COAST ARTILLERY
TECHNICAL MANUAL

FIXED SEACOAST ARTILLERY

ORDNANCE and MUNITIONS

MANUFACTURING, INSTALLATION, OPERATION & MAINTENANCE

by Jack R. Buckmeir

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This book is published by Graphic Services & Mfg. NW in Portland, Oregon and is donated to the various parks and museums to be sold with the proceeds to be used for the security and upkeep of the fortifications. Please consider your purchase of this book to be a donation to preserve history for future generations.

JACK R. BUCKMEIR
VANCOUVER, WASHINGTON
SEPTEMBER 1996

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Preface

During the 1890's and the early 1900's, artillery pieces were installed in concrete emplacements to protect the coast of the US. These weapons were designs advanced from the smoothbore cannon and were intended to defend against the most modern naval vessels at the time.

Rapid changes in strategy, armament, and air power soon made the weapons obsolete, but one must remember the overall methods and attitudes were quite different back then. The United States did not have a policy of keeping large standing armies or quantities of materiel in times of peace until the cold war era began. Since things moved at a snail's pace compared to today's rapid conflicts, there was plenty of time to observe hostile buildup and react. Besides, the citizens in those days were very frugal and believed the government should be also. (We could learn a lot from this).

Various new weapons and supplies were developed between conflicts but no large production begun until a mobilization was necessary, and after each conflict everything except the bare necessities needed to support a skeleton force was sold or scrapped.

Thus, the seacoast weapons were left in place even though obsolete, just because they were already there and could be of limited use for coastal defense.

Before 1914 there were but six government arsenals and two private companies that knew anything about the manufacture of heavy weapons (arsenals at that time were really large government manufacturing facilities capable of producing heavy artillery, ammunition, and gun carriages).

In 1917, at the start of US involvement in WWI, there were still only around 20 factories able to produce arms even though Europe had been at war for some time and a few US companies were contracting to produce materiel for the British and French. By the time the Armistice was signed there were over 8,000 manufacturing plants in the US working on ordnance contracts.

The needs in Europe were mainly troops and ammunition. The British and French were already tooled up and producing arms at a tremendous rate but needed additional ammunition capabilities. Since the Europeans used the metric system, this posed a tremendous problem to US companies since all new tools would have to be made in order to manufacture compatible materiel. After the US entered the war, it was decided that to provide the earliest possible shipment of heavy artillery to Europe obsolete pieces could be "borrowed" from coastal installations and replaced after the war. Gun tubes were removed and shipped to the arsenals to be mounted in mobile mounts while the carriages were scrapped or stored. Very few of the mobile guns were actually shipped to France because by the time it took to remanufacture even the existing weapons, the war had ended.

Of course the weapons were never replaced because they were obsolete, so this explains why many of the 5, 6, 8, 10 inch rifles and 12 inch mortars were removed in 1917 and not replaced.

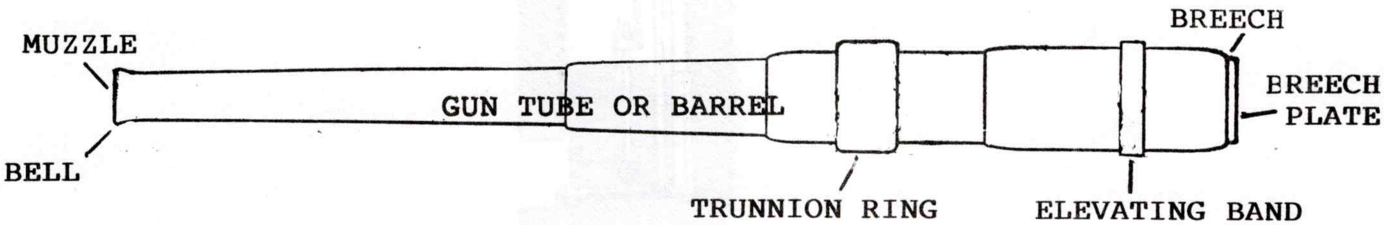
In the 1920's the 3 inch rapid fire weapons were declared obsolete and many were removed from their installations.

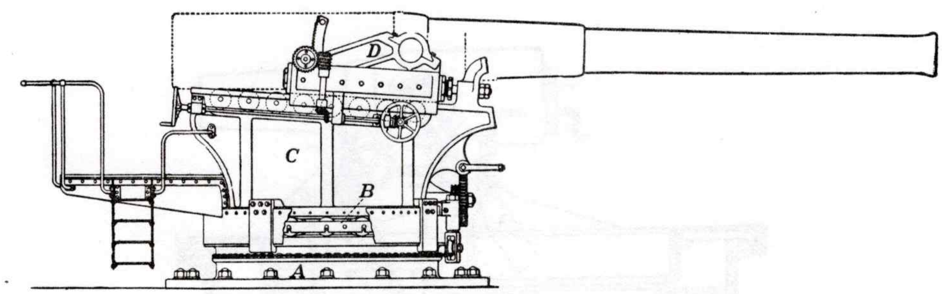
WWII brought another furious mobilization, but since we were again starting from ground zero we had to use what was there. The threat of modern air and naval power made these coastal installations even more obsolete, and new installations were designed and constructed. However, by the time the fortifications were completed, they were not needed.

After WWII the Coast Artillery was disbanded since we now had radar, missiles, and the atom bomb. Fixed fortifications were deemed of little use, as strategy now called for mobile weapons. The heavy weapons that had required so much effort to construct and install were cut up in their mountings with little effort using cutting torches and the pieces trucked off to the scrap yard. Most of the land was no longer needed and was either donated for parks or sold. It is a pity more attention was not paid to the needs of history.

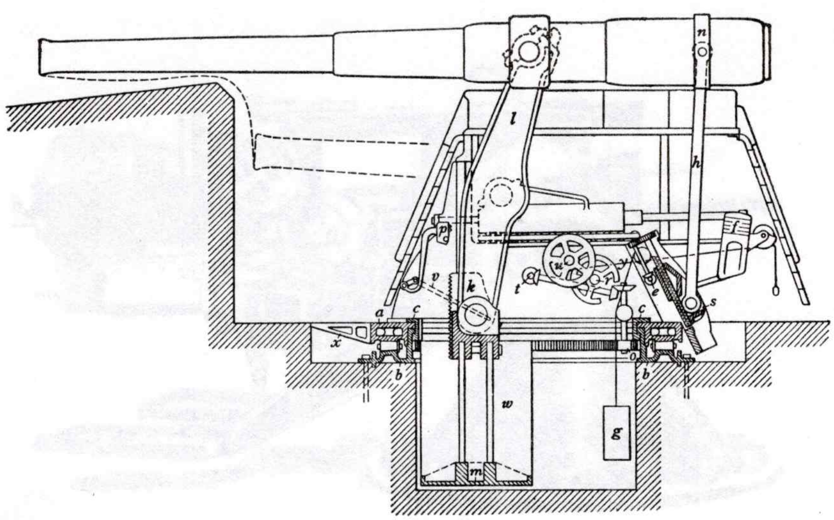
Today we are left with some of the concrete emplacements and foundations without the massive steel machinery and many of the buildings that were there. Therefore I have compiled this book to detail the image and operation of the armament that no longer exists.

