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HANDBOOK OF THE
3.2-INCH FIELD BATTERY

WITH INSTRUCTIONS FOR ITS CARE

(TWENTY PLATES)

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By order of the Secretary of War:

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HANDBOOK OF THE 3.2-INCH FIELD BATTERY.

EQUIPMENT OF BATTERY.

The equipment of the battery is as follows:

4 3.2-inch guns.
4 3.2-inch carriages and limbers for same.
8 3.2-inch caissons and limbers for same.
1 forge and battery wagon.
1 store wagon.
29 sets of harness, artillery, lead.
15 sets of harness, artillery, wheel.

THE 3.2-INCH FIELD GUN.

The 3.2-inch gun is a breech-loader, weighing, approximately, 830 pounds, intended for use in the field with troops moving rapidly. There are two principal forms: First, the model of 1885, composed of the tube, jacket, trunnion hoop, sleeve, key ring, locking ring, base ring or breech bushing, vent bushing, and breech mechanism; second, the models of 1890 and 1897, in which the body of the gun is composed of only two principal forgings, the tube and the jacket, the latter bearing the trunnions.

The model of 1885 is of the breech-insertion pattern, in which, in manufacture, the tube is inserted into the jacket through the breech, abutting against a shoulder in the jacket. In it the breechblock engages in a breech bushing, which transmits the longitudinal stress to the jacket.

In the 1890 and 1897 models the guns are constructed by muzzle insertion, in which the tube is entered from the front, and the shoulder in the jacket is in front of the trunnions. The breeckblock engages directly in the jacket without the intervention of a bushing.

The model of 1897 gun follows the lines of the model of 1890 with the exception of the powder chamber. This, in the model of 1885 and 1890 guns, was for black powder. In the model of 1897 the powder chamber has been made less than half the capacity of the earlier models, for the accommodation of smokeless powder. All the model of 1890 guns have been altered by the insertion of a lining tube, to conform to this model of powder chamber.

The principal parts of the breech mechanism are: The breech-block, block carrier, obturator, lever handle, block handle, and vent cover.

The principal parts of the breechblock are: The three-threaded sectors, three-slotted sectors, spindle recess, lever-handle lugs, nose, stop groove, latch groove, locking recess, and guide groove.

The threaded and slotted sectors permit the entry of the block past the corresponding sectors in the block recess. The block is locked in its seat by a revolution of 60 degrees about its longitudinal axis.

In the assembled block the spindle recess contains the stem of the spindle with its spring and nut.

The lever handle is mounted between the lever-handle lugs upon the lever-handle pin, which passes through the lugs. On the right lug is a shoulder, which forms a stop, against which a corresponding shoulder of the lever-handle pin abuts, thus limiting the motion of the lever handle.

The nose is the front part of the block where it is reduced in diameter to allow of its partial entry into the gas-check seat. This also leaves a recess in which fouling may collect without stopping the working of the block.

The stop groove is a longitudinal groove on the left-hand side, in which the stop on the block carrier moves, and by which the rear motion of the block is limited. It also has a circular branch, the end of which limits the motion of rotation.

The latch groove is in two parts, one longitudinal in one of the slotted sectors of the block, and the other circular in the rear portion. The front end of the groove terminates in a well, called the locking recess, into which the inner end of the latch bolt drops when the block is withdrawn, thus bolting it positively to the carrier ring.

The guide groove is a circular recess in rear of the threaded sectors of the block, in which the guide sectors engage when the block is rotated.

The principal parts of the block carrier are: Guide sectors, latch cover, latch bolt, latch spring, stop, hinge pin, exterior taper, and lugs.

The guide sectors are three projections from the interior of the carrier which fit in the corresponding slotted sectors in the breech-block, and guide and support the latter in its motion through the carrier. Ventholes are drilled through these to allow the air to escape when the breech is closed.

The latch cover is a separate piece, screwed to the carrier by two screws, by which the latch bolt and latch spring are protected and retained in their seats. It is assembled from the rear in order that,

by the removal of the two latch-cover screws, the latch and spring may be taken out while breech is closed.

The latch bolt is a locking device for the block carrier. It fits in a mortise in the same, and is actuated by a spiral spring which pushes it toward the center of the ring. Its inner end slides in the latch groove until it reaches, in closing the breech, the end of the circular branch, and in its rear motion, in opening the breech, the well at the end of the longitudinal branch; in order to reduce wear a hardened-steel pallet is inserted in the breechblock, so as to form one wall of the well at the end of the longitudinal branch of the latch groove. In either case the spring thrusts the latch bolt toward the center of the carrier, which is unlocked from its seat when the latch reaches these positions. When the breech is closed, the breechblock holds the carrier in place without requiring aid from the latch. When the carrier is unlocked in opening the breech, the block is securely bolted into it by the action of the latch, and is firmly supported while being revolved to the side. At every point between the recesses at the ends of the latch groove, the head of the latch bolt projects into the recess in the jacket and fastens the carrier to its seat. In the front face of the latch bolt there is a beveled recess into which fits a conical hardened-steel stud projecting from the face of the block-carrier seat. When the block carrier is swung into its seat, this stud, passing through a hole in the front face of the block carrier, bears against the beveled surface above mentioned in the latch bolt, and thus lifts it out of the well at the end of its groove.

The latch spring is a spiral spring compressed between a shoulder on the latch bolt and one on the latch cover; it is designed to thrust the latch bolt toward the axis of the block carrier.

The stop is a small plate on the left-hand side of the block carrier, assembled from the front by a stop screw and projecting beyond the bore of the block carrier into the stop groove. It is designed to limit the longitudinal and rotary motions of the block.

The hinge pin is mounted on the left side. It passes through the two lugs on the block carrier and a lug on the jacket. It is secured in place by two small screws passing horizontally through the block-carrier lugs into the hinge pin, perpendicular to the axis of the bore.

The exterior taper is the conical surface of contact of the block carrier in the jacket.

The lugs are ears projecting from the block carrier in which the hinge pin has its bearing.

The obturator is composed of the following parts: The spindle, front and rear exterior split rings, interior split ring, gas-check pad, filling-in disk, spindle nut, spring and spline screw.

The object of the obturator is to prevent the escape of gas from the powder chamber to the rear during firing, and to transmit to

the breechblock the stress of firing resulting from the pressure of gases upon the bottom of the bore.

The spindle is mounted in the block in the spindle recess through which its stem extends. The rear end of the stem is threaded for the spindle nut, while the front end is enlarged into a mushroom-shaped head, which forms the bottom of the bore.

The split rings are of steel, accurately finished, and split diagonally through one side. The exterior ones are made of slightly greater diameter than the conical gas-check seat in the gun, and are sprung into place. The interior one is slightly smaller than its seat on the spindle. The filling-in disk is a steel washer interposed between the gas-checking device and the front face of the breechblock. A slight shoulder on the rear face of the mushroom head supports and centers the front split ring. The rear split ring is similarly held by an offset on the front face of the filling-in disk.

The gas-check pad is a disk of asbestos and tallow, compressed under heavy pressure, and covered with canvas. It forms a yielding medium for the transmission of pressure to the block. Under the pressure of firing, the plastic nature of the pad causes it to press outward toward the gas-check seat, and inward against the spindle, forcing the split rings firmly against their seats and completely stopping the passage of gas.

The spring is of steel and surrounds the rear end of the stem, being compressed between the nut and the shoulder in the spindle recess, thus serving to take up any excess of length of the spindle due to compression of the pad.

The spindle nut is screwed on the rear end of the stem and holds the spindle in its position in the block.

The spline screw, with its seat partly in the nut and partly in the spindle stem, prevents unscrewing of the nut.

The lever handle is mounted between the lugs of the breechblock, from which it hangs vertically, when the block is closed. Its upper end has, projecting from its front face, a curved surface, which acts as a cam to force back the block and obturator after rotation, when the latter sticks in its seat from firing. A hardened-steel pallet is riveted in the seat of this cam to protect it from wear. In later models this hardened-steel pallet has been lengthened to extend through the guide sectors of the carrier ring and the central air vent through the sector has been omitted. The cam also serves to lock the block in the carrier ring, preventing its rotation during firing. The lever-handle pin passes through an eye in the upper end of the lever. It is the axis of rotation of the lever, with bearings in the breechblock lugs.

The block handle is attached to the base of the block by two screws. It is designed to assist in moving the block, especially in entering and withdrawing it.

In guns prior to the model of 1890 the vent is radial. The vent cover is a sliding bolt, mounted under a protecting cover on top of the gun. It is operated by lugs on the lever head, so as to be thrust into a hole in the rear face of the vent-bushing head when the lever is raised, and to be withdrawn when the lever is depressed after the breech is closed and the block rotated to its locked position.

In the 1890 and 1897 models the vent is axial. It is situated in the axis of the obturator spindle. A copper bushing in the face of the obturator head is provided for the protection of the vent and to enable repairs to be easily made. This bushing is now threaded at each end to prevent its being blown out. In early models it was simply driven into place or threaded at rear end only. The vent cover is an arm mounted in a guide way in the rear face of the block, with a dovetail housing secured by a screw over the guide way. A stud projecting from the upper front face of this arm travels in a slot way in the rear face of the carrier ring. When the block is rotated into its unlocked position the vent cover hangs vertically over the mouth of the vent, where it remains till, by the rotation of the block into its locked position, it is lifted from over the vent by the outward curvature of the slot way.

The action of the breech mechanism is as follows:

To Open the Breech.—Seize the lever with the left hand, thumb down, and raise it as high as possible to release it from the safety notch, then turn it to the left until the block strikes the stop, at which time the threaded sections of the block are opposite the planed sections of the seat; the breechblock handle is then grasped with the right hand, back down, the block is drawn out and swung to the left to clear the bore.

(*Note.*—If the block sticks and can not be drawn by the right hand, press the lever down with the left hand, and, as the cam is no longer opposite the safety notch, it will bear against the face of the block carrier and start the block to the rear.)

To Close and Lock the Breech.—Seize the lever with the left hand, raising it as high as possible, grasp the breechblock handle with the right hand, back down, and swing the block gently around, keeping the lever extended as in opening, and push the block into its place; then turn the lever to the right until it will fall into its place with a very slight pressure; see that the end of the lever engages in the slot. Never attempt to force the lever down; if it does not move comparatively freely, the breechblock is not in place and

requires to be moved still farther to the right. When the guns are new the lever is apt to move a little stiffly and will not fall freely.

(*Note.*—The latch is an auxiliary but not an absolutely essential part of the breech mechanism, as the gun may be fired safely without it. If the latch should fail to work, it may be removed by taking off the latch cover, a screw-driver being provided for this purpose. This should never be done except when necessary. In firing without the latch, care must be taken not to attempt to push the block home until its axis is in line with the axis of the gun. In opening the block, the block carrier must be held in place by hand until the block is withdrawn to the stop.)

SUBCALIBER TUBES AND FITTINGS FOR 3.2-INCH GUN.

There are issued to each battery of light artillery three subcaliber tubes (caliber .30 gun) and complete set of fittings.

A set of subcaliber fittings is composed of the following:

1 breech plate.
1 breech-plate sleeve.
3 breech-plate screws.
3 breech-plate screw washers.
1 muzzle sleeve.
1 muzzle rest.
2 muzzle-rest screws.
2 muzzle-rest pins.
1 muzzle spring.
1 muzzle-spring screw.
1 muzzle-spring pin.
3 connecting rods.
3 connecting-rod screws, front.
3 connecting-rod screws, rear.
2 recoil arms.
2 recoil-arm screws.
1 recoil-arm bolt.
1 recoil-arm nut.
1 recoil stirrup.
1 recoil-stirrup pin.
1 recoil-stirrup shoe.
1 recoil-stirrup shoe pin.
2 recoil-stirrup screws.
1 yoke.
1 yoke hinge.
1 yoke-hinge pin.
1 yoke plate.
4 yoke-plate screws.
1 yoke binding screw.
1 binder.
1 lock screw.
1 butt-binding screw.
1 butt-binding screw pin.

The following spare parts for subcaliber tube attachments are issued:

Spare parts for subcaliber tubes (caliber .30 gun) and attachments:

[One year's supply—all expendable.]

1 bolt, model of 1898.
1 carrier, model of 1898.
1 cut-off, model of 1898, complete.
1 ejector.
1 ejector pin.
1 extractor, complete.
1 extractor pin.
1 extractor rivet.
1 extractor spring.
1 firing pin, assembled.
1 follower.
1 follower pin.
1 gate, model of 1898.
1 hinge bar, complete.
2 magazine springs.
1 mainspring, model of 1898.
1 safety lock, complete.
1 sear.
1 sear spring.
1 side plate, model of 1898.
1 side-plate screw.
1 sleeve.
1 striker.
1 trigger.
1 trigger pin.

With the old pattern attachment (gun with stock) there is also issued "1 recoil-arm screw," and with the later pattern attachment (gun without stock) "1 extra thumb screw." There is also issued with each set of spare parts 1 wrench for each set of subcaliber fittings.

TO DISMOUNT THE MECHANISM.

Unscrew vent-cover screw and remove housing. This leaves the vent cover free to be taken out.

Unscrew latch-cover screws and latch cover; latch bolt and latch spring may then be removed.

Take out spline screw, withdraw block and swing to one side.

Remove spindle nut and spring. The spindle with the split rings, pad, and filling-in disk may then be taken from the block.

Remove hinge screws and drive hinge pin out with a copper drift.

Remove block and carrier from the gun.

Unscrew stop screw and place extractor for stop in block carrier, with legs resting on carrier between the hinge lugs. Screw extractor-screw bolt into threaded hole in the end of stop until the latter is drawn far enough from its seat to clear stop groove in breechblock. Block is then free to be withdrawn from the carrier. In using the extractor care should be taken to have its legs rest entirely on the block carrier, and not overlap the end of the stop bolt.

Ordinarily no further dismounting of the parts will be required, and the lever-handle screw has its head upset so that it can not be removed except with difficulty.

TO ASSEMBLE THE MECHANISM.

The converse of the above instructions is followed in mounting the breech mechanism on the gun.

ARTICLES CARRIED ON EACH GUN.

The following articles are carried on each gun:

1 breech cover.
1 tompion and muzzle cover.

CARRIAGE FOR 3.2-INCH GUN.

The 3.2-inch gun is mounted on a carriage entirely of metal, excepting the spokes and fellies of the wheels and the trail handspike. The principal parts are the axle, axle plates, wheels, flasks, brakes, and elevating apparatus.

In the carriage now in service the axle is solid, 3 inches in diameter, and of circular cross section.

The spindles have a set so that the bottom line is parallel to the axis of the axle.

The shoulders are forged upon the axle, and have the brake-eye straps shrunk upon them. The brake-eye straps have a lug on each side which is slotted to pass over the ends of the axle plates and thus to prevent the axles from turning on the axle plates.

In the old carriages the linchpin is a $\frac{5}{8}$-inch eye pin, but in the later models it has been enlarged, and it now has a rectangular cross section $\frac{5}{8}$ by $1\frac{1}{4}$ inches, rounded at the corners. It has a hook catch mounted on a $\frac{1}{4}$-inch rivet through the eye, which is designed to be passed around and under the spindle after the linchpin is in its seat. The latest model has the rectangular cross section, $\frac{5}{8}$ inch by $1\frac{1}{4}$ inches, rounded at the corners, but is slotted crosswise, the end and part way up the body of pin to allow the insertion of a linchpin spring $\frac{1}{2}$ inch wide, which is riveted at one end. When putting pin in axle spring will close within pin and when in place will catch and retain pin in axle. Between the linchpin and the end of the nave is a $\frac{3}{8}$-inch metal washer backed by a leather washer. The metal washer has on the outside a $\frac{1}{2}$-inch stop pin which, by bearing against the linchpin, prevents rotation of the washer.

The axle plates, one above and one below the axle, to which they are fitted, are of $\frac{7}{8}$-inch steel plates, riveted together by $\frac{5}{8}$-inch rivet. These plates extend $13\frac{1}{2}$ inches in rear of the axis of the axle and $5\frac{1}{2}$ inches to the front.

The wheels are of the Archibald pattern, $57\frac{3}{4}$ inches in diameter. The wheels for limber, caisson, forge and battery wagon, and store wagon are of the same size and model, but lighter in weight. They should never be used on the carriage. All spare wheels issued may be used on the carriage as well as on the other artillery vehicles, as they are of the heavier pattern.

The flasks are each built-up I beams, made of two thicknesses of 0.2-inch rolled steel plate, with strengthening flanges on the edges, nearly circular in cross section, forming the top and bottom of the I. This circular flange is formed by a semicircular corrugation in each. The outer-plate flange extends beyond the circle, and tangent thereto on the bottom; also on the top as far forward as the front of the trail box. These plates are fastened together by $\frac{5}{8}$-inch rivets. The assembling transom bolt, which is a $\frac{3}{4}$-inch bolt in front of and below the trunnion beds, is the only bolt that connects the flasks. All other bolts and nuts in the flask are for the purpose of assembling the various attachments to the carriage.

The two flasks are united by the transoms, the axle plates (to which they are bolted), and the lunette plate. The lunette, which combines both trail and lunette plates, is a single forging and is fas-

tened to the flasks by ten $\frac{5}{8}$-inch rivets and four $\frac{5}{8}$-inch bolts, the latter passing through the handspike attachments as well as the lunette and flask plates.

The handspike socket is attached to the lunette by the front and rear handspike attachments, which are two ear plates, each attached to the trail plate by three $\frac{5}{8}$-inch bolts, the two outer ones passing through the ear plates, trail plate, and upper flanges of the outer flask plates, and the middle bolt from below through the trail plate and attachment.

The front attachment has passing through its ears a pin secured by a split key. The rear attachment plate has through its ears a $\frac{9}{16}$-inch square pin, riveted.

The trail handspike is of wood, circular in cross section, split longitudinally, with a 0.1-inch steel plate inserted between the wood sections. These parts are assembled by six rivets perpendicular to this plate, two of which pass through assembling bands, three have washers under their heads, and one passes through a metal ferrule on the small end of the handspike. The large end of the handspike fits into the socket, by which it is attached to the trail. It is held in this socket by a $\frac{1}{4}$-inch steel pin through the socket from side to side and filed flush with the surface. The front end of this socket terminates in a web, in which there is an elongated eye, through which the front attachment passes. From the rear underside of the socket extends a second web, terminating in a square hook, which engages under the rear attachment pin. The front eyehole is sufficiently elongated to permit of the hook being disengaged from the pin by drawing the handspike to the rear, and allows of its being revolved to the front, resting, when not in use, upon the top of the trail, where it is secured by the handspike clasp, mounted on the elevating screw crank, on carriages fitted with lazy-tongs and on a bracket riveted to the front trail-box transom, on carriages fitted with the double-screw elevating mechanism.

