 1.29. The difference between them is 0.05, and 40 per cent of this is 0.02.



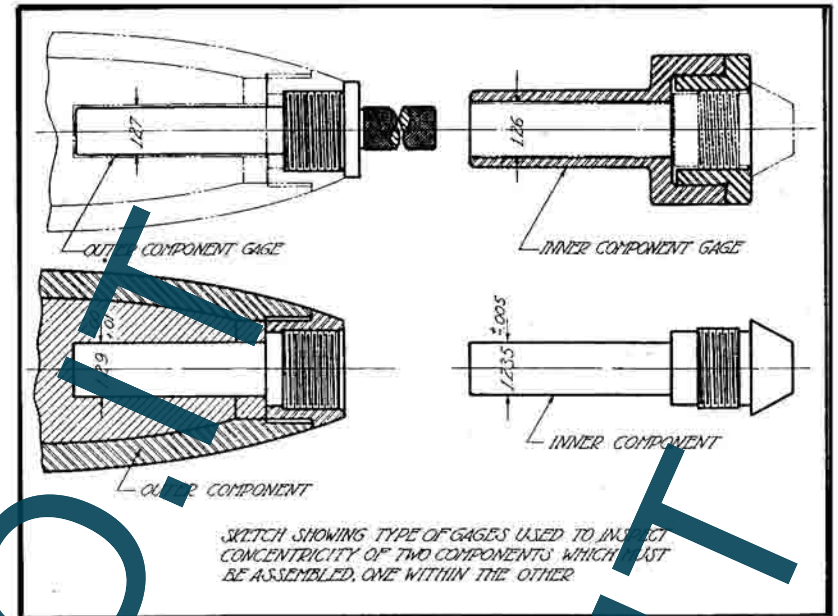



Fig. 223.—Concentricity gauges.

According to the above rule, therefore, 0.02 should be added to the maximum inside component, which is 1.24, making it 1.26 for the gauge to test the inner component, and the same quantity should be subtracted from the minimum dimension of the outside component, which is 1.29, making it 1.27, to obtain the dimension for the gauge for the outer component. The diagram above figure 223, shows the concentricity gauges for both inner and outer components of a booster casing and shell.

**Commission for standardizing of screw threads.**—An act (H. R. 10852) to provide for the appointment of a commission to standardize screw threads was passed by Congress July 13, 1918, and received the signature of the President.

**Purpose.**—The purpose of the commission was to ascertain and establish standards of screw threads for acceptance and adoption in manufacturing plants under control of the War and Navy Departments, as far as practicable, for screw threads in general use throughout the United States.

**Organization.**—Nine commissioners were appointed, one of whom was the director of the Bureau of Standards, who acted chairman of the commission; two commissioned officers of the Army, appointed by the Secretary of war; two commissioned officers of the Navy, appointed by the Secretary of the Navy; and four appointed by the Secretary of Commerce, two of whom were chosen from nominations made by the American Society of Mechanical Engineers and two

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