DESCRIPTIONS

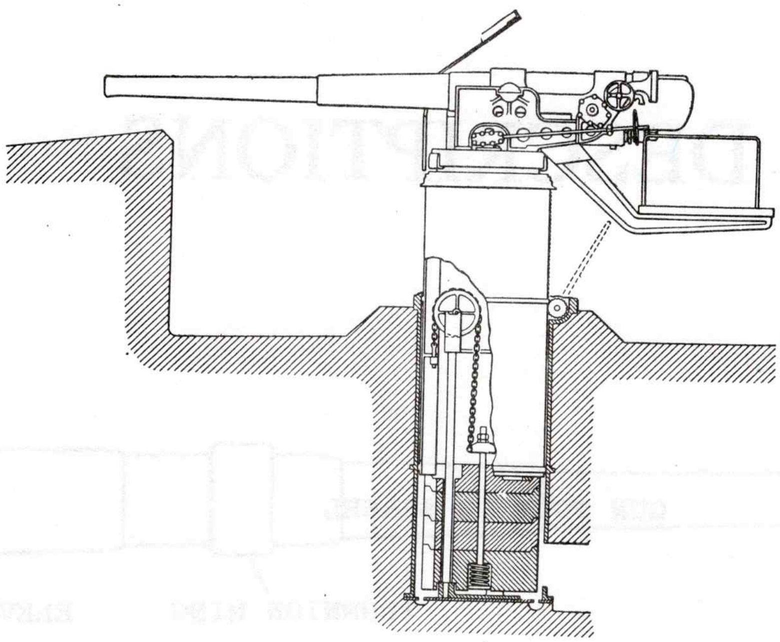




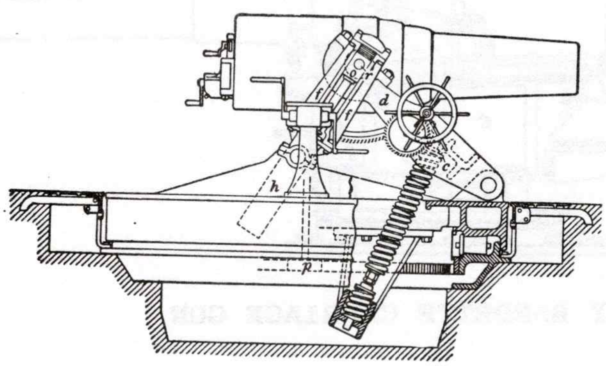
EARLY BARBETTE CARRIAGE GUN



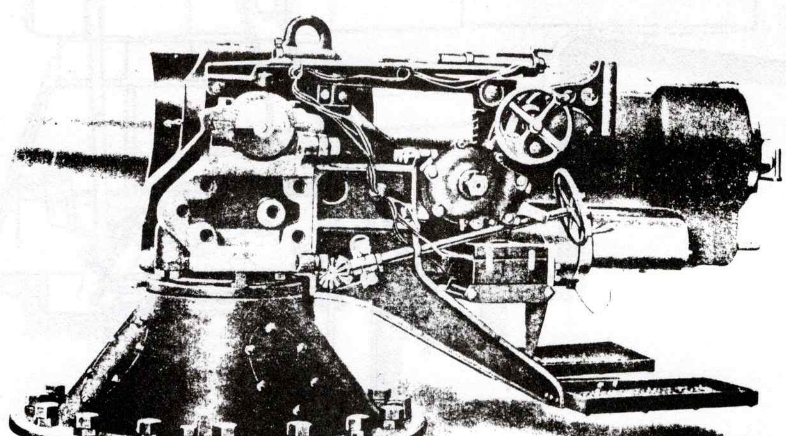
DISAPPEARING RIFLE



5 INCH RIFLE WITH SHIELD ON BALANCED PILLAR MOUNT
(3 INCH RAPID FIRE WAS VERY SIMILAR TO THIS MOUNT)



12 INCH MORTAR ON SPRING RETURN CARRIAGE



6 INCH RIFLE ON BARBETTE PEDESTAL (SHIELD REMOVED)

CHAPTER ONE
BARREL DESIGN

The old familiar smoothbore cannon was generally cast in one piece of Iron or Bronze. This design, while being relatively simple did not stand up to high pressures very well. These pieces were muzzle-loaded and early attempts to manufacture castings that could be loaded at the breech were unsuccessful.

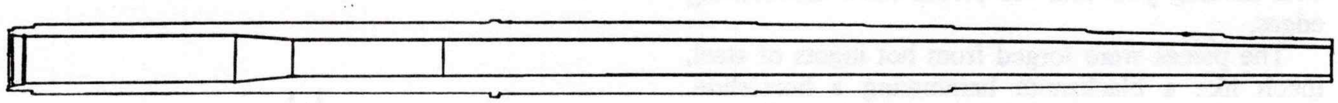
It wasn't until steel became available in large quantities in the late 1800's before radical design changes could occur. Advances in machining technology and materials now meant barrels could be made longer and with rifling grooves for greater range and accuracy. Steel could be machined to the close tolerances needed for breech loading.

Another contributing factor was the development of nitrocellulose powder, which allowed a controlled rate of expansion against the projectile rather than the instant ignition of black powder developing tremendous pressures mainly in the breech.

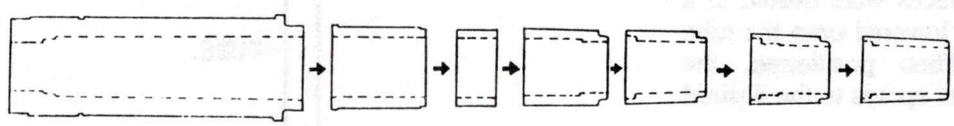
Since a single piece tube cannot contain as much pressure as a tube being compressed by another tube over it, built-up barrels were designed and known as "Compound Guns". Modern artillery barrels are made in this fashion and may look as though they are one cast piece but they are really a collection of cylinders pressed together. Some barrels are composed of long tubes covered with many rings or hoops. Some barrels, designed by Gen. William Crozier of the Ordnance Dept. in the 1800's, were tubes wrapped with many layers of square steel wire at 50,000 lb. of tension and covered with a steel jacket. These were known as "Wire Wrapped Guns"

Barrel design varied from year to year as different techniques and theories were used, however the general principles were the same.

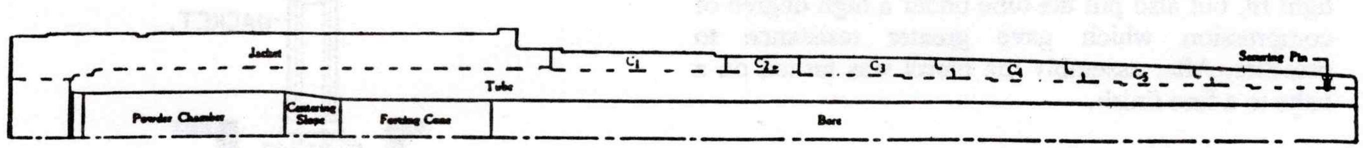
In the following diagrams we will see construction of the 10 inch model of 1888, 34 calibers in length. This barrel begins with a forged steel tube, machined and rifled:



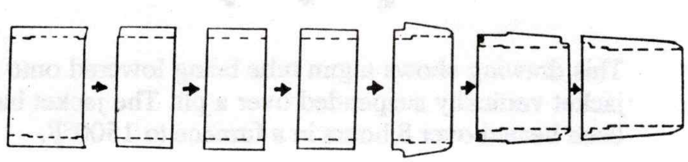
Over this tube, the following row of cylinders are pressed to make the first stage:



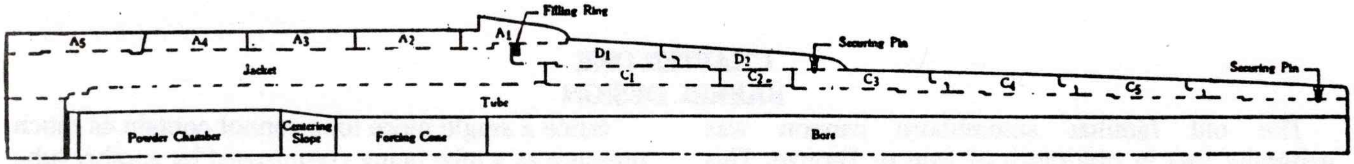
Assembled, the cut-away section looks like this:



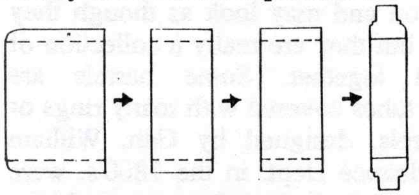
Over this, a second set of cylinders are pressed:



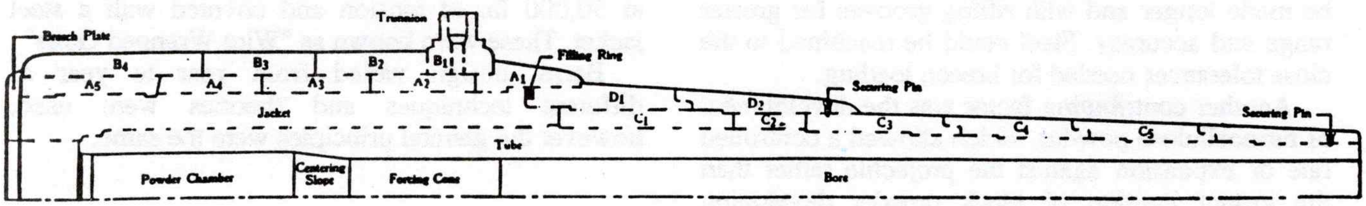
Here is a cutaway of the second phase:



Finally the third set is pressed on:



Resulting in the finished product:

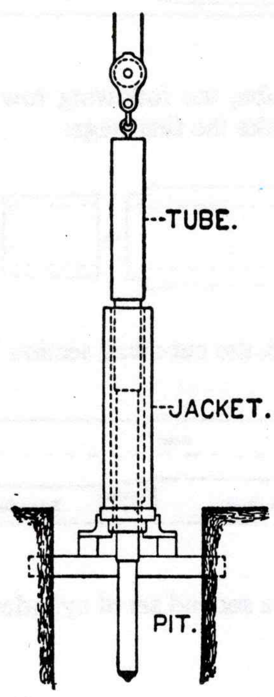


In this model you will note the pieces are secured with locking pins and the pieces have interlocking edges.