The trail handles are each riveted to the flasks by two rivets.

There are five transoms between the flasks—rear transom, two trail-box transoms (front and rear), one middle transom, and one front transom.

The rear transom, of 0.2-inch steel plate, is about 23$\frac{1}{4}$ inches from the rear end of the lunette plate. It is perpendicular to the bottom line of the flasks, and riveted to each of them by two rivets passing through side flanges bent to the rear.

The rear trail-box transom, of steel plate, is 3 feet from the end of the lunette, perpendicular to the bottom line of the flasks. It is riveted to each of them by two rivets through side flanges bent to the front. A top flange bent to the front offers a rear support for the trail-box lid. A steel plate fitted to the flasks between the rear

transom and the rear trail-box transom serves as a bottom to the sponge-bucket compartment.

The front trail-box transom is 30 inches in rear of the axle. It is perpendicular to the bottom line of the flasks and is secured to each of them by two rivets through side flanges bent to the rear. The bottom plate rests on the bottom flanges of the outer flask plates. The lid of the trail box is of steel hinged transversely, and is secured by a hinged hasp riveted to the lid, passing over a turnbuckle stud on the rear trail-box transom. Its hinge plate is riveted to the top flange of the front trail-box transom. A plate 0.1 inch thick is placed on lower end of flasks to form an extra compartment.

The middle transom, perpendicular to the bottom line of the flasks, is secured to each of them by two bolts passing through flanges bent to the rear, with nuts on the inside. There is also a bottom flange bent to the rear through which the eyebolts for the elevating apparatus pass. There are two holes, 2 inches in diameter, through this transom for the short sponge and rammer staves.

The front transom is of steel plate parallel to the bottom line of the flasks. It is in two levels, the lower level being bolted to the axle plate in front of the axle and the upper one passing over the axle. It is bolted to the axle plates by four bolts, two of which pass through the short sponge and rammer attachment. It is also bolted through two upturned flanges to each of the flasks by two bolts passing through the two flask plates, the front transom, and the axle-seat plate.

Each of the trunnion pieces is of forged steel $2\frac{1}{8}$ inches thick, assembled between the outer and inner flask plates by six through rivets. They are shaped to the trunnions, which are retained in place by the cap squares. The latter fit over the front and rear eyebolts, to which they are held by two keys secured by rings to the ends of a double key chain, running from a central ring brazed in an eye pin, screwed in the outer face of the cap square at its central point.

The rear arm of the cap square is $1\frac{1}{2}$ inches above the front arm. Below the trunnion beds, and a little in front of the axis of the trunnions, is an assembling transom bolt connecting the flasks.

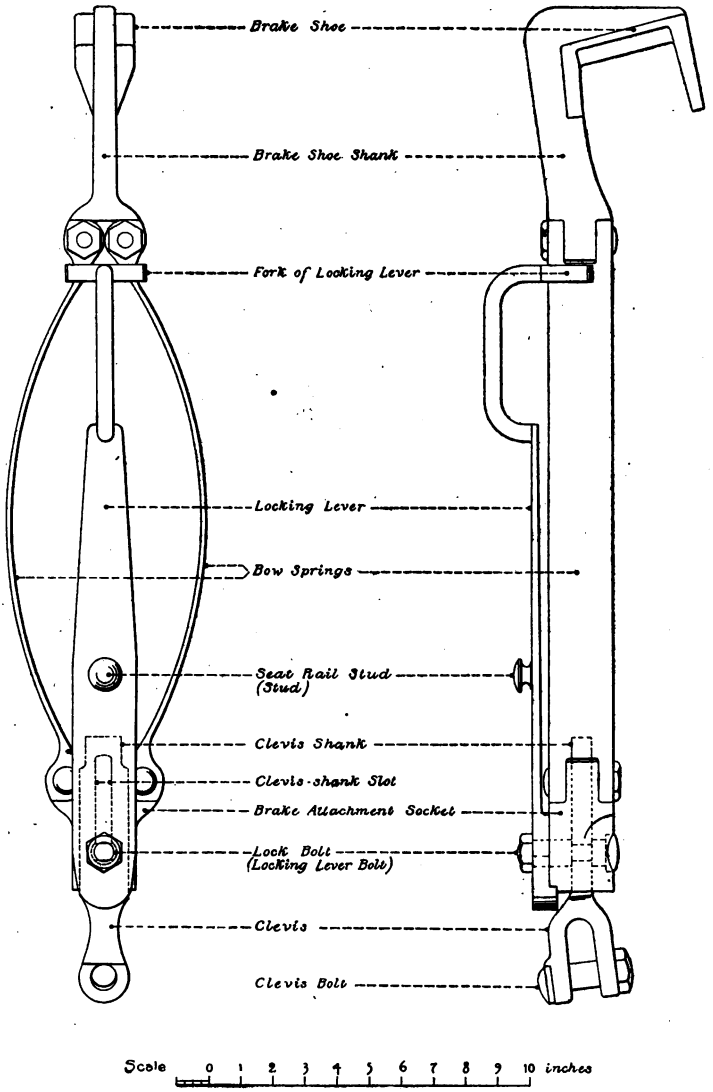
A piece of piping mounted upon this bolt is fitted between the flasks as a separator.

On each side of the flasks, between them and the wheels, is an axle seat for a cannoneer, made of 0.1-inch steel plate. A flange bent downward on the inner end is bolted to the flasks by the two front-transom flask bolts and by one bolt of the middle transoms.

A flange bent downward at the outer end is slotted to fit the axle plates, front and rear, and is stiffened by the seat standards and reenforces, which are plates riveted to its outer edges, terminating in standards for the guard rail.

The latter is a round bar bent to the form of a seat arm. Its front end terminates in an eye, which fits between ears on the end of the front standard. It is secured in this seat by the seat-rail hinge pin, whose nut is riveted on. The guard rail may be turned in a vertical

PLATE III.



plane about this rivet as an axis. Its other end is slotted so as to pass over the squared section of the latch shaft, on the inner end of which is riveted the seat-rail latch thumb piece. When the latch shaft is turned by the thumb piece until it bears in its circular seat the rail is secured in position.

THE BRAKE.

There are two brakes, one for each wheel.

The brake consists of two bow springs with their concave sides toward each other, assembled at one end to the brake-attachment socket by two bolts passing through the ears of the socket. The other ends of the spring are bolted by two bolts to the brake shoe, which is designed to fit over the tire. The socket is bolted to the shank end of the clevis by the locking-lever bolt. One section of the latter is squared so that it can work, when desired, in an elongated slot in the shank of the clevis. The U end of the clevis fits over the eye lug on the brake eye strap and is bolted to it by a $\frac{1}{8}$-inch clevis bolt.

There is also mounted on the locking-lever bolt of the attachment socket the inner end of a locking lever. The other end, terminating in a fork, passes over the bow springs near their union with the brake shoe. This lever is used to turn the locking bolt so that when its flattened section is brought opposite the slot in the clevis shank the brake may be elongated nearly the length of the slot.

When the locking lever is parallel to the axis of the brake, and its front fork is over the bow springs, the bolt is held in the round hole at the clevis end of the slot. The brake then has its shortest length and is in condition to be used either as a recoil or a traveling brake. By putting it over the wheel, to the rear, it may also be used as a mud scraper on the march. When so used it should be secured by a cord or wire, fastened to the brake shoe at one end and to the standard below the axle seat at the other, to prevent its being carried over the wheel to the front.

When the lever is turned up perpendicular to the axis of the brake the squared section of the bolt is then in the clevis-shank slot, and the brake, if on the wheel in use as a road brake, will be thrown by the tension on the springs to the front, free from the wheel, and by continuing the motion of the lever to the rear (the cannoneer on the axle seat operating it), the brake may be brought up vertical, dropped down again on the clevis, and the locking lever brought forward and secured in its position parallel to the axis of the brake.

The stud, riveted on the back of the lever near its lower end, serves to hold the brake vertical when not in use; this stud, at such time, is held in a recess on the underside of the guard rail.

LAZY-TONGS ELEVATING DEVICE.

[Plate IV.]

The elevating device on all carriages up to the model of 1897 consists of a lazy-tongs system of levers actuated by an elevating screw

operated by a crank. It is located between the flasks, in front of the trail box and in rear of the middle transom.

The double lazy-tongs system is formed of two equal and parallel ones, like parts of each having bearings at the ends of the same assembling bolts. Each system is composed of two similar oblique equilateral parallelograms, having one common vertex and having two corresponding sides in prolongation of each other. The union of the two parallelograms is made by a ¾-inch central bolt journaled in two independent side levers outside of the lazy tongs and parallel thereto.

The forward ends of these side levers are mounted on the side-lever journal rod, which has its end bearings in the two eyebolts passing through the bottom flanges of the middle transom and flasks and through the axle plates. The rear ends of the side levers are supported by journals projecting from the aluminum-bronze crosshead elevating nut, which travels on the elevating screw. These journals rest in two crosshead slides working in grooves on the inner side of the side levers. A ¾-inch transom bolt in front of this nut prevents the side levers from spreading.

The elevating screw is supported top and bottom by two brackets bolted by ⅝-inch bolts on the front side of the front trail-box transom, midway between the flasks. A nut is screwed on the lower end of the elevating screw below the lower bracket, and is secured by a stay pin.

The crank is mounted on the upper end of the elevating screw. It has a 3½-inch lever arm terminating in a handle.

The clasp for securing the handspike is mounted on the crank. It serves the double purpose of retaining the handspike and of preventing the elevating screw from rotating when on the march.

The upper parallelogram of the lazy tongs has its sides twice the length of those of the lower. The sides meeting in the common vertex are prolongations of each other and constituted by the same bar. The remaining sides of the parallelograms terminate at the gun and at the fixed point of the system A, at the bottom of the trail. (See Pl. IV.)

At the fixed point A the arms of the parallelogram are journaled on a rod whose ends are supported in the lower journal boxes; these boxes are bored in bronze brackets that are bolted to the inner sides of the flasks.

The union of the ends of the long arm, constituting the upper vertex of the larger parallelogram, is made by the upper assembling bolt, which also supports the breech-strap eye washers. A leather strap through these washers passes over the gun and holds it in contact with its seat on the upper assembling bolt.

The action of the system is as follows: The turning of the crank on the elevating screw rotates the screw, causing a vertical movement of the crosshead nut, thus raising or lowering the power ends of the side levers. This motion lifts or lowers the central journal rod and elongates or contracts the diagonals of the parallelograms. As the upper parallelogram has its sides twice that of the lower, there is a like change in the diagonals, and the point G has double the motion of the point D.

As the point of contact of the upper assembling bolt with the underside of the gun has a slight longitudinal motion, the breech strap must not be drawn tight except in traveling.

DOUBLE-SCREW ELEVATING MECHANISM.

[Plate V.]

The double-screw elevating mechanism is used on the model of 1897 carriages. Its essential parts are the double screw composed of an outer left and an inner right hand screw with its attachment to the gun; the large oscillating nut or crosshead through which the screw turns; the bearings for attaching the crosshead to the trail, and the bevel gear with crank for actuating the screw.

From the drawing (Pl. V) it will be seen that turning the crank to the right moves the vertical, which in turn moves the horizontal gear. The outer screw is free to move vertically through the horizontal gear, but is constrained to take up its motion of rotation because of a feather key which is seated in a spline in the outer screw. The left-hand motion imparted to the outer screw causes it to ascend through the crosshead. The inner screw with its right-hand pitch is prevented from rotating by the fork (not shown) and so ascends from the outer screw at the same rate as the outer screw rises from the crosshead. As the head of the elevating screw is constrained by the fork to move on the arc of a circle in the plane of fire, an oscillating motion is allowed the crosshead by means of the crosshead journals rotating in suitable boxes or bearings secured to the flasks of the piece.

As the repair of the elevating gear may require the removal of certain parts, the following method of procedure in assembling this mechanism is given. It is taken down in inverse order.

To assemble and adjust double-screw elevating mechanism: Remove elevating screw and horizontal gear from crosshead.

Slip left journal of crosshead through opening in left flask as far as possible.

Slip vertical gear on the other (right) journal of crosshead.

Place crank spindle in right crosshead bearing and slip the parts thus assembled from the front of the carriage to their proper position on right flask and bolt there.

Move crosshead and vertical gear to the right till the latter enters and seats in crosshead bearing.

Place split journal box around left journal, the split joint vertical; around this place the split bearing and bolt same into place on left side of carriage.

Secure horizontal gear by means of semicircular key, and screw to underside of crosshead.

Introduce outer elevating screw into crosshead, turning the screw down till its upper surface is flush with upper surface of crosshead.

Fasten feather key to horizontal gear.

Screw inner elevating screw into outer until head bears on top surface of latter.

Couple fork and breech-strap eye washers to head.

Secure crank to crank spindle by means of crank-locking pin.

The following implements are mounted upon the carriage: The trail handspike, two combined short sponges and rammers, and the jointed sponge and rammer.

The trail handspike is mounted on the lunette in its socket, as already described.

The maneuvering handspike is of wood, made in one piece, with a $\frac{5}{8}$-inch handspike ring $6\frac{1}{2}$ inches from its upper end. It is carried on the caisson.

The combined short sponge and rammer, for use at the breech of the gun, has a wooden staff $1\frac{1}{2}$ inches in diameter. On one end is a wooden rammer head 2 inches in diameter, protected by a brass rammer head, secured by a wood screw; it is countersunk so as not to strike the brass plug or fuze. At the other is a sponge nailed upon a wooden head.

The two combined sponges and rammers are habitually carried between the flasks, and are supported by the middle transom and by an attachment plate bolted on the axle plates in front of the axle. They are retained in place by clasps fitting over the grooved ferrules, and are secured by latches similar to the one used for the seat guard rail.

For purposes of drill or action, an attachment has been added so that the combined sponge and rammer need not be put in its traveling position between the flasks, but quickly hooked on the seat guard rail. To accomplish this there are two hooks, one fixed and the other movable.

The hook near the rammer head is movable. It is composed of two principal parts, a socket ferrule riveted to the staff and a sliding sleeve with a hook on one side. The sliding sleeve has a bolt working in the socket so as to compress a spiral spring that has one end bearing at the bottom of the socket and the other on a shoulder on the bolt body. The fixed hook is near the sponge end; it projects from a

sleeve which is riveted on the staff with two rivets. A grooved ferrule is riveted on the staff below the fixed hook.

The jointed sponge and rammer consists of a wooden staff hinged near its middle point, with a sponge at one end and a wooden rammer head, protected by a copper band, at the other. A metal sleeve slips over the hinge joint when the rammer staff is opened out.

There are two other sleeves riveted to the staff, designed to protect the same when mounted under the toggle on the outside of the left flask.

The toggle is riveted on the end of a bar, which is mounted by a staple passing through an eye at its upper end, and riveted to the toggle plate. The latter is fastened to the flask by two $\frac{5}{8}$-inch bolts. Whenever carriages are received at arsenals, the toggle above described is being changed by the addition of a jointed strap and turnbuckle.

In traveling, the toggle stud passes between the two sections of the staff doubled together and is turned so as to key them in place.

The sponge branch of the staff is uppermost, with the sponge over the axle and the rammer head in rear of it, resting on the axle plates.

Smaller implements are carried in the trail box.

The articles enumerated below are carried on each carriage:

2 brakes, bow spring recoil (part of carriage).
1 breech strap (part of carriage).
1 fuze punch and extra pins, in trail box.
2 lanyards, in trail box.
1 obturator nut wrench.
2 primer pouches, in trail box.
1 priming wire, in trail box.
1 prolonge (section of picket rope).
1 screw driver, combination, in trail box.
1 sponge and rammer, jointed, bore.
2 sponges and rammers, chamber.
1 sponge cover, bore.
2 sponge covers, chamber.
1 vent gimlet, in trail box.
1 vent punch, in trail box.
1 vent reamer, in trail box.

LIMBER FOR 3.2-INCH GUN.

[Plates VI and VII.]

The gun-carriage limber is of metal, excepting the ammunition chests, the pole, the footboards, and the spokes and fellies of the wheels.

The axle is hollow and of wrought tubular steel, circular cross section, 3 inches in diameter, $\frac{3}{8}$-inch walls. Upon it are shrunk three cast-steel, coached beds, with chamfered corners. One of these, 6 inches long, is at the middle of the axle, and one $9\frac{3}{8}$ inches long is at each end, inside of the wheel spindles, the outer part forming the shoulders. The set of the axle is such as to make the bottom element of the spindle parallel to the axis of the axle.

The coached beds serve as seats for the superposed frame of the limber, which rests upon them secured by three understraps.

The wheels and the linch washers and pins are of the same dimensions as those on the gun carriage.

The side rails, formerly called the hounds, are of angle irons, 2.5-inch face, with the exterior of the vertical face toward the wheels. That portion of this face which passes over the axle, which it partially encompasses, is cut out to fit it. A blocking piece is used on top of the axle between it and the upper flange, that the whole vertical flange need not be cut away. The side-rail understraps are bolted through the upper flanges by $\frac{5}{8}$-inch bolts and nuts, one on each side of the axle. Two tubular iron boxes with bronze screw covers and safety attachments, for primers and obturator pads, are placed one on each side of the limber, being bolted to the rear side of the axle through the bottoms of the boxes by $\frac{5}{8}$-inch bolts, and being secured to the outside of the side rails by $\frac{5}{8}$-inch ring bolts. Doubletree chains are secured to the outside of each side rail by a staple riveted therein near its front end.

The middle rail, corresponding to the fork of the old carriage, consists of two similar angle irons with edges of the top flanges in juxtaposition. The vertical flanges are cut out to fit about the axle and have blocking between it and the outer surface of the top flanges. The doubletree-bolt strap about the front end of the middle rail forms a clasp for the hole and also a support for the doubletree. The steel doubletree is mounted upon the doubletree bolt; this bolt is a part of the doubletree-bolt strap, being forged solid with it. The rear end of the pole abuts against the pole stop, which is riveted to the side faces of the middle rail.

The pole is secured in its seat by the pole bolt, which passes through it and the sides of the middle rail. This bolt is locked by turning it so that the shoulders of the slots in the two ribs projecting from the sides of the bolt prevent motion endwise.

The doubletree-bolt brace passes over the doubletree bolt and is secured upon it by a nut. Its side flanges extend down outside of each side of the middle rail and are secured by the pole bolt, which passes through them. There is, between the sides of the middle rail, immediately in front of the axle, a middle-rail brace riveted to the sides of the middle rail by ten rivets. Two diagonal braces in rear of the axle on each side of the middle rail are bolted to the side and middle rails, connecting them and stiffening the frame. Those assembled to the side rails by the ringbolts of the primer boxes are called side-rail brace rods; the other two pintle-brace rods. The pintle-hook body is mounted between the sides of the middle rail, and extends from the rear face of the axle beyond the rear end of the middle rail. It is held in position by the two pintle bolts assembling the diagonal braces to the middle rail. The pintle hook at the rear end of the body has an eye through its knob, through which the

pintle key may be passed to secure the lunette of the gun carriage. This key is at the end of the pintle-key chain, by which it is attached to the middle rail by the rear pintle bolt.

The front crossbar, also a 2.5-inch angle iron, extends across the front end of the frame. It is riveted to the side rails at their ends through the front and top flanges, and to the middle rail immediately behind the doubletree-strap bolt, through the top flange. The front flange is cut to go over the middle rail.

There are two wooden footboards. The rear one is riveted to the side and middle rails immediately in front of the ammunition chest. The front one is hinged to the rear one by two strap hinges. The three footboard brackets are riveted to the underside of the front footboard, by which the latter is given an inclination that it may better support the feet. These brackets rest upon the side and middle rails. The front footboard is secured by a hinged latch, with its hinge strap attached to its front edge. This latch engages under the doubletree bolt brace in a seat slotted for the purpose.

Under the footboards, between the middle and side rails and riveted thereto, are two cast-bronze footboard compartments. In one are carried the tool box, oil can, axle-grease can with axle-grease knife, and in the other two folding canvas watering buckets, the rear sight, and small implements. Access is had to these compartments by turning back the front footboard.

The pole is of wood and has a leather pole pad on the forward end and a neck-yoke stop on its underside. The pole is provided with a folding prop, which is detached from the pole in traveling in order to lessen the weight on the necks of the wheel horses. The prop is carried on the rear of the limber in brass pockets provided for that purpose.

The ammunition chest is mounted upon the limber frame in rear of the footboards. It is made of whitewood (excepting the front, which is of oak), strengthened by six angle plates—four for the corners and sides and two for the ends and bottom. The rear side is protected by a corrugated sheet-steel plate. These plates are fastened by copper rivets, except at the bottom, where iron wood screws are used.

The front stays are secured to the chest with one iron rivet and one screw each on the bottom and four iron rivets on the front. A backstay is secured to the box with one iron rivet and one screw on the bottom and four rivets on the back.

There is a forged-iron handle at each end of the chest, secured to it by four rivets. The lid is hinged with strap hinges, each having one rivet on the bottom, three rivets and one screw on the back, and six rivets on the lid. The hasp strap extends across the lid, to which it

is attached by six rivets. The hasp-safe plate is attached to the front edge of the top by two screws. The turnbuckle, by which the strap is secured in position, is mounted upon the turnbuckle pivot, whose plate is riveted to the front of the box, inside and out, by two rivets.

The interior of the ammunition chest is divided by two wooden partitions, held in place by being rabbeted into the front and back, and further secured by two through transom rods. Each end compartment is subdivided by wooden cross partitions which divide the end compartments into two each, forward-end compartments and rear-end compartments. Similarly the center compartment is divided by a partition which creates a forward and rear center compartment. The forward-center compartment is divided by straight short and long aluminum division plates into 15 subcompartments, each one to contain two powder charges in sealed tin cases. Similarly the forward-end compartments are each divided by curved aluminum partitions into five compartments for powder, each subcompartment holding two, or a total capacity of 50 powder charges. The rear-end and rear-center compartments are divided by short and long straight bronze partition plates into 42 subcompartments for containing that number of projectiles. The cover of the limber chest has on its underside three open-top boxes for the carrying of sundry small articles, among them the rear sight, if so desired. These boxes serve a double purpose, as they hold in place the tin powder cases, a matter of considerable importance, especially in maneuvering over rough ground.

The lid of the chest is supported when open by two brass hinge props. The chest is secured on the frame by the ammunition-chest staple, whose branches pass through the top flanges of the middle rail in rear of the footboards, and by the two ammunition-chest bolts and nuts passing through eyes in the front stays. To avoid loss these bolts and nuts are slightly riveted.

The chest is covered with heavy cotton duck.

ARTICLES CARRIED ON EACH CARRIAGE LIMBER.

1 axles-grease can, under footboards, right-hand compartment.
1 axle-grease knife, under footboards, right-hand compartment.
2 watering buckets, canvas, folding, under footboards, left-hand compartment.
1 front-sight cover, in left-hand footboard compartment.
1 cushion, canvas and hair (part of limber).
1 doubletree (part of limber).
2 gunners' haversacks, in ammunition chest.
1 handbook, 3.2-inch gun.
1 neck yoke (part of limber).
1 sperm oiler, rectangular, brass, under footboards, right-hand compartment.

1 padlock for ammunition chest (part of limber).
2 paulins, 12 by 12 feet, dyed duck.
2 singletrees (part of limber).
1 breech sight, bronze, under footboards, left-hand compartment.
1 breech-sight pouch, under footboards, left-hand compartment.
1 front sight, under footboards, left-hand compartment.
1 tool box (under footboards, right-hand compartment), containing the following tools, viz:
    1 cold chisel, ¾-inch, 8 inches long.
    1 file hand, bastard, 8-inch.
    1 hammer, hand, 12½-inch handle.
    1 small steel punch.
    1 iron nut wrench, 12 inches long.
    1 screw wrench, 12-inch.

CAISSON FOR 3.2-INCH GUN.

[Plate VIII.]

The construction of the caisson is very similar to that of the limber. The side and middle rails are lengthened, and the latter terminates at the point in a lunette, by which the caisson is coupled to its limber. The limbers for the carriages and caisson are identical.

Two ammunition chests are bolted to the iron body of the caisson in the same manner as is the single chest to the body of the limber. These chests have no oak fronts nor corrugated sheet-steel plates, as with the limber chests.

On the rear end of the middle rail is bolted the square-wheel axle bolster. Upon the square-wheel axle, secured by a toggle through an eye, is mounted the spare wheel. A spare pole is carried immediately beneath the middle rail, and is supported at the rear by means of an iron stirrup under the spare-wheel axle bolster, and at the front by an attachment with key bolt on the middle rail.

Two long-handled shovels are carried beneath the caisson midway between the middle and side rails, one on each side. The concave faces of the blades are toward and rest against the axle, the shovel points being pressed into staple straps, called "long-handle shovel attachments," in rear of the axle, and the shovel handles afterwards into clips, called "long-handle shovel spring catches," on the front crossbar, against which the ends on the handles rest.

These attachments are positive; the handles must be secured in them or they will immediately fall down, and once in they can not get out unless released by hand.

The pickaxes, which must be put on before the shovels, are carried beneath by fixtures attached to both middle and side rails. The ends of the handles are brought together, the pointed halves of the blades overlapped, one in advance of the other. The handles are then passed into a broad strap of sheet metal, called the "pickax handle

attachment," depending from the middle rail, the outer blade ends resting on brackets or shelves on the side rails, called the "side rail pickax attachments." In this position the overlapping blades should be immediately in front of a bracket or shelf on the middle rail, which is to support the picks. They should be pushed forward onto this shelf until a bolt, previously raised, falls behind them.

The axes and spades are carried between the chests. A board is permanently riveted to the side rails at each end. Within the rails on opposite sides are slots of the length and form of the ax blades, into which the blades are placed vertically, the helves resting on top of the board. The spade blades, spade handles crossed, are placed on the board, one at each side, between the helves of one and the blade of the other ax, concave face toward the ax blade, the ends of the spade blades against the outer branch of the upright metal stops fastened to the board ends. The handles of the spades are then forced down until the ends rest on top of the axes. In this position they retain the axes in place, and can not be shaken out on the march.

The metal watering bucket has been abandoned in favor of those made entirely of canvas, which fold up into a very small compass and are carried in the left footboard compartment.

The maneuvering handspike is carried along the right rail, outside. A brass socket for the large end is secured to the right axle, and under the footboard is an attachment with a swing bolt for the small end. A bronze ring on the handspike, when in position, falls immediately in rear of the attachment seat and prevents any forward motion.

Caissons are furnished with lever road brakes, each side operated separately, so that either one or both wheels can be affected. The brake arms, steel angles, are pivoted at the rear of the middle rail by the rear bolster bolt and extend out to the rear of the wheels. They are supported by a hanger strap over the side rails. On the outer ends are cast-iron brake shoes which act as mud scrapers on the march. The brake levers stand upright, inside the wheels, opposite the front side of the rear ammunition chest, and are bolted to a bronze axle bracket and segment which has a tool-steel rack for holding the lever when the brake is set. When traveling the lever is held to the rear of segment by a retaining spring and lever stop riveted to segment. The levers are connected with the brake arms by a brake rod and spring bolted together. The levers can be operated by a cannoneer on either the front or rear ammunition chest.

A section of picket rope can be carried coiled around the spare-wheel axle bolster.

Two extra boxes of projectiles can be transported, one on each side of the spare-wheel axle bolster, resting on the floor rods and lashed in position.

ARTICLES CARRIED ON EACH CAISSON LIMBER.

1 axle-grease can.
1 axle-grease knife.
2 watering buckets, canvas, folding.
1 cushion, canvas and hair.
1 doubletree (part of limber).
1 neck yoke (part of limber).
2 paulins, 12 by 12 feet, dyed duck.
1 pole prop, metallic (part of limber).
2 singletrees (part of limber).

ARTICLES CARRIED ON EACH CAISSON BODY.

2 axes, handled.
1 breech cover.
2 cushions, canvas and hair.
1 handspike, maneuvering.
2 lanterns, railroad.
2 padlocks for ammunition chests (part of caisson).
2 paulins, 12 by 12 feet, dyed duck.
2 pickaxes, handled.
1 pole (spare).
1 prolonge (section of picket rope).
2 shovels, long-handled.
2 spades, short-handled.
1 tompion and muzzle cover (combined); the latter in the breech cover, which is secured by its straps and buckles to the spare-wheel axle toggle.
1 wheel (spare).

COMBINED FORGE AND BATTERY WAGON FOR 3.2-INCH GUNS.

[Plate IX.]

The dimensions and construction of the iron body for the battery wagon are the same as for the caisson.

The limber, constructed in the same manner as the limber for the carriage or caisson, except that the packing for ammunition in the chest and the primer and obturator boxes are omitted, carries all that pertains to the forge with the exception of the anvil, vise, and sledge.

The battery-wagon body is carried on the rear wheels, and is made of whitewood and oak, with three compartments. The largest is entered from either side of the top, the openings being covered with hinged lids. A door at the front opens into the other two compartments, which are of equal size, and just contain, one, a chest of saddler's, and the other a chest of carpenter's tools. The tools in the chests are all arranged so that they can be taken out one by one without disturbing the rest, except the jack plane, which is behind the smoothing plane. The chests are provided with handles, so that

they can be taken out of the wagon and carried about; they are furnished with locks and keys. In addition to the space in these chests occupied by the tools, there is enough for small stores, for which two canvas bags are provided for each chest.

In the main compartment are carried the grindstone and cans for sperm and coal oil, secured by permanent packing. There is also space in this compartment for such stores and spare parts as may be designated by the battery commander. At the rear of the wagon body is a folding rack for forage, and there is a rail around the top to which forage can be lashed. The rear wheels are provided with road brakes like those on the caisson.

The lever road brake adopted for the caisson is also used on the battery wagon.

The anvil is carried on the middle rail in front of and bracing the door of the chest compartment. It is secured by a bolt with a crank nut, passing through its body and the middle rail. A vise is permanently bolted on the middle rail in rear of the lunette, and a sledge hammer is secured along the rail between the vise and the anvil by a sheet-steel strap and turnbuckle, called the "sledge and lunette prop attachment." The lunette prop is carried between the flanges of the middle rail, being held in place by the understrap of its attachment and by the understrap that secures the vise in place on the middle rail.

ARTICLES CARRIED ON LIMBER OF FORGE AND BATTERY WAGON.

1 axle-grease can, in footboard compartment.
1 axle-grease knife, in footboard compartment.
1 coal bag, canvas, 3 bushels.
1 doubletree (part of limber).
1 neck yoke (part of limber).
2 paulins, 12 by 12 feet, dyed duck.
2 singletrees (part of limber).
2 watering buckets, canvas, folding, in footboard compartment.

ARTICLES CARRIED ON BODY OF FORGE AND BATTERY WAGON.

1 anvil (100 pounds).
2 water buckets (galvanized steel).
1 grindstone, arbor, crank, and frame (iron), complete.
1 hammer, sledge, medium.
2 jackscrews.
2 lanterns, railroad.
1 lunette prop (part of battery wagon).
1 oil can, kerosene, 3 gallons.
1 oil can, sperm, 2¼ pints.
2 padlocks and keys (part of battery wagon).
1 prolonge (section of picket rope).
1 vise, forge.

SPARE PARTS FOR RIFLE.

(Expendable parts marked *.)

6 spindles.
4 carrier-latch bolts.*
8 carrier-latch springs.*
3 gas-check pads.*
2 split rings, steel, front.*
2 split rings, steel, rear.*
4 vent bushings, copper.*

SPARE PARTS FOR CARRIAGE.

(Expendable parts marked *.)

1 crosshead elevating nut.*
1 pair bow spring brakes, complete.
2 singletrees.
1 doubletree.
1 neck yoke.
4 pole pads.*
6 linchpins.*
8 linchpin washers.*
8 ammunition chest bolts and nuts.*
4 turnbuckles for ammunition chests.*
4 breech-strap eyewashers.*
2 nuts for assembling bolts for lazy tongs.*
4 shoes for caisson brakes.*
4 lid props.*
4 lid-prop plate pivots.*
2 pintle keys and chains.*

THE ARTILLERY STORE WAGON (OLD DESIGN).

This wagon was intended primarily for carrying the artillery knapsacks, but it will doubtless be used for carrying many other articles as well. It has the same track as other artillery vehicles, and the rear wheel is the same as the wheel used on the 3.2-inch carriage. The body of the wagon has a cut-under which allows a somewhat greater turning angle than is obtained with the other carriages.

The weight of the wagon, with its accessories, is about 2,100 pounds, and its capacity is about 227 cubic feet.

Under the body of the wagon and above the axles are carried the following spare parts and intrenching tools, viz:

2 axes.
1 doubletree.
2 pickaxes.
2 long-handled shovels.
2 singletrees.
2 spades.

The driver's seat is a box with a hinged cover, provided with lock and key. The interior of the seat box is divided by two partitions into three compartments. The middle one is for the following, provision being made for each by suitable attachments or holders, viz:

1 axle-grease can.
1 axle-grease knife.
1 coal-oil can.
1 cold chisel.
1 hand hammer.
1 lantern, railroad.
1 screw wrench.

The two end compartments, with a capacity of nearly 3 cubic feet, may be used for the transportation of such of the expendable supplies as the battery commander wishes to carry there.

On the rear of this wagon a 25-gallon water keg is carried, slung by chains and resting on a cradle built out from the back of the wagon body. The keg has a large bronze handle in the middle of each end for carrying the keg and putting it up and taking it down from its traveling position. The bedplates of the handles extend above them into eyes for the chain links; the keg is therefore hung to the chains above the center. A large bronze screw bung with leather washer provides a good-sized hole for filling the keg and for holding the water securely. A spigot or faucet at one end, well protected by the chime, enables the water to be drawn off while in the traveling position. The cover of the wagon is double, the first one being a waterproof canvas or duck; this one covers the wagon bows of the top and the front hood only. The second cover is made of the colored cotton duck used for paulins. This one extends beyond the other halfway down the sides of the body and in the rear sufficiently to meet in the center when folded across, the whole cover, top, and sides being made that much longer than the wagon. The ends of the sides are eyeleted about two-thirds of the way up from the bottom for stout lacing cord, one side having a tongue, or overlapping piece, sewed along the edge on the inner side to cover the eyelets of both sides when drawn together by the lacing cord. When so drawn together for about two-thirds of the way up, the upper part, corresponding to the top of the cover extended, falls down over on the outside, closing the end of the wagon completely, so as to shed all water and make it waterproof.

When the rear of the wagon cover is unlaced the whole cover can be turned back over the wagon to give unobstructed access to the interior, so that the load may be handed in over the tailboard to a man inside charged with storing it away from the front to the rear. In front, just back of the driver's seat, is a canvas partition or curtain, the halves of which overlap in the center and are secured by

straps and buckles. This curtain is strongly fastened to the wagon top, and its function is to hold the load from pitching forward. It extends from the top to the driver's seat only. Below the seat top the seat box supports the thrust forward of the load. The first loading should go under the front curtain against the seat box. The back of the driver's seat folding down to the front and the front curtain opening in the center, the lower middle ends being free and permitting being fastened up, access can be had to the interior from the front, and the wagon may be loaded from the front, but not so readily, the opening through the curtain being limited.

The pole and double and single trees of this wagon are the same as for the other 3.2-inch carriages. The pole, when unhitched from the horses, will fall to the ground; it is not supported by the hounds as on ordinary wagons. This construction was intentional. Motion below the horizontal, when on the march, is necessary for a pole of an artillery wagon. If supported horizontally by the hounds, in camp the pole would be used without support for a harness rack, and for other purposes that would strain the gear irons and kingbolt. A prop—same as used for other field carriages for the end of the pole—can be carried always conveniently just back of the driver's seat, between it and the front curtain, whether the wagon be with or without load. A boot to protect the driver's legs from the rain and snow is provided. It is to be hooked on each side by an attached leather strap to hooks attached to the front wagon-top bow, to fall over his legs and the brake lever. When not in use the boot is to be folded once longitudinally. This brings together in pairs four eyelet holes on the lower side, two at the corners, and two at the slit in the middle, and by these holes hung on hooks fastened to the top of the bow to which the front curtain is secured. It will then hang down smoothly against the front face of the curtain, back of the driver. A nest of water buckets like the other field-carriage buckets can be carried by securing the bail of the outer bucket over the reach or reach braces. No special place or attachment is provided for this purpose. The paulin or paulins may be folded in long folds and thrown across the wagon top for transportation, or suitably folded and carried on and strapped or roped to the water keg, or carried on the floor of the wagon inside under the load.