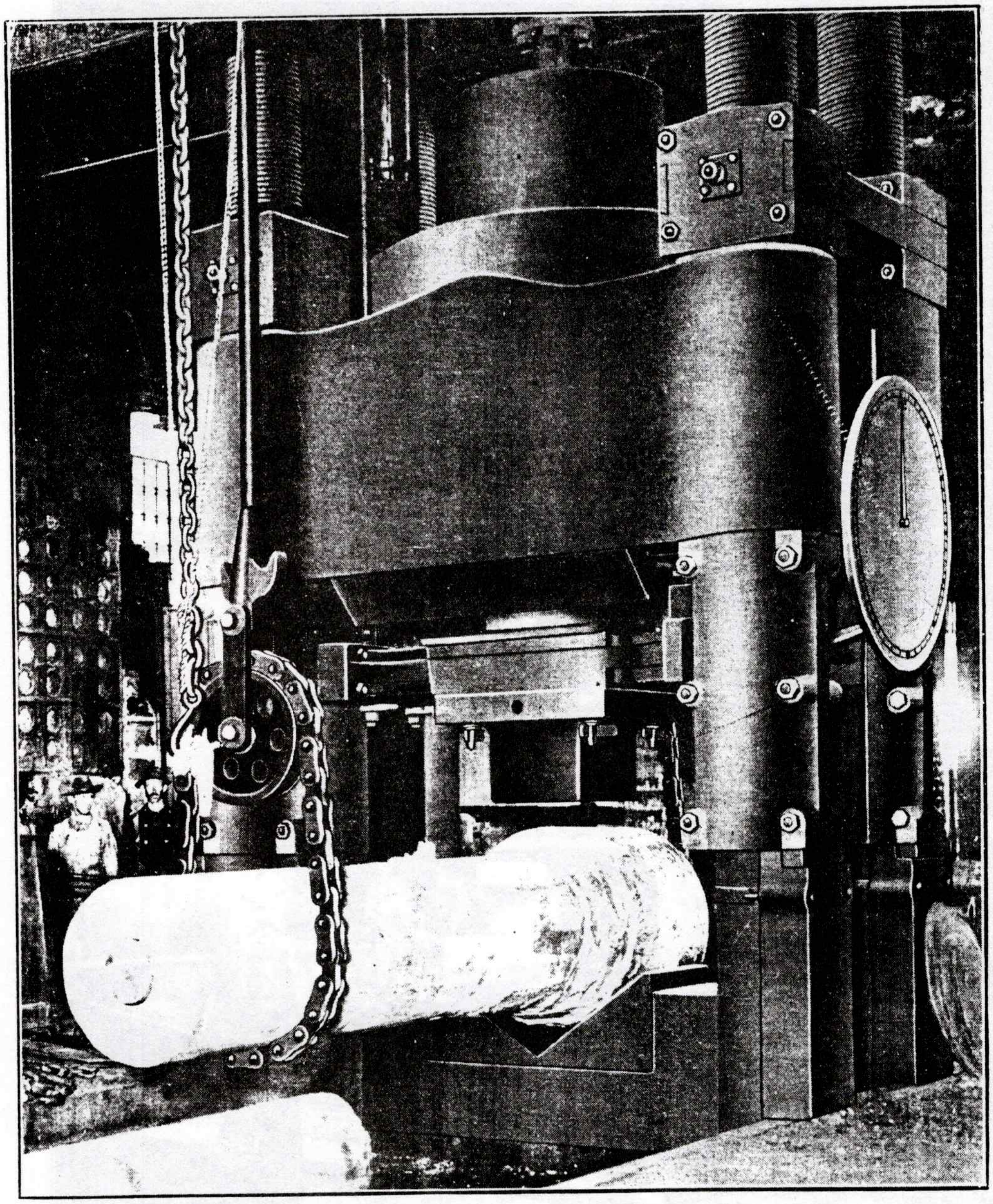
The pieces were forged from hot ingots of steel, much like a blacksmith hammering a horseshoe. Larger pieces were forged with a mandrel inside the ingot while smaller rings or hoops were forged using a mandrel as an anvil (see illustrations).

Assembly was accomplished by suspending the tube vertically in a pit. The pieces were heated in a furnace to expand them, then lowered onto the tube and pressed into place. When positioned, the assembly was cooled with water sprays to the desired degree of shrinkage.

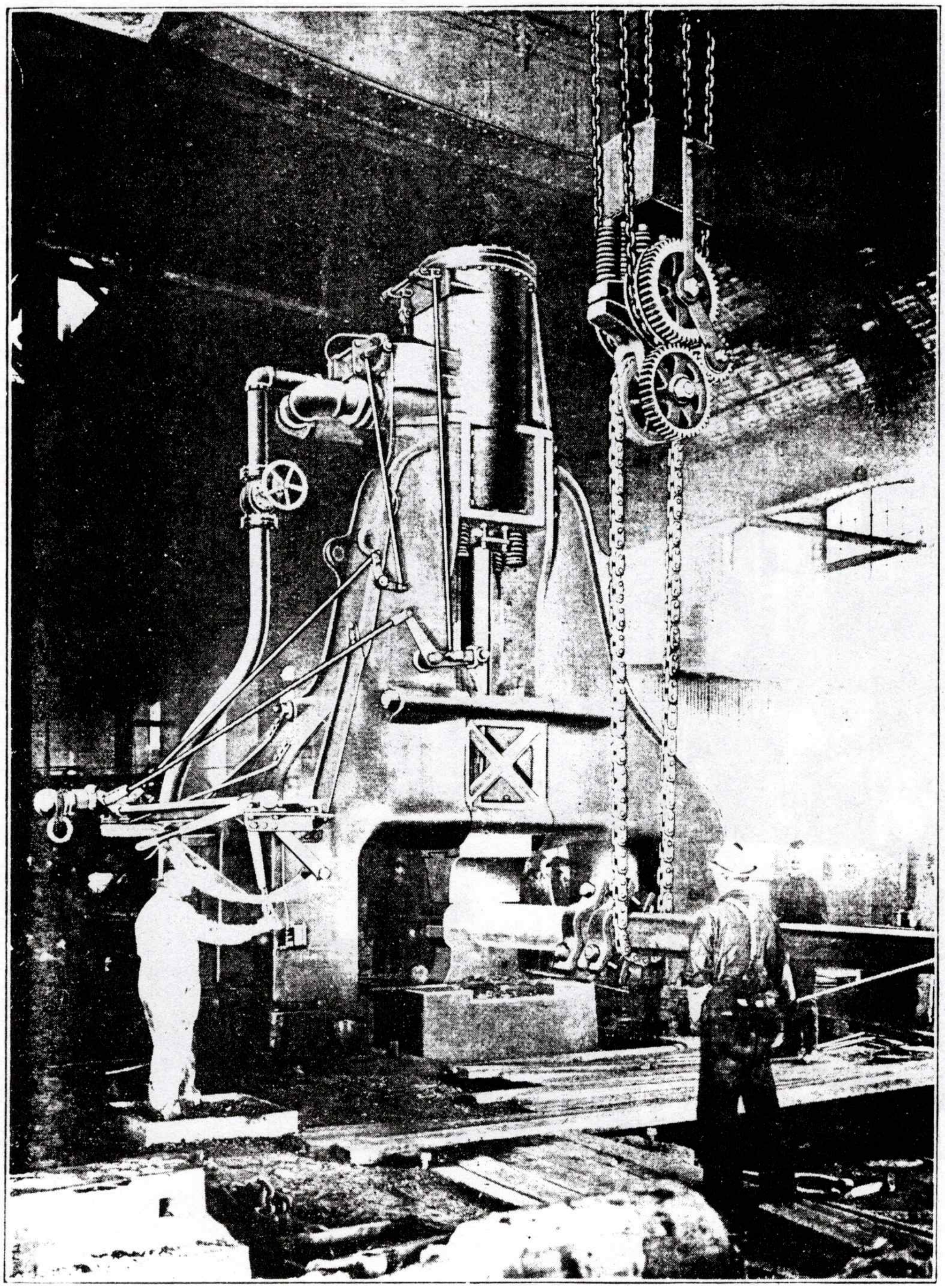
Not only did shrinking the pieces create a very tight fit, but also put the tube under a high degree of compression which gave greater resistance to pressure. After assembly the barrel was turned on a lathe to a fine finish.