ARTILLERY STORE WAGON (NEW DESIGN).

[Plate X.]

Nomenclature.

Number.	Name of part.	Location, etc.	Material.
1	Front truck		
1	Rear truck		
1	Body		
1	Brake		
	FRONT TRUCK.		
2	Front wheels	On front axle	Archibald.
2	Linchpins	Through end of axles	Steel No. 2.
2	Linchpin springs	Riveted to linchpins	Spring steel.
2	Linchpin washers (R. and L.)	Between nave box and linchpin	Steel No. 1.
2	Washers	Between nave box and linchpin washer	Fiber.
1	Front axle	Connects front wheels	Steel.
2	Axle-clip yokes	Bolster-plate clip to axle	Steel No. 1.
1	Axle bolster plate	Between lower bolsters	Steel No. 1.
1	Hound	Between upper and lower bolsters	Steel No. 1.
1	Hound truss	From hounds to axle	Steel No. 1.
1	Hound-truss clip	Hound truss to axle	Steel No. 1.
2	Hound braces (R. and L.)	Hound to axle	Steel No. 1.
2	Hound-brace bolts	Hound to hound brace	Steel No. 1.
2	Hound-brace clips	Front axle to hound brace	Steel No. 1.
2	Hound stays (R. and L.)	On hound, under fifth wheel	Steel No. 1.
2	Hound-stay chains	Doubletree to hound	Steel No. 1.
2	Hound-stay bolts		Steel No. 1.
1	Fifth wheel	Underside of front bolsters	Steel No. 1.
1	Doubletree bolt and brace	On front of hound	Steel No. 1.
2	Doubletree-bolt brace bolts		Steel No. 1.
1	Doubletree-bolt strap	On hound	Steel No. 1.
1	Lower bolster plate	On top of lower bolster	Steel No. 1.
2	Bolster-plate clips	Fastens bolster plate to bolster	Steel No. 1.
1	Pole strap	Between arms of hound	Steel No. 1.
1	Pole-strap reenforce	Between arms of hound	Steel No. 1.
1	Pole bolt		Steel No. 1.
1	Pole socket	Between front ends of hound	Bronze No.1
1	Body-bolster brace	Fastens front and rear upper bolster to middle upper bolster.	Steel No. 1.
2	Bolster side bearings	On ends of middle upper bolster	Steel No. 1.
1	Upper bolster plate	In center, under middle upper bolster	Steel No. 1.
1	Bolster knuckle	In center of lower bolster	Steel No. 1.
1	Knuckle rod	Connecting locker-shaft bearings	Steel No. 1.
2	Knuckle-rod pipes	Between rocker-shaft bearings	Pipe.
1	Knuckle-rod washer		Pipe No. 1.
2	Rocker-shaft body bearings	On undersides of front and rear and upper bolsters.	Bronze No. 1.
1	Rocker-shaft fifth-wheel front bearing	On top of fifth wheel in front	Bronze No. 1.
1	Rocker-shaft fifth-wheel back bearing	On top of fifth wheel in rear	Bronze No. 1.
1	Lower bolster (2 pieces)	Between hound and axle	Oak.
1	Front upper bolster	Connects wagon box and fifth wheel	Oak.
1	Middle upper bolster	Connects wagon box and fifth wheel	Oak.
1	Rear upper bolster	Connects wagon box and fifth wheel	Oak.
1	Pole	In pole socket	Red oak.
1	Pole prop	Underside of front end of pole	Steel.
1	Neck yoke	On end of pole	Oak.
1	Doubletree	On doubletree bolt	Steel No. 1.
2	Singletrees	On end hooks of doubletree	Steel No. 1.
	REAR TRUCK.		
2	Rear wheels	On front axle	Archibald.
2	Linchpins	Through end of axle	Steel No. 2.
2	Linchpin springs	Riveted to linchpin	Spring steel.
2	Linchpin washers	Between nave box and linchpin	Steel No. 1.
2	Washers	Between nave box and linch washer	Fiber.
1	Rear axle	Connects rear wheels	Steel.
2	Rear-axle braces	Connects wagon box and axle	Steel No. 1.
2	Rear-axle clips	Connects bolster with axle	Steel No. 1.
1	Rear-axle center brace	Connects wagon box and axle	Steel No. 1.
1	Rear-axle center clip	Connects bolster with axle	Steel No. 1.
2	Rear-axle end-bolster clips	Connects bolster with axle	Steel No. 1.
2	End-bolster clip yokes	Between axle and bolster clip nuts	Steel No. 1.
2	Rear-bolster head washers	Between wagon body and bolster brace nuts.	Bronze No. 1.
1	Axle bolster	Between wagon body and axle	Oak.

Number.	Name of part.	Location, etc.	Material.
	BRAKE.		
1	Brake beam	Attached to body in front of rear wheels	Oak.
2	Brake-beam hangers	Attaches beam to body	Steel No. 1.
2	Brake-beam hanger bearings	Bearing for hanger	Steel No. 1.
2	Brake-beam washers	Under nuts of brake-beam hanger bolt	Steel No. 1.
2	Brake-shoe holders	Attached to end of brake beam	Steel angle.
2	Brake-shoe holder bolts	Attaches holder to beam	Steel No. 1.
1	Brake quadrant	Attached to wagon body	Steel No. 1.
2	Brake-quadrant brackets	Between body and quadrant, supports quadrant.	Bronze No. 1.
1	Brake latch	Attached to brake lever	Tool steel.
1	Brake shaft	Attached to rear-axle braces	Steel No. 3.
1	Brake-shaft spring hook	Attached to brake shaft	Steel No. 1.
1	Brake connecting rod	Connects brake shaft with brake beam	Steel No. 1.
1	Brake connecting-rod pin	Fastens connecting rod to brake beam	Steel No. 1.
2	Brake-quadrant yokes	Riveted to brake beam	Steel No. 1.
2	Brake-shaft upper loops	Riveted to brake beam	Steel No. 1.
2	Brake-shaft lower loops	Riveted to brake beam	Steel No. 1.
1	Brake spring	Connects brake-shaft spring hook with rear bolster.	Steel wire.
1	Brake-spring eyebolt	Connects spring with rear bolster	Steel No. 1.
1	Brake latch pin	Fastens latch to sides of brake-shaft lever	Steel No. 1.
2	Brake shoes	Fastened to shoe holder	Oak.
3	Brake-shaft bearings	Brake shaft to rear-axle brace	Bronze No. 1.
3	Brake-shaft bearing bolts	Fastens brake-shaft bearing to rear-axle brace.	Steel No. 1.
1	Brake ring and ferrule	On end of brake stake	Steel No. 1.
1	Brake stake	Attached to brake-shaft lever	Hickory.
	WAGON BODY.		
1	Wooden body		Poplar.
2	Front end irons (R. and L.)	Front end wagon box, sides to bottom	Steel No. 1.
2	End-gate and irons (R. and L.)	Sides of end gate	Steel No. 1.
2	End-gate hooks (R. and L.)	On back of gate	Steel No. 1.
2	End-gate chains	Fastens end gate to wagon box	Steel No. 1.
2	End-gate hinges	Fastens end gate to wagon body	Steel No. 1.
2	Side stays (end)	At rear of box	Steel No. 1.
2	Side stays (center)	At center of box	Steel No. 1.
4	T side stays	On sides of box between side stays	Steel T.
2	Front end rods	Across front of box	Steel No. 1.
12	Upper bow staples	Along upper edges of sides of box	Bronze No. 1.
12	Lower bow staples	12 inches below the upper bow staples	Bronze No. 1.
2	Rub irons		Steel No. 1.
6	Bows	In bow staples	Hickory.
1	Canvas cover		Canvas.
1	Tool box	Suspended under rear end of wagon box	Poplar.

DESCRIPTION OF THE WAGON.

This wagon will be used for carrying the knapsacks of the battery or such authorized stores and equipments as can not be accommodated on the other vehicles.

The body of the wagon is made of poplar and oak and is held together by side straps and two oak cleats bolted to the bottom of the bed and supporting the side braces. The wagon is supplied with bows and a reversible cover which are readily removed.

The axles are the standard axles used on the 3.2-inch limber. The wheels have 3-inch tires and the standard nave box, but are lighter than the service wheels with 3-inch tires. The front wheels are 38 inches in diameter and turn under the bed.

The running gear is the stiff-pole type without a reach.

The hound is made of steel and is supported by an oak bolster which is strapped to the front axle. It is firmly secured in place by braces and truss rods.

The pole, which is the new regulation 3.2-inch pole, fits in its seat between the ends of the hound and is held in place by a pole bolt. The end of the pole has a slight vertical movement to prevent a sudden jar on the horses' necks. The upper front gear consists of three oak bolsters, to which the fifth wheel is attached by means of a knuckle rod which acts as a hinge for the upper gear. This hinge movement prevents the bed overturning when the front wheels are on different levels, and is limited by two rubber buffers attached to the middle bolster and which strike against the fifth wheel.

The rear gear has an oak bolster which is strapped to the rear axle and fastened to the bed. These parts are held securely in position by three steel braces, two of which pass under the axle and are bolted to the bed in front and rear, and the third is fastened to the axle and in front to the oak cleat under the center of the bed.

The brake shaft has an arm on each end, with loops to take the brake stake. The power is transmitted to the middle point of the oak brake beam, which causes the brake shoes to bear equally on the two wheels. The brake has a latch, which, when the brake is set, engages in the teeth of a quadrant on the side of the bed. It is released by a rope, one end of which is attached to this latch. A mogul spring fastened to an arm on the brake shaft releases the brake when the latch is disengaged from the quadrant.

The quadrant, brake stake, and latch are reversible, fitted for either side, and readily changed.

A rope attached to a ring at the end of the brake stake may be used to set the brake by a man on foot or by the driver of the wheel team.

The wagon, empty, weighs 1,810 pounds.

The capacity of the bed is 70 cubic feet and will carry a load which should not exceed 4,500 pounds on good roads or 3,500 pounds on rough roads.

The tool box, which is under the bed in rear of the hind axle, is arranged to carry the following tools and implements, which are supplied with each wagon:

1 axle-grease can.
1 axle-grease-can knife.
1 coal-oil can.
1 hand hammer, 12¼-inch handle.
1 lantern, railroad.
1 iron nut wrench, 10-inch.
1 screw wrench, 12-inch.

THE ARTILLERY HARNESS.

(Plate XI.)

The component parts of the artillery harness are given in the table below. Plate XI shows the harness for the off-wheel and off-lead horses. The nomenclature corresponding to the numbers in the

plate will be found in the table except as follows: 21, hame tug, a part of the collar; 41, blanket, issued separately from harness; 42, cincha strap, part of saddle quarter strap.

No. in plate.	Component parts.	Wheel.		Lead.	
		Near horse.	Off horse.	Near horse.	Off horse.
1–4	Back strap and crupper, complete	.....	.....	1	1
	Consisting of—				
1	Body and hip straps	.....	.....	1	1
2	Dock, crupper	.....	.....	1	1
3	Loin strap	.....	.....	1	1
4	Trace loops	.....	.....	4	4
	Back-strap hooks	.....	.....	1	1
8, 9	Breast strap, complete	1	1	.....	.....
	Consisting of—				
8	Breast strap	1	1	.....	.....
9	Breast-strap hooks	2	2	.....	.....
2–7	Breeching, complete	1	1	.....	.....
	Consisting of—				
5	Back strap and hip straps	1	1	.....	.....
6	Body	1	1	.....	.....
2	Dock, crupper	1	1	.....	.....
	Back-strap hooks	1	1	.....	.....
	Side-strap hooks	2	2	.....	.....
3	Loin strap	1	1	.....	.....
7	Side straps	2	2	.....	.....
4	Trace loops	2	2	.....	.....
10–19	Bridle, complete	1	1	1	1
	Consisting of—				
10	Brow band	1	1	1	1
11	Brow-band ornaments	2	2	2	2
12	Cheek pieces	2	2	2	2
18	Coupling strap	.....	1	.....	1
19	Connecting strap	.....	1	.....	1
13	Crownpiece	1	1	1	1
14	Curb bit	1	1	1	1
15	Curb chain	1	1	1	1
16	Reins	1	1	1	1
17	Throat latch	1	1	1	1
20	Collar, steel	1	1	1	1
40	Collar, strap	1	1	1	1
22, 23	Halter, complete	1	1	1	1
	Consisting of—				
22	Headstall	1	1	1	1
23	Strap	1	1	1	1
24, 25	Martingale, complete	1	1	.....	.....
	Consisting of—				
24	Martingale	1	1	.....	.....
25	Cincha strap	1	1	.....	.....
26–33	Saddle, complete	1	1	1	1
	Consisting of—				
26	Cantle hooks	1	1	.....	.....
27	Cinchas	1	1	1	1
28	Lead-rein roller and strap	.....	1	.....	1
29	Quarter-straps, including rings, safes, and cincha straps	1	1	1	1
30	Coat straps	3	2	4	3
31	Saddletree, leather-covered	1	1	1	1
32	Stirrups, brass	2	2	2	2
33	Stirrup straps	2	2	2	2
34	Saddlebags, pairs	1	1	1	1
35	Saddlebag side straps	2	2	2	2
36	Traces, lead, wire	.....	.....	2	2
37	Traces, wheel, wire	2	2	.....	.....
38	Trace chains, with mogul springs	2	2	.....	.....
39	Trace chain with ring	.....	.....	2	2
	Whip	1	.....	1	.....
	Sweat leathers	2	.....	2	.....

STEEL COLLARS.

SIZES AND DIRECTIONS FOR FITTING.

Steel collars are made in the following sizes: 2 A, 2 B, 4 A. 4 B, 5, 5 A, 5 B, 6, 6 A, 6 B, 7, 7 A, 7 B, and 8 A. The number and shape of

the collar are stamped on the front side under the extension bolt. The A and B shapes have straighter sides than the numbers without letters. When issued with harness, unless otherwise ordered, 10 per cent of the collars are No. 5, 50 per cent No. 5 A, and 40 per cent No. 6. In requisitions the size of collars desired should be given.

The steel collar pads are made in seven different sizes; No. 0 is 4 inches wide, No. 1 is 4.5 inches, No. 2 is 5 inches, etc., to No. 6, which is 7 inches wide. The pad connections are also furnished in seven sizes, from No. 0 to No. 6. For the plain number of collar (5, 6, or 7), the regular adjustment requires a pad connection of the same number as the pad. The A and B shapes have straighter sides and take a pad connection two sizes larger than the pad; that is, it would take a No. 3 connection with a No. 1 pad, etc., for the regular adjustment in these shapes. When the collar is very wide at the top and narrow at the bottom the size of the pad connection must be increased one or two numbers to allow the collar to close easily at the bottom. In the reverse case a smaller pad connection should be used. The collar pads are numbered on the front inner side. The pad connections are numbered on the side having the round holes, which side must be kept to the front on the collar. In requisitions for collar pads and pad connections the sizes desired must be stated.

The buckle is made in two sizes. No. 2 is 1 inch longer than No. 1, and is used with the larger sizes of collar pad.

The correct adjustment and fitting of collars is of the utmost importance. The variety of sizes and shapes of collars, pads, pad connections, and buckles issued by the Ordnance Department is sufficient to enable any horse to be correctly fitted. Efficient supervision by officers of the fitting of collars and of the adjustment of the point of draft (trace plate) is required to secure proper results.

Table of dimensions.

[Size of collar fitted with No. 3 pads.]

No. of collar.	Length of collar inside.	Width 6 inches down from top.	Width 8 inches down from top.	Width at draft.
	Inches.	*Inches.*	*Inches.*	*Inches.*
2 A	18	6⅜	7⅛	8⅝
2 B	18	6⅜	6⅞	8
4 A	19½	7	7¼	8¼
4 B	19½	6½	7⅛	8⅝
5	21	7⅝	8⅜	9½
5 A	21	7	7¾	9
5 B	21	6½	7⅛	8¼
6	22½	7⅝	8¼	9¼
6 A	22½	7	7¾	9½
6 B	22½	7	7¼	9¼
7	24	7⅝	8¼	10¼
7 A	24	7	7¾	9⅝
7 B	24	7	7⅛	10
8 A	25½	7	7¾	9¾

Table of dimensions—Continued.

[Size of collar fitted with No. 1 pads.]

No. of collar.	Length of collar inside.	Width 6 inches down from top.	Width 8 inches down from top.	Width at draft
	Inches.	*Inches.*	*Inches.*	*Inches.*
2 A	16½	5½	5⅞	7
2 B	16½	4¾	5½	6¾
4 A	18	5⅞	6¼	7¼
4 B	18	5⅛	5⅞	7⅜
5	19½	6¼	7⅛	8¼
5 A	19½	5½	6⅜	7½
5 B	19½	5⅜	5¾	7¼
6	21	6⅜	7½	8½
6 A	21	6	6¾	8⅛
6 B	21	5¾	6½	8¼
7	22½	6⅜	7⅜	8⅝
7 A	22½	5¾	6¼	8¼
7 B	22½	5¾	6⅜	8½
8 A	24	5¾	6½	8½

The table of dimensions gives the largest and smallest size that each collar can be made with the No. 3 and No. 1 pads. Adding one-half inch in length and width to the smallest dimensions given in the table will give the size of the collars when fitted with the No. 2 pads. These examples are given to show the three regular adjustments in each size of collar, but these dimensions can be varied to suit the different shapes of necks. The largest pad can be put in the top of the collar and the bottom taken into its smallest dimensions, or the smallest pad can be put in the top and the bottom left out. While each collar can be lengthened or shortened and taken in or let out at the bottom by means of the adjustments provided, the width at the top can not be changed without using a larger or smaller pad.

In fitting irregular shapes none of the connections may give just the proper tension on the pad. In such a case use the one that comes nearest and straighten or bend the extension at the top. When the collar requires to be widened at top to relieve the pressure on the pad and make it lock easily at the bottom, open the collar wide and place a round piece of hard wood or iron, 1 inch in diameter and 2 inches long, between the connection and collar side, close up to the hinge; then press the sides together and bend both sides alike, so that they will be the same length at the bottom. Do not let the fulcrum rest on the pad, for it will bend it. If the collar sides require straightening to close them tighter on the pad and give more tension on the latch at the bottom, open the collar at the bottom, hook the wrench over the top of collar side, and press down the lever, treating both sides alike. Both of these operations can be performed with the collar put together.

The spare parts furnished for the repair of the collars, with the correct names of the parts, are shown on Plate XII.

Canvas collar pads are not part of the artillery harness, but are furnished upon requisition. They are made in sizes Nos. 2, 3, 4, 5, and 6, as called for; if no size is called for they are made in equal proportions of Nos. 4, 5, and 6.

THE CARE AND PRESERVATION OF LEATHER.

Attention is invited to the following:

"It is forbidden to use any dressing or polishing material on the leather accouterments or equipments of the soldier, the horse equipments for cavalry, or the artillery harness, except the preparations supplied by the Ordnance Department for that purpose." (A. R. 293 of 1913.)

REASON FOR OILING LEATHER.

Leather as it comes from the tannery in manufacture is hard, rough, brittle, inflexible, and readily absorbs water. To remove these undesirable qualities and render the leather soft, pliable, flexible, and impervious to water, to increase the strength and toughness of the fiber, and to give the leather such a surface color and finish as will make it most sightly and suitable for the purpose for which intended, the manufacture is continued by hand stuffing it with a "dubbing" made of pure cod-liver oil and tallow, which the experience of curriers has shown to be the best material for this purpose. This dubbing is thoroughly absorbed by the leather, penetrating it completely, and is not merely limited to the surface.

The russet leather now used by the Ordnance Department in the manufacture of all leather equipments is pure oak tanned, of No. 1 tannage and finish, hand stuffed with a light dubbing made of pure cod-liver oil and tallow to preserve the leather, the dubbing being so sparingly used that the oil will not exude. This leather as it comes from the manufacturer contains enough oil to materially improve its quality and prolong its life, but not enough to soil the clothing if the equipment is properly cared for. No oil whatever is added to the leather in the manufacture of the equipment at the Government arsenals.

CARE OF RUSSET LEATHER.

Leather equipments which have become wet should be dried in the shade. Wet leather exposed to the direct days of the sun or to the heat of a stove or radiator becomes hard and brittle.

When russet-leather equipments become soiled in service they should be cleaned by carefully washing the leather with a sponge moistened with a heavy lather made of clean water and castile, crown, or Propert's soap, and then rubbing vigorously with a dry cloth until the leather is completely dry.

If the leather becomes harsh, dry, and brittle from exposure to water or other causes, clean as above described, and while the leather is still slightly moist apply an exceedingly light coat of neat's-foot oil by rubbing with a soft cloth moistened (not *saturated*) with the oil. If it is found that too much oil has been used, the surplus can be readily removed by rubbing with a sponge moistened with naphtha or gasoline.

Where a polish is desired, the leather should first be thoroughly cleaned and then the leather polished or dressing supplied by the Ordnance Department should be applied sparingly and thoroughly rubbed in with a soft dry cloth. Scars, cuts, or abrasions of the leather may be improved in appearance but not obliterated by similar use of the leather polish.

Russet leather may be cleaned, oiled, and polished as described above, but it should be noted that if more than a light coat of oil be given, the leather will be greatly darkened and will quickly soil the clothing. No method of cleaning will restore the original light color of the leather or remove stains or discolorations.

CARE OF BLACK LEATHER.

To clean and dress black leather, wash it in water (lukewarm preferred) with castile soap. An old horse brush will be found very satisfactory for applying the soap and water. Dry in the shade; when almost dry, apply the blacking, rubbing it in thoroughly with a toothbrush or a brush having stiff bristles.

Dry in the shade and then apply neat's-foot oil with a sponge or rag, rubbing in well until the leather is soft and pliable.

When dry, a certain amount of oil and blacking will exude from the leather; this should be rubbed off with a dry cloth.

SIGHTS FOR THE 3.2-INCH FIELD GUN.

FRONT SIGHT.

[Plate XIII.]

The front sight consists of a bronze standard fastened by four screws to a seat on the right rimbase of the gun. In the upper part of the standard there is a circular aperture containing a cross.

The parts of the sight are the body, cross carrier, cross, and the direction sight. The carrier is formed of two cylinders, the rear one of which carries a cross made of two pieces of steel ribbon halved on each other and having their planes parallel to the axis of the gun. This cylinder fits into the forward one, and a countersunk screw unites them. The cross is set with its arms making an angle of 45 degrees with the horizon. The cross carrier can be removed from the body for the adjustment of the cross ribbons, and two cuts,

one vertical and the other horizontal, with a clamp screw, form the means of fastening it in place. At the top of the device is the direction site, which is a pyramidal projection, for the purpose of quickly training the piece in nearly the direction required. The latest model differs from the previous one only in the additional strength to resist bending given to the body by the substitution for the two cuts of a single vertical cut.

REAR SIGHT.

[Plate XIV.]

The rear sight is made of bronze and brass, and is composed of the following principal parts:

Graduated vertical limb.	Elevating screw.
Base.	Sighting leaf.
Trunnion.	Vernier.
Deflection scale.	Adjusting screw of spirit level.
Level.	Trunnion clamping screw.
Deflection screw.	Seating pin.

The base of the sight is provided with a taper shank, which fits into a corresponding socket on the rear of the gun. A small steel seating pin drops into a recess in the socket and insures the correct seating of the sight.

The trunnion is pivoted in the base in such a way as to admit of partial rotation in a plane perpendicular to the axis of the gun. This motion is limited in either direction by the clamp screw, and the trunnion can be fastened by it at any position.

The deflection scale forms the lower part of the vertical limb and is at right angles to it. The limb has a horizontal motion, guided by slots in the trunnion and actuated by the deflection screw. This permits the sight to be set for drift, windage, etc.

The deflection scale is graduated to show thousandths of range.

A spirit level is attached to the deflection scale and is provided with holding and adjusting screws. The trunnion clamp screw allows a motion of about 25 degrees in the vertical limb in either direction, and the level enables the gunner to level his gun or make the limb of his sight vertical.

The elevating screw extends from end to end of the vertical limb and causes the sighting leaf to move along the limb. The vertical limb is graduated to degrees by horizontal lines, and each degree is divided into sixths by diagonal lines. The sighting leaf carries a vernier, which, in conjunction with the diagonal lines, permits of reading to minutes. A peephole in the sighting leaf, 0.05 of an inch in diameter, is used with the cross of the front sight for accurate sighting. A quick sight can be taken by using the top of the leaf and the direction point of the front sight.

In the latest model of the sight there are four sets of graduations. On the right side of the rear face of the vertical limb the scale is divided, as above described, into degrees and minutes. On the left side the sight is graduated for shrapnel, and on the reverse side for shell, in yards of range. On the left edge is a time scale graduation in seconds, for use in setting the time fuze. For shrapnel the scale is divided by horizontal lines for intervals of 250 yards up to 4,500, but by using the vernier and diagonal lines a reading can be obtained to 50 yards. For shell the scale is graduated by horizontal lines for every hundred yards up to 4,500.

The rear sight should be removed from the gun before firing.

The latest model herein described and illustrated differs from the older models in having a wider vertical slot, a stronger brass tube for level, a more efficient trunnion clamping screw and a notch in the sliding leaf for use with the direction sight of the front sight; also in the addition of the time scale graduation and the change in the deflection scale to show thousandths of range.

DESCRIPTION OF TELESCOPIC SIGHTS.

[Plates XV and XVI.]

The telescopic sights in service are the model of 1896, the model of 1896 M, the model of 1897, the model of 1898, and the model of 1898 M.

The telescopic sight, model of 1896, consists of a telescope carried by an adjustable frame which is attached by trunnions and a projecting lug between them to a bracket fastened to the right trunnion of the gun or to a sight standard.

The telescope is supported by having its forward end pivoted and secured to the frame, while the other end has a sliding motion along the elevation arc, through contact with the vernier piece. The telescope is an ordinary inverting one, provided with an achromatic objective composed of two lenses in contact and a Ramsden eyepiece to magnify the image formed by the objective. It is made without an erecting eyepiece, in order to give more light, larger field, and to make the sight more compact.

The advantages gained by the use of a telescope consist in an increased power of vision and a large decrease in personal error. These enable a gunner to clearly see an object which is indistinct to the eye and to lay a gun on it with facility and accuracy.

Within the telescope is a sliding diaphragm carrying a horizontal and vertical pointer. Lateral motion is given this diaphragm by a deflection screw on the right side of the telescope. On this deflection screw a small arrowhead indicates the direction for right deflection.

Deflection is given by moving this sliding diaphragm along a graduated horn scale below the diaphragm. The amount of deflec-

tion is indicated by the vertical pointer. The horizontal pointer is for laying, and its tip is laid accurately on the object sighted.

The deflection scale is held by a clamping piece secured by two small screws. It is capable of adjustment within this clamping piece by unscrewing the two small screws referred to.

The deflection scale reads to 1° 30′ on each side of the zero, and the smallest subdivision reads to 3′. Every fifth subdivision on each side of the zero is numbered consecutively from 1 to 6.

The zero of the scale is marked by a small hole.

The telescope is properly focused when the plane of the pointers is at the position of distinct vision and the image of the object is in the same plane as the pointers. To accomplish this condition, both the eyepiece and objective are given the necessary motions within the telescope tube.

The motion of the eyepiece is given by screwing or unscrewing it in its bushing, and that of the objective by a focusing screw collar back of the sunshade.

The diameter of the objective is 1 inch.

The power of the telescope is 10, and its field of view is 2° 50′.

In sighting, the tip of the horizontal pointer is brought to bear on the image of the object sighted; and this process is precisely the same as bringing the tip of the horizontal pointer onto a material object in the same plane as the pointer, and, provided the focusing is correct for each observer, there can be no variation in the sighting.

The frame of steel is made as light as practicable, and so constructed that it protects the telescope from mechanical injury.

The elevation arc, the center of which is on the horizontal axis of the telescope, is graduated from −7° to +22°, but owing to the space occupied by the vernier these limits for practical purposes are −7° and 16°.

The vernier reads to 2′.

It is fastened to the vernier piece on the telescope, forward of the deflection screw, and is provided with two set screws, one at each end, for securing it to this piece, as well as for purposes of adjustment.

The line of sight at zero deflection is the optical axis of the telescope.

A level is attached to the left side of the telescope. Its axis is parallel to that of the sight trunnions, or axis of revolution of the sight. This enables the sight to be used as a quadrant in its own bracket.

The angle of elevation is given by turning a milled-head micrometer screw which actuates a worm spindle; and the latter engaging in the work rack cut in a projection on the right side of the telescope gives the desired angular motion to the telescope about its horizontal axis. For one complete turn of this micrometer screw the telescope is elevated or depressed 1°.

Any lacklash between the worm spindle and the worm rack is overcome by means of a spring pressing upward against the bottom side of the telescope.

The micrometer screw which actuates the worm spindle is graduated to minutes. It is provided on top with two small screws which secure the collar on which the graduations are made. Unscrewing them, the collar can be turned and the vernier and micrometer readings made to agree.

To obtain a correct angle of elevation it is essential that the elevation arc should be truly vertical for all angles of elevation of the gun, and for any inclination the gun trunnions might have to the horizontal. This is accomplished by means of a cross level fastened to the underside of the frame, parallel to the horizontal axis of the telescope and perpendicular to the axis of revolution of the sight. The cross level is provided with two openings, one on the top and one on the bottom, to permit of easy observation in direct and reverse laying.

The adjustable frame of the sight is attached to the bracket on the gun trunnion by two trunnions of equal diameters, and a leveling lug between them.

The line passing through the centers of these trunnions is called the axis of revolution of the sight or the axis of the sight trunnions, and is parallel to the optical axis of the telescope at zero elevation.

The sight bracket, which is fastened to the right trunnion of the gun, is provided with two V's and a leveling screw.

The sight trunnions are seated in the V's, and the leveling lug between them bears against the leveling screw. The leveling screw working against the lug levels the sight.

The overbalancing of the sight, and the method of suspension to the bracket, enable the sight to be used for reverse laying. The undercut in the cross level exposes the bubble for adjustment.

A strap fastened loosely to the frame is used for carrying the sight.

For each sight there is provided a leather case in which the sight is carried and kept.

Telescopic sight model of 1896 M differs from model of 1896 in having—

1. A larger field of view.
2. A greater lateral movement of the sliding diaphragm.
3. A rocking worm spindle instead of a fixed one.

The field of this telescope has been obtained by using an eyepiece of larger field.

The lateral movement of the sliding diaphragm is 2° 30′ on each side of the zero of the deflection scale, and this scale itself is graduated to indicate this movement. The numbering of the deflection scale is also different from that of the model of 1896 sight in that

every tenth subdivision is numbered with its proper 30′ and degree mark. The value of any deflection can thus be read directly in degrees and minutes.

The rocking worm spindle is a distinct feature of this sight, and the change was made to provide for a constant pressure of the worm spindle in the worm rack and to prevent uneven wear of the latter.

The power of the telescope on this sight is 10, and its field is 5° 5′.

Open sights on top of the telescope are provided to enable the gunner to quickly bring an object into the field of the telescope.

Telescopic sight model of 1897 differs from model of 1896 in having—

1. A noninverting telescope.
2. A larger field of view.
3. A larger objective—1.2 inches.
4. Greater lateral movement of the sliding diaphragm.
5. A set of cross wires instead of pointers.

The noninverting telescope is obtained by inserting the Hastings-Brashear compound erecting prism between the sliding diaphragm and the objective. This compound prism consist of two prisms having angles of 30°, 60°, and 90°, laid with their 30° angle toward each other on a parallel-sided glass plate, and on the other side of this plate is laid a third prism having a true 90° angle. Successive reflections at the surfaces of these three prisms erect the image without any lateral displacement of the rays of light other than that necessary for the purpose, and without lengthening the telescope tube or diminishring the field of view. This compound prism is mounted in a frame provided with two sets of screws, by means of which it is adjusted after being assembled in the telescope. Just forward of the sliding diaphragm the telescope tube is cut away on top to admit the prism and its frame. Two screws passing through flanges on the latter secure it to the tube and determine its position. A roof-shaped plate screwed to the telescope tube protects the prism from dust or mechanical injury.

The increase in the diameter of the objective from 1 inch to 1.2 inches was made to give a brighter field of view and to partially compensate for the light lost by absorption in the erecting prism.

The movement of the sliding diaphragm is 2° 15′ on each side of the zero of the deflection scale, and the scale itself is graduated to indicate this movement. The degree marks only are numbered on this scale; and the value of the smallest division, 3′, is indicated by the symbol $\frac{1}{20}$° directly under the zero hole of the scale.

The cross wires attached to the sliding diaphragm are of platinum wire. The vertical wire indicates the amount of deflection, and the intersection of the two wires is laid on the object sighted.

The field of view of the telescope is 5° 12′, and the power is 9.

A set of open sights on the telescope acts as a finder for it.

Telescopic sight model of 1898 is a new design, similar to the earlier models described in its method of attachment to the sight bracket, but differing from them in general construction and in the more important details.

The sight consists of two principal parts, the trunnion casting and the telescope, which is pivoted to the casting at its forward end.

The trunnion casting is made of phosphor-bronze on account of its great hardness, elasticity, and resistance to corrosion. This casting comprises the trunnions, the leveling lug, the bearing for the horizontal axis of the telescope, and the elevation arc with the bearing for the elevation worm spindle.

To provide for interchangeability, the dimensions of the trunnions and leveling lug are made the same as in the other telescopic sights.

The bearing for the horizontal axis of the telescope is drilled through the trunnion casting near the forward trunnion. The elevation arc and the bearing for the elevating-worm spindle constitute one piece. This latter bearing is practically dust proof, being closed entirely in rear, and having only sufficient opening in front for the worm rack to engage.

The elevation arc is graduated as in the other sights.

The fundamental line of all the telescopic sights is the axis of revolution defined by the trunnions; and since the elevation arc and the bearing for the horizontal axis of the telescope form, as they do, a part of the casting which contains the axis of revolution it follows that such a construction is all that can be desired.

The telescope is attached to the trunnion casting by its horizontal axis and the worm rack. The horizontal axis, or pivot of the telescope, projects through the trunnion casting. Within the bearing for this pivot is an annular groove which contains a spiral spring, one end of which bears against the trunnion casting and the other against the telescope. This spring serves to overcome any backlash in the worm rack when the telescope is moved in altitude, and being placed under considerable strain in fitting it in its groove the pressure it exerts against the telescope in every position is practically uniform.

The worm rack on the left side of the telescope projects into the opening in the trunnion casting and engages with the elevating worm spindle.

The telescope can be run out and disengaged entirely from the worm spindle without affecting the adjustment of the telescope.

The micrometer screw on the elevating worm spindle is graduated to 1′, and its adjustments are made as in the other sights.

The vernier is attached to a vernier piece on the left side of the telescope, and is adjusted by means of two screws working into the vernier piece, one at each end, and against two shoulder pieces bearing against the vernier. This adjustment differs from that in the

other sights in that a given turn of an adjusting screw produces an opposite movement in the vernier.

The vernier reads to 2′.

The telescopic level is fastened to the right side of the telescope.

The level is a minute one, the bubble moving $\frac{1}{10}$ of an inch for 1′ of elevation.

For giving deflection, a set of platinum wires, one vertical and one horizontal, and two scales, one inside and one outside, are provided.

The vertical cross wire is attached to a sliding diaphragm actuated by the deflection screw on the right side of the telescope. In giving deflection this vertical wire moves along the interior horn scale and indicates the reading. In addition, this diaphragm has a pointer which at the same time moves along the outside silver scale, giving the reading without looking into the telescope. The telescope is cut away at this place to make room for the outside scale and to reveal the pointer. In order that the pointer should give a correct reading, the screw actuating the fixed diaphragm is accurately cut and the backlash is overcome by two spiral springs working against the sliding diaphragm.

The horizontal cross wire is attached to a fixed diaphragm placed behind the sliding one. For the purpose of adjustment, this diaphragm can be given a slight motion in a vertical direction and secured in the correct position.

The interior horn scale is graduated to 2° 30′ on each side of the zero. The smallest division is 3′. This scale is held and adjusted as in the other telescopic sights; on the scale is engraved R FIRE L, indicating the direction of motion for the vertical cross wire in order to direct the gun to the left or right of the object sighted.