This drawing shows a gun tube being lowered onto a jacket vertically suspended over a pit. The jacket has been heated over 8 hours in a furnace to 1500°F.

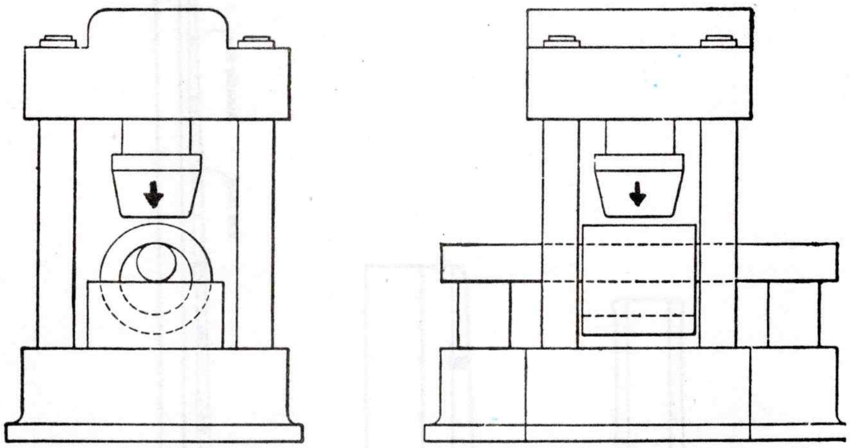


This 1800's photo was taken at the Bethlehem Steel Works and shows a 5000 ton hydraulic press forging a 12 inch gun barrel. Note the mandrel in the center of the ingot to retain the bore shape. The ingot was turned by the chain around it at the front and by a chain around the mandrel in the back (out of view). The process was repeated until the desired shape was obtained.
(taken from Tschappat's "Ordnance and Gunnery" 1917)

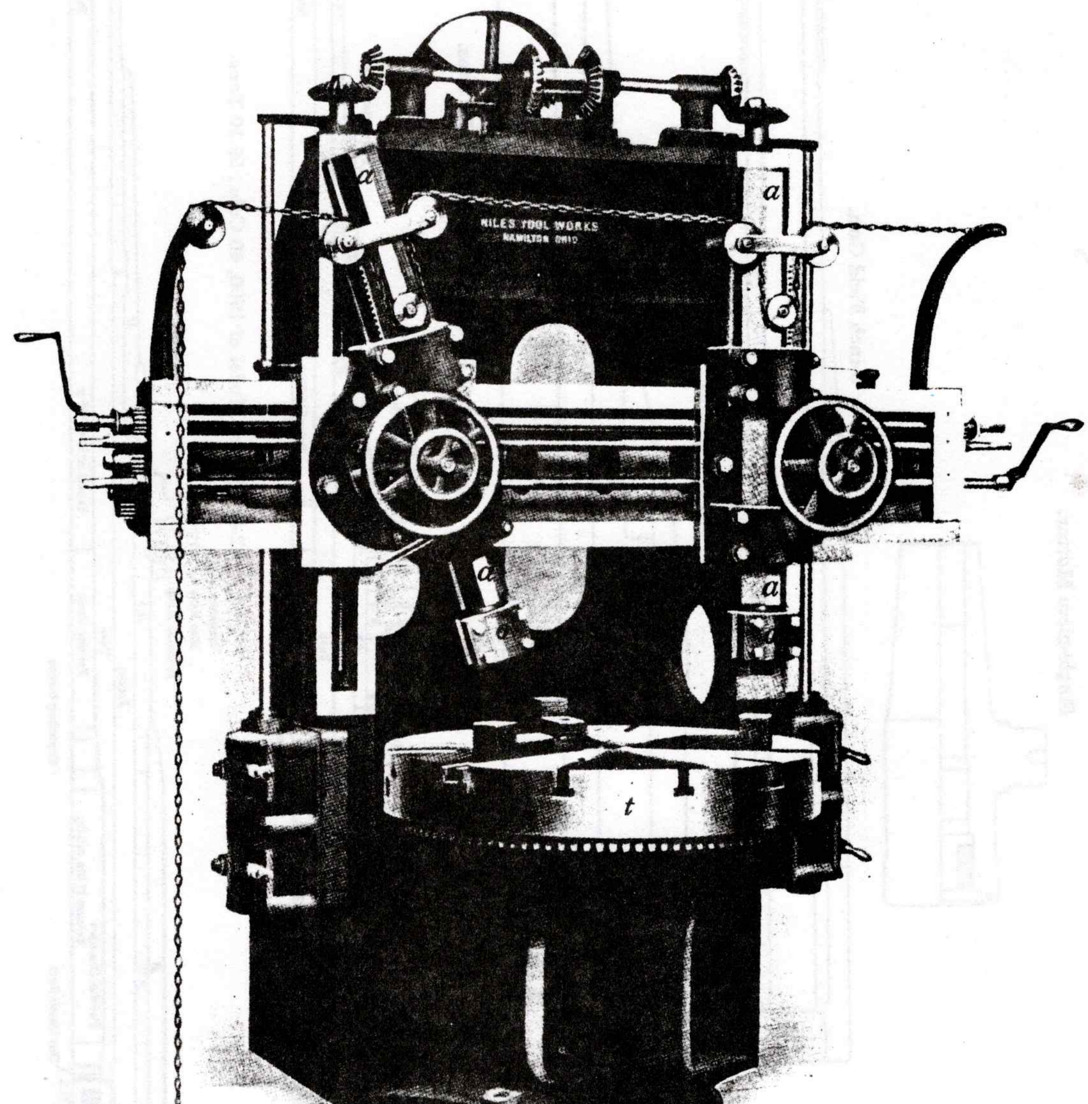


This 1800's photo shows a 10 ton steam hammer forging a tube. The piece is revolved by rotating the chain around the mandrel between hammer blows.
(taken from Tschappat's "Ordnance and Gunnery" 1917)