The cross wires and the fixed and sliding diaphragm are exposed to view by unscrewing the four screws holding the cap which contains the socket for the eyepiece.

The outside scale is graduated to degrees and half degrees, the 3′ readings being obtained from the micrometer deflection screw. The expression R FIRE L is also engraved on this scale.

The micrometer deflection screw which actuates the sliding diaphragm is graduated on its collar with two series of figures from 0 to 9 in opposite directions. Each division equals 3′, and a complete turn of the screw moves the sliding diaphragm 30′. One series of figures gives the correct reading when the deflection movement is for firing to the left and the other series for the contrary movement.

On the telescope near the graduated collar is engraved $\overset{\text{L}}{\updownarrow}_{\text{R}}$, indicating the direction of rotation of the micrometer deflection screw for firing to the left or right of the object sighted.

The cross level is attached to the underside of the telescope and is provided with an opening at the top for direct laying and one at the bottom for reverse laying. The level tube fits in a larger tube cast with the telescope, and for the purpose of adjustment is provided with four radial set screws which fit in a flare at one end of the level tube and bear against the outside tubes.

The level is a 3′ one, the bubble moving a tenth of an inch for a change of inclination of 3′.

The telescope attached to this sight was especially designed to give a large field of view, an erect image, and the maximum amount of light the eye will receive under the most favorable conditions.

The field of view of a telescope depends on its power and the field of the eyepiece. Ordinarily the field of an eyepiece rarely exceeds 40°, but in this case, besides making the eyepiece achromatic, the field was increased to nearly 50°. An increase of this amount in the field of the eyepiece is always accompanied by lack of perfect definition at the margin of the field. By dividing the field of the eyepiece by the power of the telescope its field of view is obtained. In this telescope the field of the eyepiece is 48° and the power is eight, consequently the field of the telescope is 6°.

The power of eight was selected as sufficient for proper magnification of the deflection scale, and any power above eight would have correspondingly diminished the field of view.

The erect image is formed by the insertion of a Hastings-Brashear erecting prism between the eyepiece and the objective. The opening for the insertion of the prism and its frame is made in the underside of the telescope tube.

The eye receives the maximum amount of light through a telescope of this character when the diameter of the pencil of light emerging from the eyepiece is equal to that of the pupil of the eye. The diameter of the emerging pencil is equal to the diameter of the objective divided by the power of the telescope. To fulfill this condition the diameter of the objective was made 1.25 inches; the diameter of the emerging pencil of light is therefore nearly $\frac{1}{8}$ inch. Except at night, when the pupil of the eye may dilate to $\frac{1}{4}$ inch, the telescope is adapted to all conditions of light.

The loss of light in the telescope is due to absorption in the lenses and prism, and when these are made of the best glasses and the surfaces carefully prepared the loss of light is reduced to a minimum.

The objective is focused by a focusing collar back of the sunshade.

The eyepiece is focused by screwing or unscrewing it in its bearing, which forms part of the cap covering the deflection scale and cross wires.

The sunshade with the dew cap is retained in place by a small set screw which permits the sunshade to be pulled in or out and rotated about the telescope.

The telescope tube is made of thick brass, so that it may be handled without danger of bending or the sight losing its adjustments.

The model of 1898 M sight is the same as the model of 1898, except that the power is reduced to 4 and the field is slightly increased. This instrument is especially adapted for seacoast service where haze and other imperfect light conditions are experienced. For land service, where better light can usually be obtained, the higher-power instruments are preferable.

The telescopic sights admit of attachment to either a gun or, in seacoast service, to the gun carriage. For the former, a trunnion bracket is provided, which is fastened to the right trunnion; and for the latter, a carriage bracket or sight holder, which is fastened to a sight standard on the carriage.

INSTRUCTIONS FOR USING.

Before using the sight the case containing it should be slung over the gunner's shoulder and the sight should not be removed until the gunner is ready to use it. While the sight is in the case the cover should be kept fastened. In handling the sight always use the strap fastened to the frame.

See that the objective is screwed home.

To focus the sight, screw the eyepiece until the pointers or the cross wires, with every roughness on them, are distinctly visible. The objective is focused by directing the telescope on a distant object and turning the focusing collar until on shifting the eye over the eyepiece the intersection of the cross wires remains on the same point of the object, or, in other words, until there is no parallax. When the objective is focused, should the image not be clearly defined, then the eyepiece is not correctly focused and it must be screwed until the definition is satisfactory. An objective once focused is correct for all observers, but the eyepiece requires focusing for each individual.

To set the sight for deflection, take hold of it with the left hand and, looking into the telescope, move the deflection screw with the thumb and forefinger of the right hand until the required deflection is obtained. The deflection scales have indicated on them by means of letters and arrowheads the direction in which the pointers or cross wires must be moved in order to direct the gun to the right or left of the object sighted.

To set the sight for elevation, turn the micrometer screw controlling the elevating worm spindle until the required elevation is obtained.

The sight is now ready to be placed on its brackets on the gun trunnion. It should be set very carefully by bringing the leveling

lug to bear *gently* against the leveling screw. The sight is levele by turning the leveling screw until the cross-level bubble comes t the center. The gun carriage should then be traversed until th target is brought into the field of view. The tip of the horizonta pointer or the intersection of the cross wire is laid accurately o the target. If, when this is done, the bubble is still at the cente of the cross level, the gun is laid correctly; if the bubble is not i the center of the cross level, the sight must be releveled and th operation of laying repeated until the condition for correct laying mentioned above, obtains. In all cases the last act of the gunne before taking the sight from its bracket preparatory to firing shoul be to verify the leveling of the sight.

The telescopic level enables the gunner to use the quadrant angl of elevation. To do this the sight is first set for deflection only and the gun aligned on the target. The sight is then set for the required quadrant angle of elevation and the gun elevated or depressed until the bubble in the telescopic level comes to its center. It should be noted that a correction must be applied to the angle of elevation to obtain the quadrant angle and that this correction depends on the difference of elevation of the gun site and the target.

For reverse laying the sight is reversed in its bracket and leveled, the cross level being exposed on its underside to render the bubble visible.

Before firing the sight must in all cases be removed from its bracket.

CARE AND PRESERVATION.

These sights are delicate instruments and must not be subjected to any rough usage, jars, or strains. They must, when not in use, be kept in their leather cases in a dry place. To obtain satisfactory vision the glasses should be kept perfectly clean and dry. The glasses will seldom require cleaning on the inside; but when necessary they should be unscrewed and cleaned by a competent person. A piece of chamois skin or clean linen handkerchief will answer for cleaning purposes, care being taken that the cleaning material contains neither dirt nor grit. The object glass should be screwed home and should be kept in that position. The erecting prism in the noninverting telescopes should not be removed.

The trunnions on these sights are purposely left bright; the other portions are generally lacquered. Sandpaper or emery paper should not be used on the trunnions; when a trunnion has rusted a slight rubbing with crocus paper will remove the rust. A little vaseline should always be kept on them as a preventive of rust. The worm and worm rack should be oiled with machine oil. When dust ac-

cumulates on the pointers or cross wires it should be removed by a fine camel's-hair brush in the hands of an experienced person.

The V bearings of the sight brackets should be kept slightly greased and the finger drawn through them before inserting the sight, to remove dust, etc. Before putting the sight in its case it should be carefully examined and all traces of dust or moisture removed, and every precaution taken to prevent rusting.

Place the sight in its case with the trunnions downward. When sights are stored in their cases they should be inspected periodically.

THE GUNNER'S QUADRANT.

[Plate XVII.]

This instrument is used on all kinds of guns and mortars, either to give the elevation directly or to verify the angles obtained by ordinary sights. On the 3.2-inch gun the quadrant should be applied to surfaces perpendicular or parallel to the axis of the bore. There are three models in service—1892, 1897, and 1898.

The model of 1892 is composed of two main parts—the body, carrying the graduated arc, and the movable arm, carrying the index and the level. The movable arm also carries a graduation in minutes from 0 to 60, and the level, which is capable of a longitudinal movement along the arm, carries a second index for reading this scale.

Degrees are read upon the graduated arm of the body, minutes by the sliding level and scale on the movable arm.

The graduated arc is provided on the inside with a toothed circular rack, each tooth of which corresponds to a degree mark. The movable arm is hollow and holds a spindle which carries on its end a small toothed sector. A spiral spring contained inside the hollow arm constantly urges the spindle and sector outward, thereby engaging the teeth of the sector with those of the graduated arc and holding the arm in any position it may be placed. To move the arm it is necessary to press back the sector against the action of the spiral spring until its teeth clear those of the graduated arc; the arm may now be moved to a new position, and when the pressure is removed from the sector its teeth will again engage with those of the graduated arc.

The quadrant, model of 1897, is of the same design as model of 1892, with the following modifications:

The bronze frame is made heavier, the better to withstand the accidents of service. The housing of the level is heavier and the feet are shod with steel plates held fast to the bronze frame by dovetailing and by screws.

The quadrant, model of 1898, is of the design shown on plate. The frame is aluminum, and the feet are shod with steel plates as in the model of 1897. The arc is graduated on both sides of frame for a maximum of 66° of elevation or depression. This new model has a stronger and improved level.

USE OF THE QUADRANT.

MODELS OF 1892 AND 1897.

To give any elevation less than 45°, as 13° 17′: Place the index on the movable arm opposite the 13° mark on the graduated arc of the body, slide the level along the arm until its index is opposite the seventeenth division of the scale on the movable arm. The quadrant is now set to the required reading. Place the quadrant on its seats or on surfaces parallel or perpendicular to the axis of the bore, always being careful to keep the side of the graduated arc in use to the left, looking in the direction of the target, and to keep the arrow showing the line of fire pointing in the direction of the target. Elevate the piece until the bubble of the level comes to rest at the center. This will be the elevation required.

To give any elevation greater than 45°, as 63° 33′: Place the index on the movable arm opposite the 63° mark on the graduated arc of the body (this mark will be found on the opposite side of the quadrant from the 13° mark), slide the level along the movable arm until its index is opposite the thirty-third division of the scale on the arm. The quadrant is now set to read 63° 33′.

Place the quadrant on its seats or on the surfaces parallel or perpendicular to the axis of the bore, being careful, as before, to keep the side of the graduated arc in use to the left of the piece, looking in the direction of the target, and to keep the arrows showing the line of fire pointing in the direction of the target. Elevate the piece until the bubble comes to rest at the center of the level. This will be the elevation required.

It is thus seen that any elevation or depression in degrees and minutes from 0° to 90°, within the limits imposed by the method of mounting, can be given by this quadrant. It will be noticed that this quadrant is graduated on one side from 0° to 44° and on the other from 45° to 89°. The extra degree on both sides would be given by the sliding level. It will also be noticed that if 45° be given on the one side by moving the arm to 44° and the index then placed to give readings about 45°, without changing the arm or level, it will still record 45°, for the position of the level to give a reading of 60′ below 45° is also the position to give a reading of 0′ above 45°, and

the main index will be found to stand at 45° on the opposite side of the graduated arc. (See Plate XVII.)

Model of 1898.

The mode of setting this quadrant for a given reading is the same as in the other models, using the graduations on either side of frame. Its use is simplified in that it is only necessary to place it on its seat with the arrow indicating "line of fire" elevation or "line of fire" depression, as the case may be, pointing toward the target.

RANGE FINDING.

Ranges by Weldon range finder: Two Weldon range finders, of the form known as the compass or surveying range finder, and one steel tape are issued to each battery of field artillery for use in the rapid determination of ranges of targets. A full description of this instrument and of the method of using it will be found in the pamphlet entitled "Description and Instructions for Use of the Weldon Range Finder," published by the Ordnance Department.

Range by B. C. telescope: When time permits, ranges should be more accurately determined by the use of the B. C. telescope or the panoramic sight in accordance with the method indicated on pages 117 and 130 of the "Handbook of the 3-inch Field Artillery Material with instructions for its care" (Form No. 1659), published by the Ordnance Department.

Ranges by trial shots: The method of obtaining ranges by trial shots is given in Artillery Memoranda No. 2, pages 8 and 9.

Distance by time interval recorders: This method is based upon the fact that sound travels about 1,100 feet per second in air. Hence if the time in seconds between the flash and the report of a gun, or between the flash and the report of a shell fired from the battery, be noted, the distance is obtained by multiplying the time in seconds by 1,100 feet.

Range table for shell and shrapnel in 3.2 field gun.

[Muzzle velocity, 1,685 feet per second. Standard weight of projectile, 13½ pounds.]

Range.	Angle of elevation.	△R for ± △1′ in elevation.	△R for ± △10 feet per second in muzzle velocity.	△R for wind 10 miles per hour.	△R for change of ± 1/10 C.	Time of flight.	Drift.	Deflection for 10 miles crosswind.	Angle of departure.	Angle of fall.	Slope of fall.	Terminal velocity.	Maximum ordinate.	Value of "C."
Yards.	° ′	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Seconds.*	*Mils.*	*Mils.*	° ′	° ′	*Ion.*	*Feet per second.*	*Feet.*	
100	−18.0	15.4	1.1	0.2	1.0	0.18	0.1	0.0	6.0	6.0	573.0	1,613	0	1.362
200	−11.5	15.4	2.2	.4	2.2	.37	.2	.1	12.5	13.0	264.0	1,568	1	1.358
300	**−5.0**	**14.3**	**3.3**	**.6**	**3.6**	**.57**	**.3**	**.2**	**19.0**	**20.0**	**172.0**	**1,523**	**1**	**1.353**
400	2.0	13.3	4.3	.8	5.2	.77	.4	.4	26.0	28.0	123.0	1,478	2	1.348
500	10.5	13.3	5.3	1.1	7.0	.98	.5	.5	33.5	37.0	92.9	1,434	4	1.338
600	18.0	13.3	6.3	1.4	9.0	1.19	.7	.7	41.0	46.0	74.7	1,490	6	1.328
700	25.5	12.5	7.2	1.8	11.3	1.41	.9	.9	48.5	56.0	61.4	1,447	8	1.318
800	**33.5**	**11.8**	**8.1**	**2.3**	**13.8**	**1.64**	**1.1**	**1.1**	**56.5**	**1 7.0**	**51.3**	**1,306**	**11**	**1.309**
900	42.0	11.8	8.9	2.8	16.5	1.87	1.3	1.3	1 5.0	1 19.0	43.5	1,267	14	1.300
1,000	51.0	10.5	9.6	3.3	19.4	2.11	1.5	1.5	1 14.0	1 32.0	37.4	1,231	18	1.292
1,100	1 0.5	9.5	10.3	3.9	22.5	2.36	1.7	1.6	1 23.5	1 45.0	33.1	1,198	23	1.287
1,200	1 10.5	9.5	10.9	4.6	25.8	2.62	1.9	1.8	1 33.5	1 59.0	29.1	1,169	28	1.284
1,300	**1 21.0**	**9.5**	**11.4**	**5.3**	**29.3**	**2.88**	**2.1**	**1.9**	**1 44.0**	**2 13.0**	**25.8**	**1,142**	**34**	**1.282**
1,400	1 31.5	9.5	11.9	6.1	32.9	3.14	2.3	2.0	1 54.5	2 29.0	23.1	1,118	40	1.281
1,500	1 42.5	9.0	12.4	7.0	36.6	3.41	2.5	2.1	2 5.5	2 46.0	20.7	1,096	47	1.280
1,600	1 53.5	8.7	12.9	8.0	40.4	3.69	2.8	2.2	2 16.5	3 3.0	18.8	1,076	56	1.279
1,700	2 5.0	8.3	13.3	9.2	44.3	3.97	3.0	2.4	2 28.0	3 21.0	17.1	1,057	75	1.279
1,800	**2 17.0**	**8.0**	**13.8**	**10.5**	**48.3**	**4.26**	**3.3**	**2.6**	**2 40.0**	**3 39.0**	**15.7**	**1,039**	**75**	**1.279**
1,900	2 29.5	8.0	14.3	11.9	52.3	4.55	3.6	2.8	2 52.5	3 58.0	14.4	1,022	86	1.280
2,000	2 42.0	7.7	14.7	13.4	56.3	4.85	3.9	3.0	3 5.0	4 17.0	13.4	1,007	97	1.280
2,100	2 55.0	7.4	15.2	15.0	60.4	5.15	4.2	3.1	3 18.0	4 37.0	12.4	993	109	1.281
2,200	3 8.5	7.4	15.6	16.6	64.5	5.46	4.5	3.2	3 31.5	4 57.0	11.5	980	123	1.283
2,300	**3 22.0**	**7.2**	**16.0**	**18.3**	**68.7**	**5.77**	**4.8**	**3.3**	**3 45.0**	**5 18.0**	**10.8**	**968**	**138**	**1.287**
2,400	3 36.0	7.2	16.5	19.9	72.9	6.08	5.1	3.4	3 59.0	5 40.0	10.1	956	154	1.292
2,500	3 50.0	7.0	16.9	21.5	77.1	6.39	5.4	3.5	4 13.0	6 2.0	9.46	945	170	1.297
2,600	4 4.5	7.0	17.3	23.1	81.4	6.71	5.8	3.7	4 27.5	6 24.0	8.92	935	187	1.303
2,700	4 19.0	6.7	17.6	24.7	85.7	7.03	6.1	3.8	4 42.5	6 47.0	8.41	925	205	1.318
2,800	**4 34.5**	**6.5**	**17.9**	**26.3**	**90.0**	**7.35**	**6.4**	**3.9**	**4 57.5**	**7 10.0**	**7.95**	**915**	**225**	**1.313**
2,900	4 50.5	6.2	18.2	27.9	94.4	7.68	6.7	4.1	5 12.0	7 34.0	7.51	905	247	1.315
3,000	5 6.5	6.2	18.5	29.5	98.8	8.02	7.1	4.2	5 28.5	7 59.0	7.13	895	269	1.317