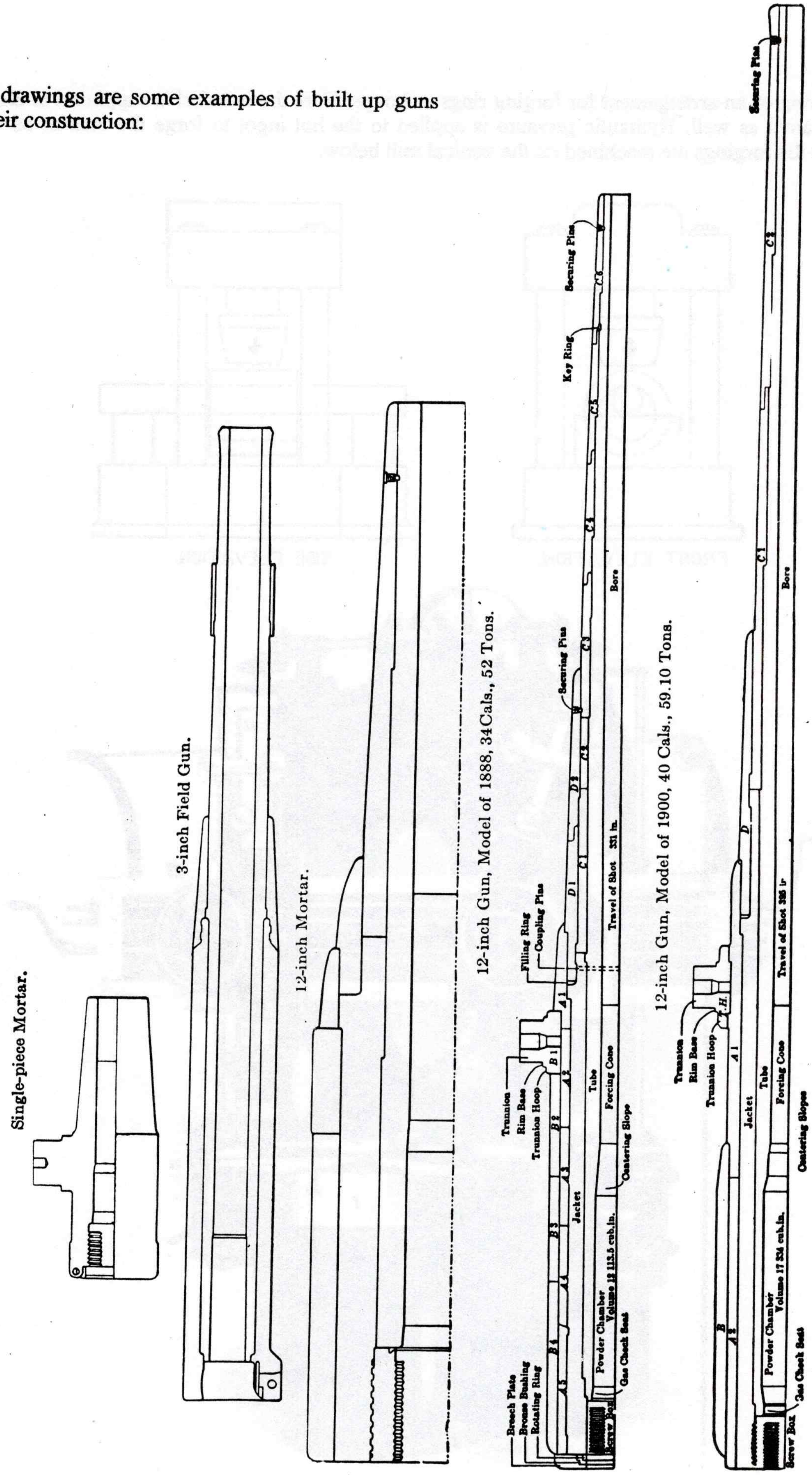
This is a drawing of an arrangement for forging rings or hoops. Here the mandrel is supported at each end and becomes the anvil as well. Hydraulic pressure is applied to the hot ingot to forge the interior as well as the exterior. Then the forgings are machined on the vertical mill below.



FRONT ELEVATION.　　SIDE ELEVATION.



These drawings are some examples of built up guns and their construction:



Single-piece Mortar.

3-inch Field Gun.

12-inch Mortar.

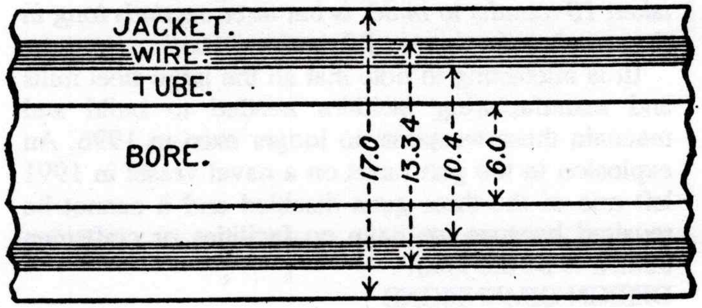
12-inch Gun, Model of 1888, 34 Cals., 52 Tons.

12-inch Gun, Model of 1900, 40 Cals., 59.10 Tons.

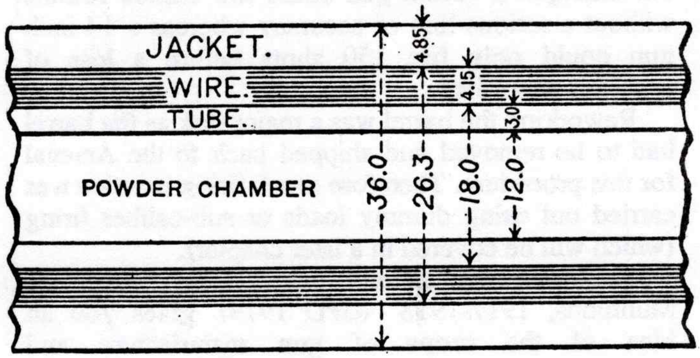
WIRE WRAPPED GUNS

Wire-wrapped barrels were cheaper and easier to build but were not as rigid and had a tendency to "droop" when idle and to "whip" when fired. Some barrels were built with replaceable liners to compensate for the extreme wear on the bore from firing, but replacing liners in wire-wrapped barrels was considerably harder with less than satisfactory results.

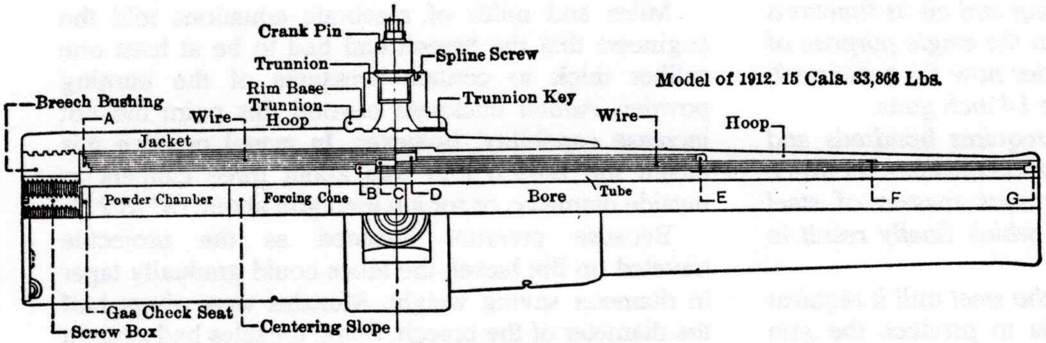
The drawings below are examples of wire-wrapped guns. The cross sections are that of a 6 inch and 12 inch gun.



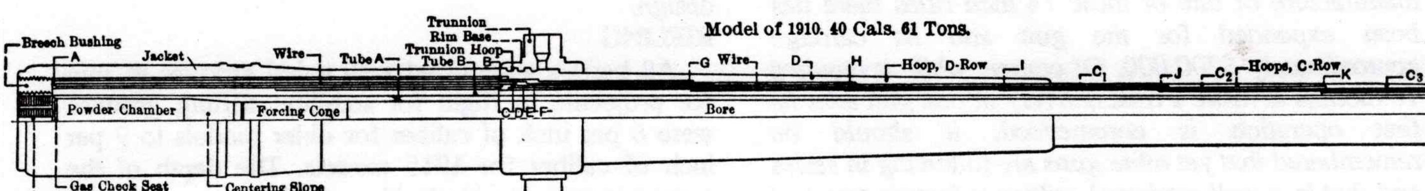
6" barrel



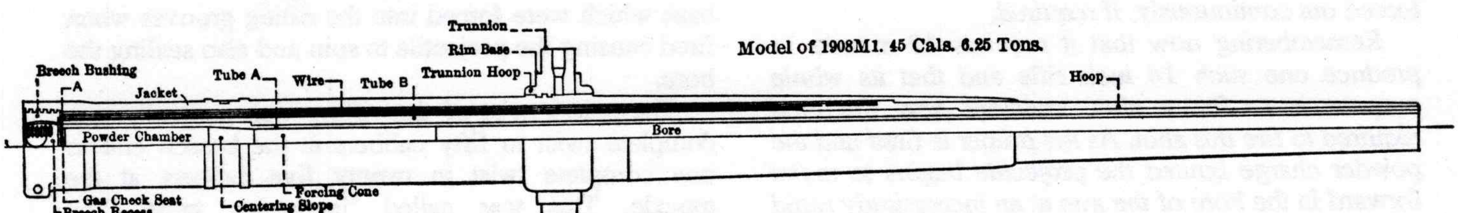
12" barrel



12"MORTAR MODEL 1912.



14"GUN MODEL 1910.



6"GUN MODEL 1908.

LINERS

Many barrels were made with replaceable liners. Due to pressures and heat from burning powder, the bore would wear out after many firings. The general rule was the larger the caliber, the greater the wear. For example a 75mm gun could fire 12,000 rounds without a serious loss of accuracy whereas a 14 inch gun could only fire 150 shots before a loss of accuracy was noted.

Reworking the barrel was a major task as the barrel had to be removed and shipped back to the Arsenal for this procedure. Therefore much firing practice was carried out using dummy loads or sub-caliber firing (which will be covered in a later chapter).

The following excerpt, taken from "America's Munitions, 1917-1918" (GPO 1919) gives you an idea of the scope of gun manufacture and maintenance at the time:

"It may be helpful to keep in mind throughout that the sole purpose of a gun is to fire a projectile, as was stated at the very beginning of this chapter. All other operations connected with the life of a gun, its manufacture, its transportation to the place where it is to be used, its aiming, its loading and all its functions and operations are bound up in the single purpose of actually firing the shot. Consider now for a moment, the life of, let us say, one of the 14 inch guns.

In the great steel mills it requires hundreds and perhaps thousands of workmen to constitute the force necessary to handle the enormous masses of steel through the various processes which finally result in the finished gun.

From the first operation in the steel mill it requires perhaps as long as 10 months to produce the gun ready for the first test. During the 10 months of manufacture of one of these 14 inch rifles there has been expended for the gun and its carriage approximately $200,000. Of course, while it requires 10 months to make a final delivery of one gun after its first operation is commenced, it should be remembered that yet other guns are following in series and that in a well-equipped ordnance factory two and perhaps three guns per month of this kind can be turned out continuously, if required.

Remembering now that it requires 10 months to produce one such 14 inch rifle and that its whole purpose is to fire a shot, consider now the time required to fire this shot. As the primer is fired and the powder charge ignited the projectile begins to move forward in the bore of the gun at an increasingly rapid rate, so that by the time it emerges from the muzzle and starts on its errand of death and destruction, it has taken from a thirtieth to a fiftieth of a second in time depending on certain conditions.

Assuming that a fiftieth of a second has been taken up and that the life of a large high-pressure gun at a normal rate of firing is 150 shots, it is obvious the that in the actual firing of these 150 shots only three seconds of time are consumed.

Therefore, the active life of the gun, which has taken 10 months to build, is but three seconds long in the actual performance of throwing a shot".

(It is interesting to note that all the large steel mills and manufacturing facilities needed to build and maintain these weapons no longer exist in 1996. An explosion in the gun turret on a naval vessel in 1991 left one of the three guns disabled and it cannot be repaired because we have no facilities or craftsmen trained to do the job.)

DESIGN DIMENSIONS

Many of the size dimensions of the guns are designated in calibers, or the diameter in inches of the bore. A 6 inch gun might have a 50 caliber long barrel, for example: 6X50= 300 inches. Older models of large guns generally had 34 or 35 caliber barrels while newer models had up to 50 caliber barrels.

Miles and miles of algebraic equations told the engineers that the breech end had to be at least one caliber thick to contain pressures of the burning powder. Added thickness beyond this point did not increase capability, however. In actual practice this meant the breech end was about three calibers in outside diameter, or for a 6 inch gun about 18" to 21".

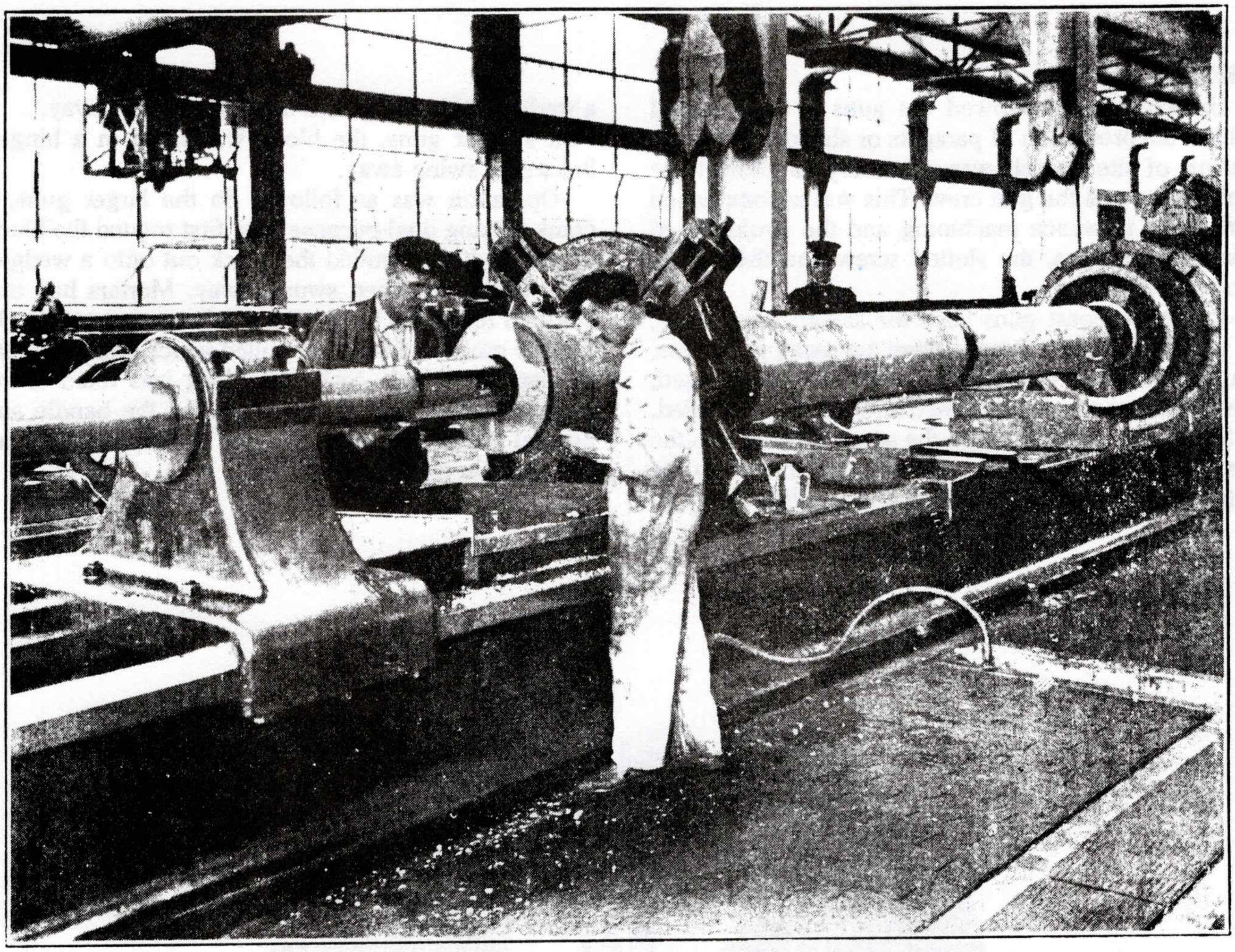
Because pressure lessened as the projectile traveled up the barrel, the tubes could gradually taper in diameter saving weight. Muzzles were about half the diameter of the breech. Some muzzles had straight ends and some had bell-shaped ends depending on design.

RIFLING

All barrels were rifled with spiral grooves to spin the projectile in flight for stability. Rifling grooves were 6 per inch of caliber for older models to 9 per inch of caliber for 1915 models. The depth of the groove increased with the size of caliber.

Shells had brass or copper rings pressed onto the base which were forced into the rifling grooves when fired causing the projectile to spin and also sealing the bore.

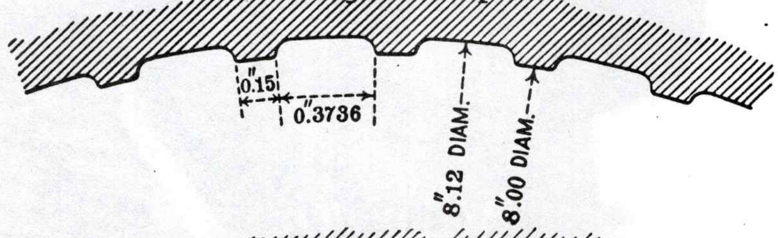
The spiral twist of the rifling was generally one complete twist in fifty calibers at the breech end to one complete twist in twenty five calibers at the muzzle. This was called "increasing twist" The projectile would spin more as it approached the end of the barrel. Mortars used one twist in 40 calibers to one twist in 20 calibers. Some pieces used a uniform twist throughout the bore.