3,100.....	5	22.5	5.9	18.8	31.2	103.2	8.36	7.4	4.3	5	44.5	8	25.0	6.76	885	292	1.319
3,200.....	5	39.5	5.9	19.1	33.0	107.6	8.71	7.8	4.4	6	1.5	8	51.0	6.42	876	317	1.321
3,300.....	**5**	**56.5**	**5.7**	**19.4**	**35.0**	**112.1**	**9.06**	**8.2**	**4.5**	**6**	**18.5**	**9**	**18.0**	**6.11**	**866**	**343**	**1.321**
3,400.....	6	14.0	5.6	19.7	37.2	116.5	9.42	8.6	4.6	6	36.0	9	46.0	5.81	857	371	1.321
3,500.....	6	32.0	5.6	20.0	39.5	121.0	9.78	9.0	4.7	6	54.0	10	15.0	5.53	848	400	1.322
3,600.....	6	50.0	5.3	20.3	41.8	125.5	10.15	9.5	4.8	7	12.0	10	44.0	5.28	839	431	1.322
3,700.....	7	9.0	5.1	20.6	44.2	130.0	10.52	9.9	5.0	7	31.0	11	14.0	5.04	831	463	1.322
3,800.....	**7**	**28.0**	**5.0**	**20.9**	**46.6**	**134.5**	**10.90**	**10.4**	**5.1**	**7**	**50.0**	**11**	**45.0**	**4.81**	**823**	**497**	**1.323**
3,900.....	7	48.5	5.0	21.2	49.0	139.1	11.28	10.9	5.2	8	9.5	12	17.0	4.59	815	534	1.323
4,000.....	8	8.5	5.0	21.5	51.5	143.6	11.67	11.4	5.3	8	29.5	12	51.0	4.38	808	573	1.324
4,100.....	8	28.5	4.9	21.8	54.1	148.2	12.06	11.8	5.4	8	50.5	13	26.0	4.18	801	714	1.324
4,200.....	8	49.5	4.7	22.1	56.7	152.8	12.46	12.3	5.5	9	10.5	14	2.0	3.99	794	657	1.325
4,300.....	**9**	**10.5**	**4.6**	**22.4**	**59.4**	**157.4**	**12.86**	**12.8**	**5.6**	**9**	**31.5**	**14**	**38.0**	**3.83**	**787**	**701**	**1.325**
4,400.....	9	32.5	4.6	22.7	62.2	162.0	13.27	13.3	5.7	9	53.0	15	15.0	3.67	780	746	1.326
4,500.....	9	54.5	4.6	23.0	65.0	166.7	13.69	13.8	5.8	9	15.5	15	52.0	3.52	773	793	1.327
4,600.....	10	16.5	4.4	23.3	67.9	171.4	14.11	14.4	6.0	10	37.5	16	30.0	3.38	767	842	1.328
4,700.....	10	39.5	4.2	23.6	70.9	176.1	14.53	14.9	6.1	11	0.5	17	8.0	3.24	761	894	1.329
4,800.....	**11**	**3.5**	**4.2**	**23.9**	**73.9**	**180.8**	**14.96**	**15.5**	**6.2**	**11**	**23.5**	**17**	**47.0**	**3.12**	**755**	**949**	**1.331**
4,900.....	11	22.5	4.2	24.2	77.0	185.5	15.40	16.1	6.3	11	47.5	18	27.0	3.00	749	1,006	1.333
5,000.....	11	51.5	4.2	24.5	80.2	190.2	15.84	16.8	6.4	12	11.5	19	7.0	2.89	744	1,065	1.335
5,100.....	12	15.5	3.9	24.8	83.5	195.0	16.28	17.4	6.5	12	35.5	19	47.0	2.78	738	1,125	1.357
5,200.....	12	41.5	3.8	25.1	86.9	199.8	16.73	18.1	6.6	13	0.5	20	28.0	2.68	733	1,188	1.340
5,300.....	**13**	**7.0**	**3.8**	**25.4**	**90.4**	**204.6**	**17.19**	**18.8**	**6.7**	**13**	**26.0**	**21**	**11.0**	**2.58**	**728**	**1,254**	**1.341**
5,400.....	13	33.5	3.7	25.7	93.9	209.5	17.66	19.5	6.9	13	52.5	21	56.0	2.48	723	1,324	1.342
5,500.....	14	0.5	3.6	26.0	97.5	214.3	18.14	20.2	7.0	14	19.5	22	42.0	2.39	718	1,397	1.343
5,600.....	14	28.5	3.5	26.3	101.2	219.2	18.63	21.0	7.1	14	47.5	23	29.0	2.30	714	1,474	1.343
5,700.....	14	57.5	3.3	26.6	105.1	224.1	19.14	21.7	7.2	15	16.5	24	17.0	2.22	709	1,555	1.344
5,800.....	**15**	**28.0**	**3.0**	**26.9**	**109.2**	**229.0**	**19.67**	**22.5**	**7.3**	**15**	**47.0**	**25**	**8.0**	**2.13**	**705**	**1,641**	**1.343**
5,900.....	16	0.5	3.0	27.2	113.5	233.9	20.21	23.2	7.4	16	18.5	26	1.0	2.05	701	1,733	1.342
6,000.....	16	34.0	2.9	27.5	118.0	238.9	20.77	24.0	7.5	16	52.0	26	56.0	1.97	697	1,832	1.341

CARTRIDGES.

The powder charge of 3.2-inch smokeless powder is contained in a bag of raw silk. The weight of the charge is about 15¼ ounces, varying somewhat with different manufacturers and even with different lots from the same factory. On the bottom of the bag is sewed a small disk containing about ¼ ounce of black rifle powder; this is the priming charge which ignites the slower-burning smokeless powder.

The whole is contained in a cylindrical tin can with removable top. The top, which has under it a rubber gasket, is removed by means of two wires which serve as a lever for prying it off.

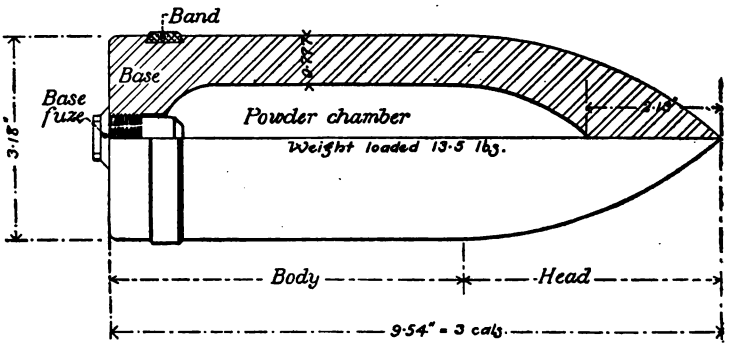
These cans are being replaced by the latest model in which hermetical sealing is secured by means of a soldered strip of zinc which covers the joint between the body and top of a cylindrical tin can. To open the can, the soldered strip is torn off and the top of can removed.

PROJECTILES FOR 3.2-INCH GUNS.

Three kinds of projectiles are used for the 3.2-inch gun—shell, shrapnel, and canister.

SHELL.

The shell is of cast iron. It is three calibers long, and the radius of the curve of the head is two calibers. It weighs 13 pounds and



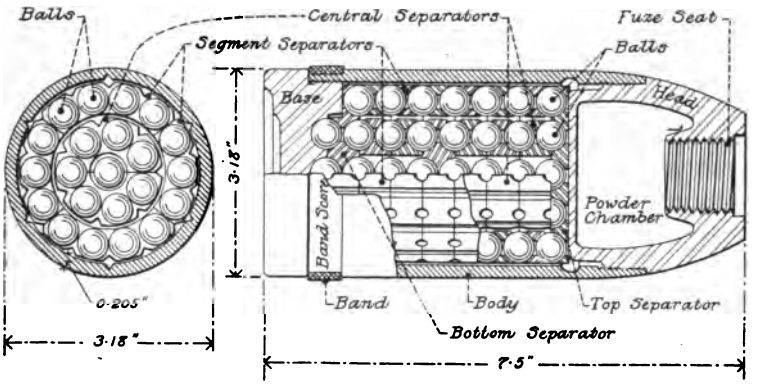
has a bursting charge of ½ pound, making the total weight 13½ pounds. It is rotated by a ½-inch rolled pure-copper band, seated in a dovetailed groove, 0.625 inch from its base. Scores are cut on the face of the seat into which the band is pressed, thus preventing rotation of the band on the shell. A base-percussion fuze is used with the shell.

SHRAPNEL.

The Frankford Arsenal shrapnel, exclusive of the filling, consists of three main parts—the head, body, and base.

The head is a hollow casting machined on the exterior and threaded to screw into the body. The point is threaded to receive the Frankford Arsenal combination fuze. The bursting charge of $2\frac{3}{4}$ ounces is contained in this section. The interior surface of the casting is lacquered to prevent premature ignition of the charge from friction.

The body is made of steel tubing, machined on the outside and threaded at its two ends for the head and base. It is weakened for fracture by longitudinal grooves cut upon its interior. It contains a charge of 162 balls, $\frac{1}{2}$ inch in diameter, each of $8\frac{1}{2}$ parts lead, hardened by 1 part antimony, 41 to the pound, arranged in seven layers of 22 each, with a bottom layer of eight. These are separated by cast-iron plates, with beds conforming to the shape of the balls.



The separators are designed to prevent the deformation of the balls under the shock of discharge and also to furnish additional fragments of effective size. The bottom separator plate has lugs projecting from it which fit into recesses in the base, preventing independent rotation of the charge within the body. The top separator, against which the head is secured in assembling, is flat on the upper side.

The base is of cast iron, threaded and screwed into the body and is of sufficient strength to resist the shock of discharge and support the rotating band.

The band is of copper, shrunk and pressed by a die into its seat, which is roughened to prevent slipping.

The total weight of the shrapnel, exclusive of fuze, is 12 pounds $6\frac{1}{2}$ ounces. The total number of balls and individual pieces in the shrapnel complete, before bursting, is 200.

The following are the weights and dimensions of the Frankford Arsenal shrapnel:

Weight (without fuze or bursting charge)	12 lbs. 6½ oz.
Total length (without fuze)	7.5 inches.
Diameter of body	3.185 inches.
Exterior diameter of band	3.30 inches.
Width of band	0.5 inch.
Distance of band from base	0.625 inch
Diameter of ball	0.5 inch.
Weight of ball (41 to the pound)	171 grains.
Number of balls	162
Weight of fuze	1 lb. 1 oz.
Weight of powder charge	2¾ ounces.
Weight, total, of shrapnel	13 lbs. 10 oz.

CANISTER.

[Plate XVIII.]

The Sawyer canister used in the 3.2-inch gun consists of a cylindrical case filled with cast-iron balls.

The case is made of malleable cast iron, machined to proper diameter and length. The bottom is ½ inch thick and is cast in one piece, with thin walls which have a thickness of only 0.15 inch in rear and 0.1 inch in front. There are three holes in the bottom. The case contains from 222 to 226 cast-iron balls 0.625 inch diameter and is covered with a top of flanged tin plate 0.04 inch thick, riveted to the case. Two sets of cuts of 120 degrees each are made through the walls of the case to insure its breaking up in the bore. The thickness of metal left between the cuts of each set, 0.2 inch, is just sufficient to make the case strong enough to stand loading and transportation. The object of the rotating band is primarily to prevent the canister from slipping through the bore when hastily loaded. It also assists in breaking up the case and increasing the dispersion. The canister, when finished, is given a coat of black lacquer. When the gun is discharged the canister is broken into three nearly equal pieces, and at the same time the balls are blown out with a cone of dispersion which will just cover the front of the gun, say 17 yards at a range of 100 yards.

The total weight of the 3.2-inch canister is 11 pounds 6 ounces minimum and 11 pounds 10 ounces maximum, distributed as follows:

	Pounds.	Ounces.
Balls	7	8
Case	3	14½
Cap or top		1½
Total (average)	11	8

FUZES.

FRANKFORD ARSENAL BASE-PERCUSSION FUZE, "HIGH C," MODEL OF 1900.

[Plate XIX.]

This fuze consists of the following parts, assembled as shown on the drawing:

a, body, brass.
b, primer-closing screw, brass.
b', closing cap, brass.
c, tin-foil disk.
d, primer cup, brass.
e, percussion composition.
f, primer shield.
g, firing-pin sleeve, brass.
h, firing pin, brass.
i, split-ring spring, brass.

There are no fuzes of this type on hand; there are about 28,000 plungers, consisting of the firing pin, the firing-pin sleeve, and the split-ring spring, for which fuze bodies may be manufactured from time to time, when required for projectiles of older manufacture tapped for this fuze.

The fuze is made principally from hard-rolled brass rods.

The body, which forms a housing for the parts of the fuze, has a beveled flange thinned down on the edges to make a gas-tight joint on the base of the shell. It has also a flat on the base for a wrench. The outside of the body is turned and threaded, and the interior, after being bored out for the plunger, is threaded for the cap which holds the plunger in position.

The service base fuzes have a left-hand thread on the fuze bodies, which, in connection with the right-hand twist of the rifling, causes a tendency of the fuze to tighten in its seat when fired.

The cap is bored out to form a recess for the primer, and is threaded on the interior for the primer-closing screw. A hole in the bottom of the primer recess permits the firing pin to strike the primer on impact. The primer-closing screw holds the primer in place, and has a vent which admits the flame from the primer to the shell-bursting charge. The cap has a notch cut on one side of its circumference for a spanner wrench. It is locked in place by driving a portion of the sharp lip into a notch in the end of the body of the fuze.

The primer has two chambers, separated by a solid vented partition. The lower chamber, 0.03 inch deep, is undercut to assist in holding the percussion pellet in place. The composition of this pellet is:

	Per cent.
Sulphur	8.76
Antimony sulphide	26.31
Potassium chlorate	50.54
Glass crystals	12.39
Shellac	2.00

The thoroughly pulverized ingredients are mixed dry, and alcohol is added to dissolve the shellac just before using. The shellac solidifies the pellet, and causes it to stick to the metal recess. The primer shield prevents any dislodgement of the composition during transportation or by the shock of discharge, and it also restrains the firing-pin point during flight of the projectile.

The upper primer chamber contains about 2.5 grains of black rifle powder, held in by a tin-foil disk. For fuzes used in small shell, this is sufficient to ignite the shell charge.

The firing pin and firing-pin sleeve constitute the plunger, and when the fuze is armed they are locked together by means of the split-ring spring and the locking groove near the base of the firing pin, in order to utilize their combined mass in striking the blow to explode the primer.

In the unarmed, or safe, condition of the fuze, the split ring rests on the conical slope on firing pin and sustains the firing-pin sleeve. The resistance of this ring to the expansion necessary to force it over the slope is less than the force required to transit the maximum acceleration of the projectile to the sleeve. This insures the arming of the fuze when fired.

The counterbored-ring recess in the rear of sleeve requires careful adjustment of dimensions. The diameter at rear will just receive the unexpanded ring and the diameter of counterbore will just receive the expanded ring. When the ring rests in the locking groove it has an intermediate expansion sufficient to prevent its withdrawal from the sleeve, and this locks the sleeve and firing pin together.

The plunger is assembled by slipping the split ring over the firing pin until it rests on the conical slope, and then inserting the pin into the sleeve from the rear. The plunger is then placed in the fuze body, pin to the front, and the fuze cap, with its parts properly assembled, screwed down hard and keyed as previously explained.

The length of the unarmed plunger is shorter than the plunger cavity by from 0.01 to 0.02 inch, so that a slight movement of the plunger is discernible when the assembled fuze is held to the ear and shaken. This is required to insure that the screwing down of the fuze cap to its shoulder shall not apply pressure to the upper end of sleeve, which would tend to force the ring over the slope and arm the fuze. The act of arming shortens the plunger and increases materially the longitudinal play of the plunger in its cavity. This fact permits a ready and simple means of inspecting for premature arming without dismantling the fuze. A very little practice in holding to the ear and shaking two fuzes, one armed and the other not, will serve to distinguish the marked difference in the play of the plunger.

The base of the fuze body is stamped to show the distinguishing fuze letter, the resistance to arming ("high" or "low"), place of manufacture, and date of model. Fuzes with "high" resistance to arming are issued and transported in loaded shell.

Just before screwing a fuze into a loaded shell a thick lead paint should be applied with a small brush to the fuze thread, and the fuze should then be screwed down hard, forcing the excess of paint out under the flange. The paint assists to make a gas-tight joint and may serve to prevent a premature explosion in case of a failure to remove all loose grains of powder from the fuze-seat thread.

The action of the fuze when the piece is discharged is as follows:

The firing-pin sleeve moves relatively to the rear for the reason previously stated, and is locked to the firing pin as explained. The point of the firing pin now projects above the sleeve and the fuze is armed, or ready.

As the projectile meets with atmospheric retardation the plunger creeps forward until stopped by the primer shield. When the projectile strikes, the pin pierces the shield and the thin layer of percussion composition. The small portion of this composition caught between the point of the pin and the solid primer partition, or anvil, is ignited.

The ratios of the weights of the sleeves, in grains, to the resistances of the split-ring pins, in pounds, for the various pieces in service have been determined by actual firing tests, by a specially designed apparatus, assembled in shells of different calibers and involving fuze plungers with varying ratios. These plungers were assembled in a way to permit arming in the usual way and to prevent inverse arming by impact. By inverse arming is meant the forcing of the firing pin forward through the sleeve, instead of the sleeve rearward over the pin.

THE 15-SECOND COMBINATION FUZE.

[Plate XX, figs. 1 to 5.]

This fuze consists of the following parts, assembled as shown on the drawing:

a, body, bronze.
b, powder ring.
b', retaining ring, brass.
b^2, brass washer.
b^3, gas-check cup.
b^4, felt gas check.
c, time train.
d, time-train cone, lead.
e, cone cover, brass.
f, cap, brass.
g, clamping nut, brass.
h, concussion or time plunger, brass.
h', split-ring spring, brass.
i, safety pin, brass.
j, connecting tube.
k, closing screw, brass.
k', powder magazine.
l, percussion primer.
m, concussion firing pin, steel.

n, percussion firing-pin sleeve, brass.
o, percussion firing pin, brass.
p, cone dowel pins, brass.
q, cover dowel pins, brass.
r, percussion composition.
r', tin-foil disk.
s, vents (4).
t, split-ring spring percussion plunger, brass.
u, wrench hole.
z, bottom closing screw, brass.
z', paper disk.
z², base cover, brass.

The time element is composed of the concussion or time plunger *h*, the firing pin *m*, the cone *d*, the time-train *c*, the cone cover *e*, the cap *f*, and the clamping nut *g*.

The plunger *h* is cylindrical in shape and contains the fulminate primer *r* in a recess at its base. Its upper extremity is pierced to receive a safety pin, *i*, which retains the plunger in its safe or unarmed position in handling and transportation. When the safety pin is removed, which is done just before firing, the weight of the plunger rests on the split-ring spring *h'*.

The action of the latter on discharge is similar to that of the split-ring spring of other ring-resistance fuzes already described.

The cone *d* is an alloy of soft metal held in place on the fuze body by the clamping nut *g* and a groove at the bottom, and is prevented from turning by four steel dowel pins, *p*.

The lip on the bottom of the cone, entering the groove in the body, acts as a gas check to prevent ignition of the powder in the connecting tube. On the exterior of the cone *d* is a left-handed groove which carries the time train *c*, and this time train communicates at its lower end with the priming charge in the tube *j* and thence with the magazine *k'*.

The time train *c* is formed of a lead tube filled with meal powder and wire drawn.

The cone cover *e* is of brass, and is held in place by the cap *f*, and prevented from turning by a small pin, *q*, projecting from the body *a*, and fitting in a slot in its lower edge. On the exterior of the cone is a left-handed groove corresponding to that on the time cone *d*, and this groove is pierced with holes numbered from 1 to 15, corresponding to the number of seconds, the spaces between the holes being divided into five equal parts.

The percussion element of this fuze consists of a ring-resistance plunger and an ordinary percussion primer.

ACTION OF THE FUZE.

As a Time Fuze.—A hole is punched through the cover, time train, and lead cone at the point in the cover corresponding to the number of seconds desired. Just before loading, the safety pin *i* is removed. This allows the time plunger *h* to rest on the fuze body, where it is held by the split-ring spring *h'*. The projectile is now

inserted in the gun. By shock of discharge the split-ring spring is expanded and the plunger forced to the rear, the primer *r* striking the firing pin and exploding. The flame from the primer passes through the four radial holes *s* and ignites the ring of compressed powder *b*. The only vent for these gases is the punched hole, and they ignite the time train at that point. The latter burns and ignites the powder in the tube *j* and the magazine *k*. The flame from the magazine charge passes through the percussion primer and percussion-plunger chamber and ignites the bursting charge in the shrapnel.

As a Percussion Fuze.—The percussion plunger arms by shock of discharge and fires the percussion primer on impact as in other percussion fuzes. The percussion plunger is grooved or fluted to permit ready passage of the flame from the front to the rear. In order to use this fuze in base-charge shrapnel an extension piece of the form shown on the drawing is screwed into the base of the fuze in place of the bottom closing screw *z*. The ignition of the pellet of compressed powder in the extension piece transmits the flame through the central tube to the base charge.

PAINTING ARTILLERY MATERIAL.

The paint issued for this purpose is olive drab paint put up in 5-pound cans ready for use, and is applied to both wood and metal parts. If the paint is too thick, turpentine should be used as a thinner, but in quantities not greater than 2 per cent by volume.

All steel and iron nonbearing surfaces will be painted. Wearing and bearing surfaces, teeth of gear wheels, elevating screws, piston rods, cylinders, counter-recoil springs, and interior of cradle will not be painted.

All parts to be painted should be free from dirt or grease. They may be washed in a liquid made by dissolving one-half pound sal soda in 8 quarts of warm water, then be rinsed in clean water, and wiped thoroughly dry.

Where the material is in fair condition and only marred in spots, the marred places should be primed and permitted to dry. Then the whole surface should be sandpapered with No. 1½ sandpaper and a coat of paint applied and allowed to dry thoroughly before use.

Where the material is in bad condition all parts should be thoroughly sandpapered with No. 2½ sandpaper, be given a coat of paint, and be permitted to dry for at least sixteen hours; then sandpaper with No. 00 sandpaper, apply a finishing coat, and permit the parts to dry thoroughly before use.

In general, two coats of paint per year will be sufficient to keep the material in good condition. After repeated painting the paint

may be so thick as to scale off in places or give an unsightly appearance. It may then be removed for repainting, as follows:

Dissolve 1 pound of concentrated lye, powdered form, in 6 pints of hot water, and slake in enough lime to give the solution the consistency of paint. Use the solution freshly mixed and apply to the parts where paint is to be removed with a brush or with waste tied to the end of a stick. When the solution begins to dry on the surface use a scraper to remove the old paint, and complete the cleaning of the surface with cloth and water. If one application is not sufficent to loosen the paint, apply a second coat. Before painting wash the surface with sal soda water, rinse with clean water, and then wipe thoroughly, as described above.

OILS FOR ARTILLERY MATERIAL.

For the service, cleaning, and preservation of this material the Ordnance Department issues cylinder (or hydrolene) oil, lubricating (or synovial) oil, sperm oil, coal oil, neat's-foot oil, and light slushing oil. Each of these oils is suited for the particular purpose for which it is issued, as stated below, and care should be taken that it is not used for other purposes.

The lubricating (or synovial) oil will be used exclusively in all oil holes of the material, and in lubricating such parts as wheels and axles, gun and cradle slides, pintle socket, elevating and traversing mechanisms, exterior of cylinders, brake bearings, hinges, different surfaces of breechlocks, threads of breech recess, etc.

The sperm oil is a lighter lubricant than the synovial oil, and may be used on the gears of sights, fuze setters, range quadrants, parts of revolvers, etc.; synovial oil may also be used on such parts.

Coal oil is issued by the Ordnance Department for cleaning purposes. In the field it may be used for lanterns. Coal oil for general illuminating purposes is furnished by the Quartermaster's Department.

Neat's-foot oil is used for the care and preservation of all leather equipment, and should be applied as directed on page 40.

Light slushing oil is prescribed for use in the protection and preservation of all bright or unpainted surfaces of steel or iron on all parts of the equipment when the material is to remain unused for an appreciable length of time. Its use as a lubricant for mobile artillery is forbidden.

Before applying the slushing oil to any surface the part should be thoroughly cleaned, so as to be free from rust, water, coal oil, lubricating oil, etc., as their presence will cause rusting under the slushing oil. The slushing oil should then be applied in a *thin uniform coat*, since this is all that is necessary to give good protection.

Except in very cold weather it can be applied by using a paint brush as when painting; in cold weather it should be applied by stippling—that is, lightly tapping the surface with the end of the brush held with bristles perpendicular to the surface to be covered. It can be applied to the bores of guns by the slush brush issued for the purpose. In cold weather it should be warmed before use for coating the bores of gun.

It may be readily removed by the use of burlap or waste dipped in coal oil.

REPAIRS FOR FIELD ARTILLERY MATERIAL ISSUED TO THE UNITED STATES ARMY AND THE ORGANIZED MILITIA.

Instructions relative to making repairs to field batteries and furnishing ordance stores and supplies for them will be found in General Orders, No. 9, War Department, Washington, January 12, 1911, General Orders, No. 116 of 1911, and General Orders, No. 136 of 1911, so far as pertains to the United States Army, and in General Orders, No. 225, War Department, Washington, December 19, 1910, so far as pertains to the Organized Militia.

Instructions in reference to the care, use, and repair of delicate instruments, such as sights, telescopes, and range finders will be found in General Orders, No. 47, War Department, Washington, March 24, 1905.

GENERAL INFORMATION WITH REFERENCE TO ORDNANCE SUPPLIES FOR ARTILLERY.

Cavalry saddles are usually supplied in three sizes, in the following proportions:

	Per cent.
No. 1, 11-inch seat	15
No. 2, 11½-inch seat	50
No. 3, 12-inch seat	35

Since November, 1901, the adjustable quarter straps have been made three inches shorter on either side than they formerly were.

Curb bits are issued in various sizes, determined by the length of the mouthpiece:

	Per cent.
No. 1, length of mouthpiece, 4½ inches	15
No. 2, length of mouthpiece, 4¾ inches	75
No. 3, length of mouthpiece, 5 inches	10

No. 4, length of mouthpiece, 5¼ inches, and No. 5, length of mouthpiece, 5½ inches, are issued only when specially called for.

All bits, both curb and snaffle, are made of 27 per cent nickel steel, a practically noncorrosive metal.

The olive-drab saddle blanket is regulation for all arms of the service.

The nave box and wrench are issued only upon special requisition, which states the necessity therefor and when such issue will be manifestly for the interests of the service.

Halter chains will be supplied when requested.

Such articles as may be needed for training the horse, the cavesson, longing rein, running rein, etc., may be readily made up by the battery saddler from supplies furnished by the Ordnance Department.

For the training of enlisted men, leather heads and wooden stands for supporting them will be needed. The saddler and the wheelwright or carpenter will be able to supply these by means of the tools in the forge and battery wagon.

If necessary, the leather blacking issued may also be used in lieu of stencil paste. The stencil brush should be dipped in the blacking and as much of the blacking as possible should then be taken from the brush until it is left nearly dry; it is then applied by a vertical movement of the brush. A little practice will enable one to make a clear-cut marking, perfectly black and perfectly indelible.

TOOLS, ACCESSORIES, AND CLEANING AND PRESERVING MATERIAL.

Blacksmith's, carpenter's, and saddler's tools, saddler's material, and cleaning and preserving material will be issued to a 3.2-inch battery when organized, in accordance with the allowance prescribed for a 3-inch battery.

Tools and accessories for the guns, carriages, and other vehicles are enumerated under each.

INDEX.

WAR DEPARTMENT,

OFFICE OF THE CHIEF OF ORDNANCE,

Washington, December 2, 1914.

July 30, 1902.

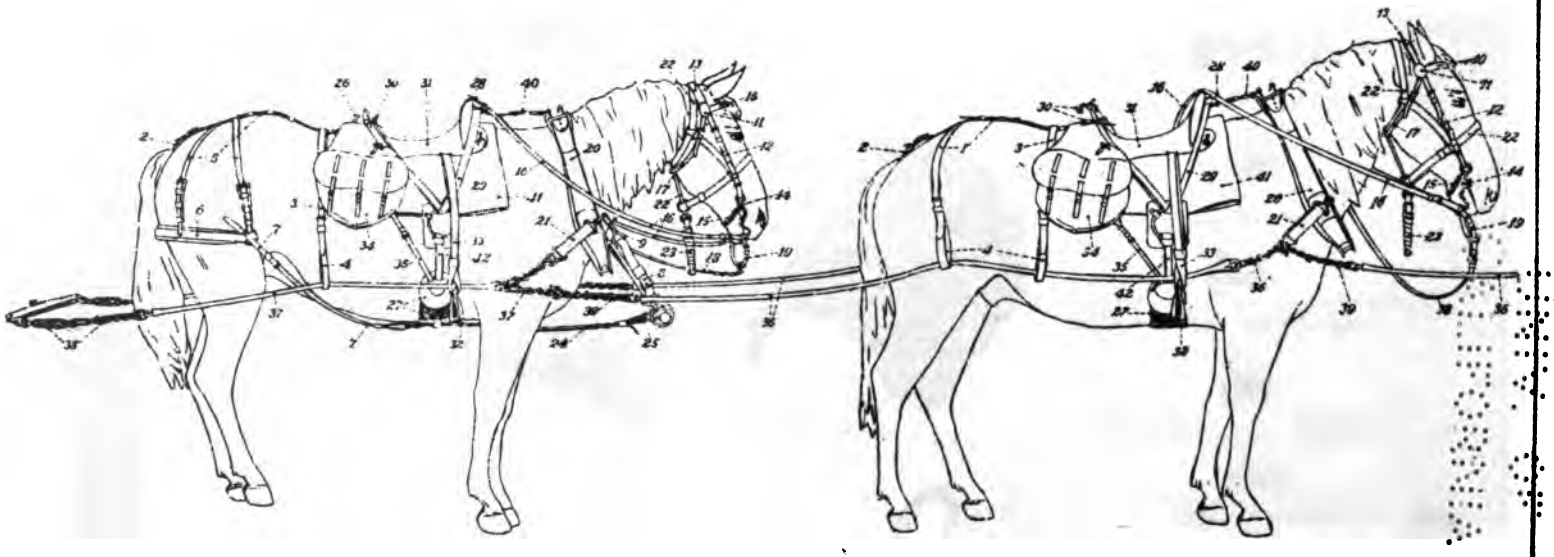
Revised June 23, 1908.

Revised December 2, 1914.

Form No. 1660.

Ed. Aug. 24–17—700.

PLATE XI.



Off Wheel Harness

Off Lead Harness.

Artillery Harness

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COLLAR STRAP

COLLAR PAD CONNECTION

BUCKLE LATCH

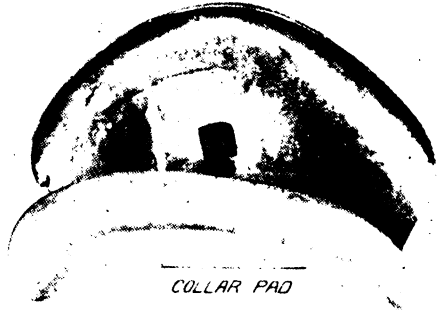
BOLT AND NUT FOR TOP CONNECTION

BOLT AND NUT FOR BOTTOM OF COLLAR

PAD BOLT AND NUT

BOLT AND NUT FOR TRACE PLATE

BOLT AND NUT FOR EXTENSION

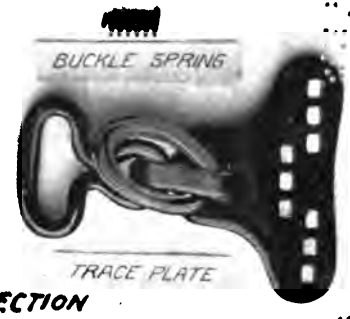


COLLAR PAD

DRAFT SPRING

WRENCH

PAD HOOK



TRACE PLATE

COLLAR BACK STRAP CONNECTION

PLATE XIX.

BASE PERCUSSION FUZE "HIGH C."

FIG. 3.
BEFORE ARMING.

FIG. 4.
AFTER ARMING.

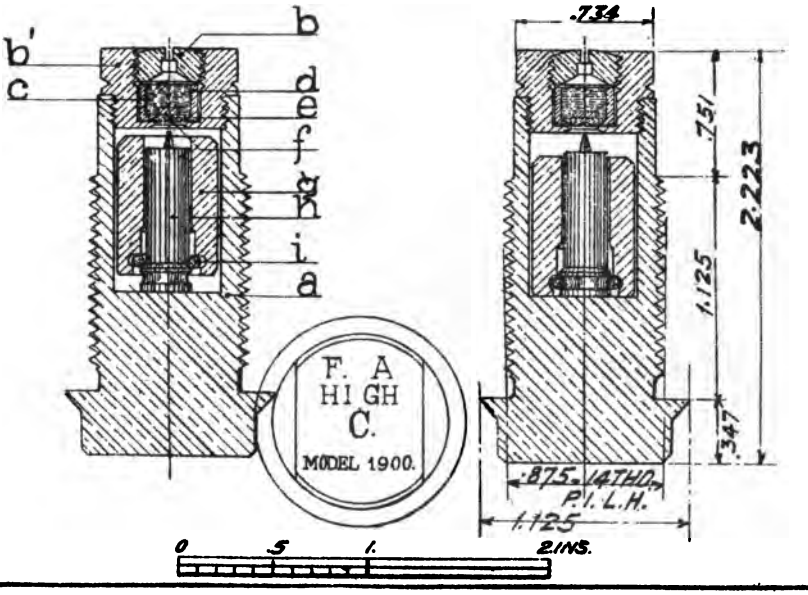


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PLATE XX.

FRANKFORD ARSENAL COMBINATION FUZES.
MODEL 1900.

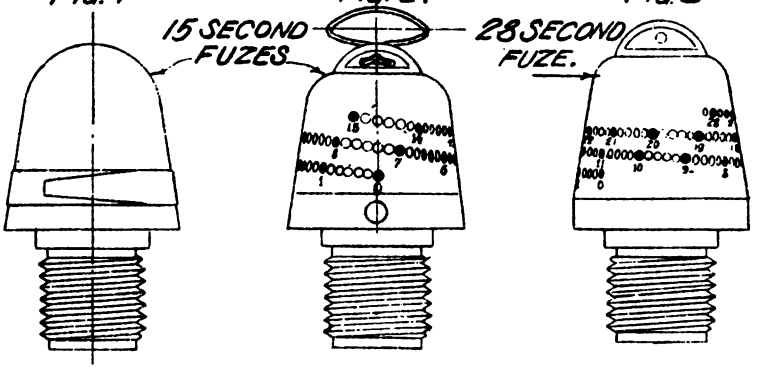
FIG. 1

FIG. 2.

15 SECOND FUZES

FIG. 3

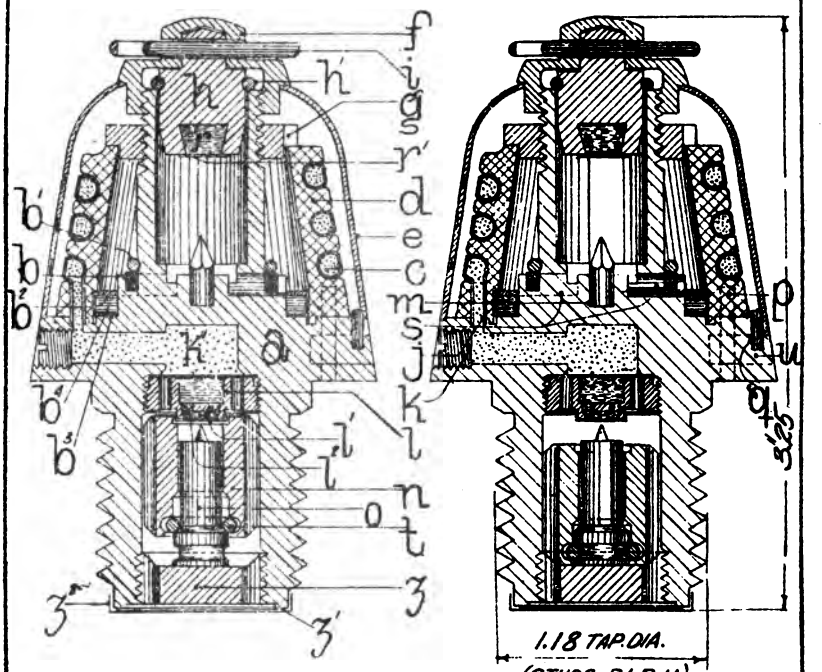
28 SECOND FUZE.

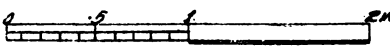


FRANKFORD ARSENAL 15 SEC. COMBINATION FUZE.

FIG 4.
BEFORE ARMING.

FIG. 5
AFTER ARMING.





SCALE OF INCHES

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