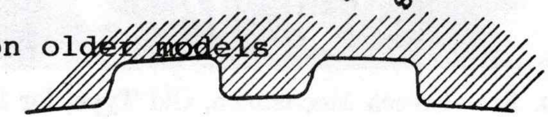
TUBE OF A 155 MILLIMETER GUN IN A LATHE BEING BORED

The ingot out of which this tube was made, came from the mold in an octagonal shape and later was forged in to a square shape and finally made round. (taken from "America's Munitions 1917-1918 GPO 1919)

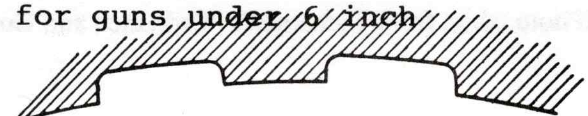
1. Rifling at 6 per inch



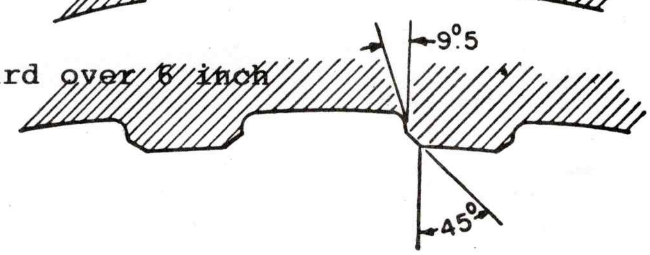
2. Rifling used on older models



3. 1915 standard for guns under 6 inch



4. 1915 standard over 6 inch



BREECHES

Breech loading allowed the guns to be serviced behind the protection of parapets or shields. Complete sealing of the breech was necessary to protect the mechanism and the gun crew. This was accomplished with close tolerance machining and the evolution of two basic designs, the slotted screw and the wedge block mechanisms.

Larger seacoast guns used the slotted screw type, in which the screw threads were cut away in sectors, usually 4 to 6. When the breech block was engaged, the screw threads were meshed and the breech sealed. A fraction of a turn brought the screw threads into the cut away sectors which allowed the block to be extracted. In extraction, the block was pulled onto a wedged slide which was hinged to swing away.

On smaller guns, the block was fixed in a hinged bracket to swing away.

Operation was as follows: on the larger guns, a crank turning dual-purpose gear first rotated the block to unlock it then pulled the block out onto a wedged slide which was then swung away. Mortars had one crank to rotate the block and another to extract it . On smaller guns a handle was pulled which caused a gear to rotate the block. Since the block was fixed to the hinged bracket, a further pull locked the handle and bracket together and caused the block to swing out and away in one smooth motion.

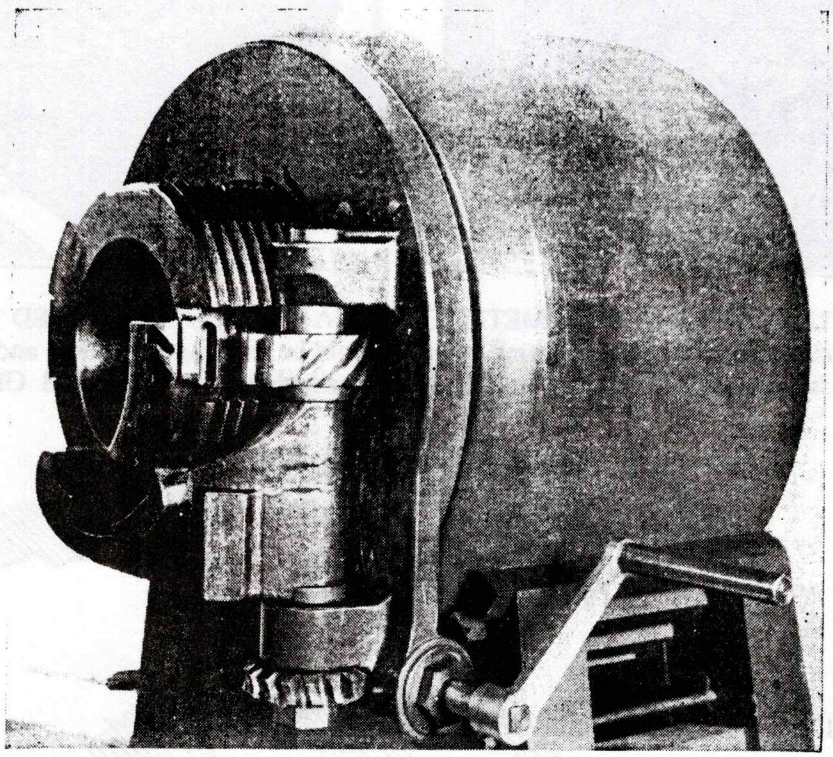


FIG. 81.—Breech Mechanism, Old Type, for 14-in. Guns.

(Photo taken from Tschappat's "Ordnance and Gunnery" 1917)

This drawing is of the breech mechanism on the preceeding page:

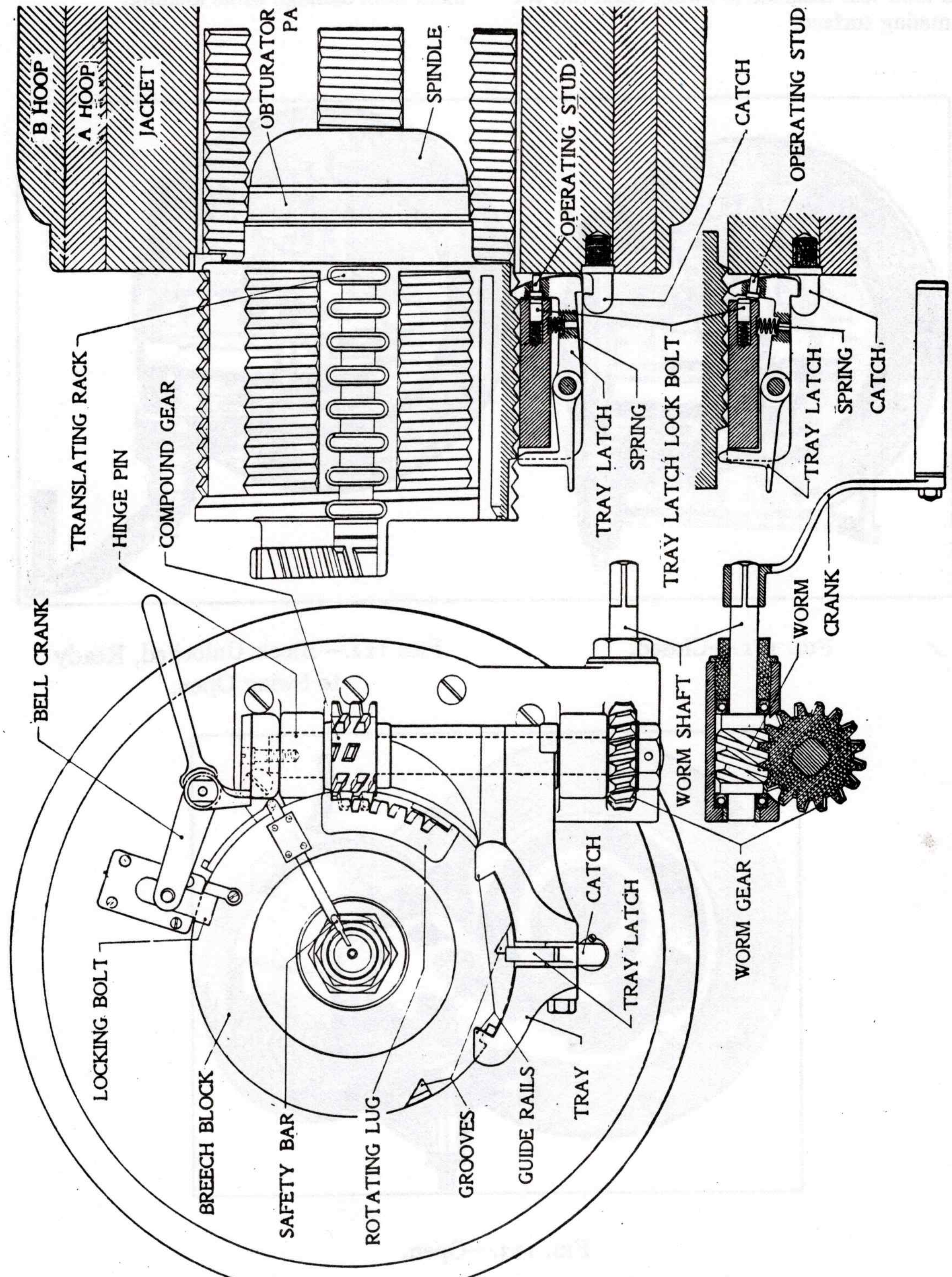


FIG. 77.—Breech Mechanism, Old Type, for Heavy Guns.

THE BOFORS BREECH MECHANISM

This mechanism was used on many 6 inch guns. The main distinguishing feature between this and similar mechanisms was the cone-shaped breech block which took less distance to swing open but yet had a large mating surface.

This model had a moveable loading tray that sat in the cut away sectors when locked and moved over to cover the breech threads when unlocked protecting them from damage while loading.

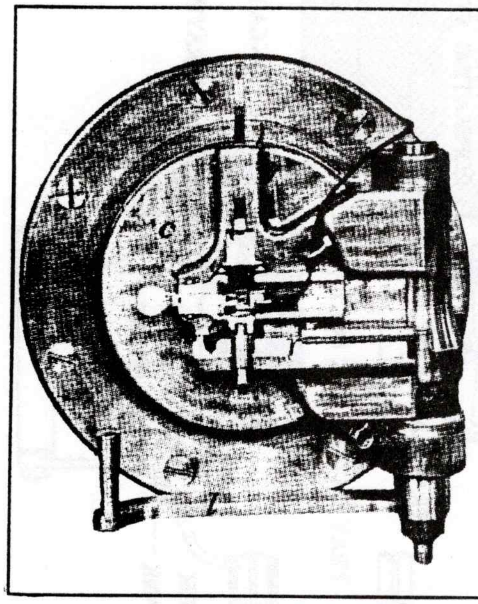


FIG. 111.—Closed.

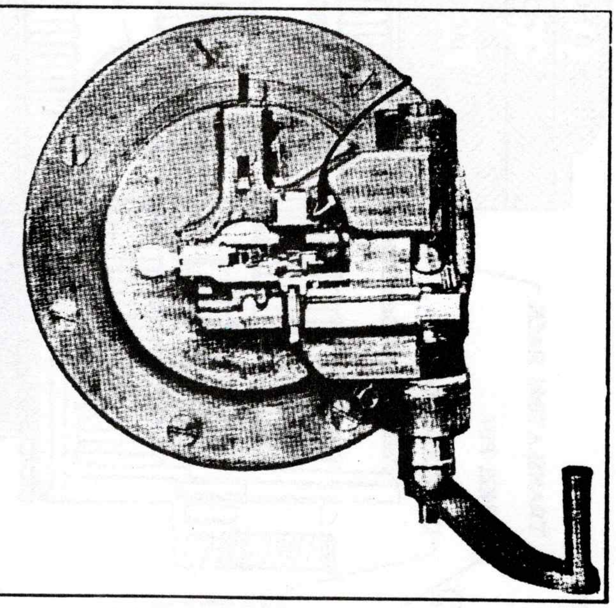


FIG. 112.—Block Unlocked, Ready to Swing Open.

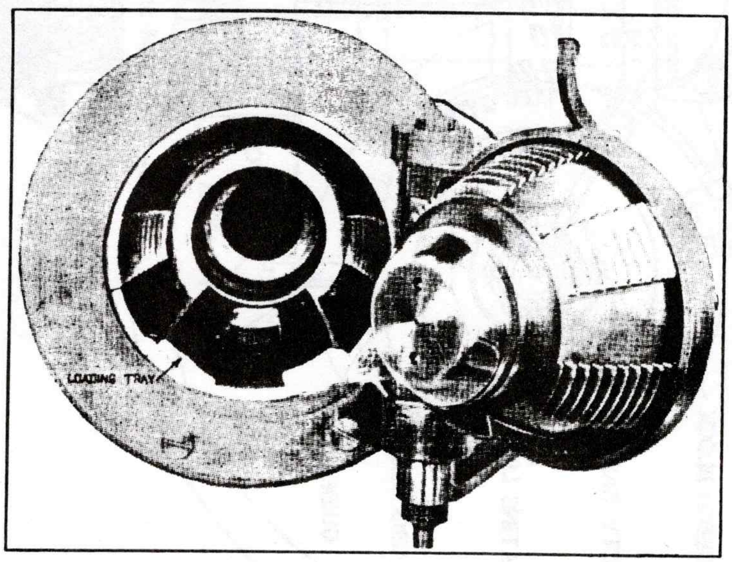


FIG. 113.—Open.

BOFORS RAPID FIRE BREECH MECHANISM.

12 INCH MORTAR MECHANISM

This is a drawing of the breech mechanism for the 12 inch mortar. You will note that there are two cranks, one to unlòck the block and one to extract the block. The revolving crank rotated the block by turning a large ring gear while the translating crank pulled the block out onto the slide. After extraction the tray latch was activated to allow the tray assembly to be swung aside for access.

This drawing also shows the breech block in place, how the obturator positioned in the bore for sealing, and the general built-up nature of the overall barrel design.

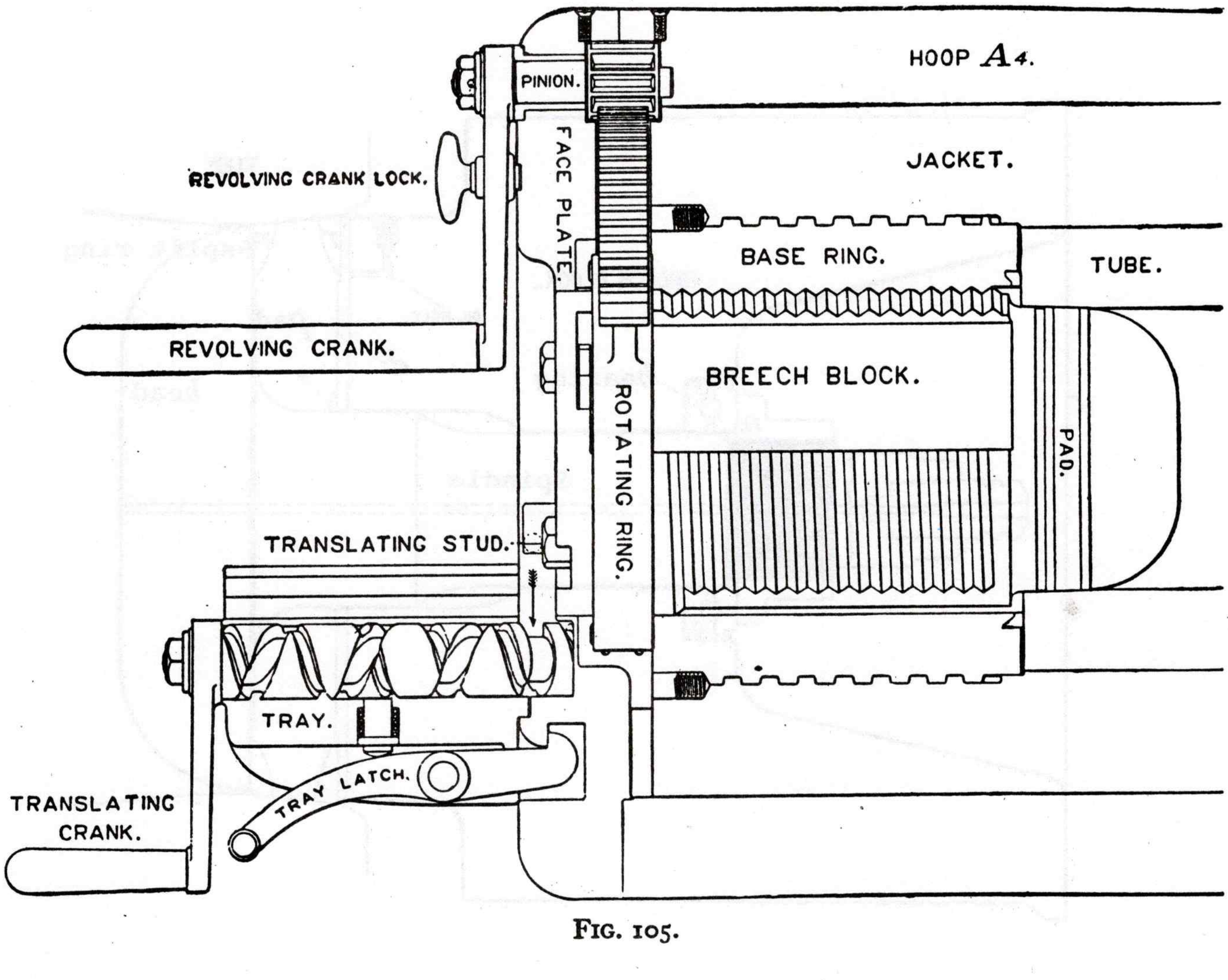


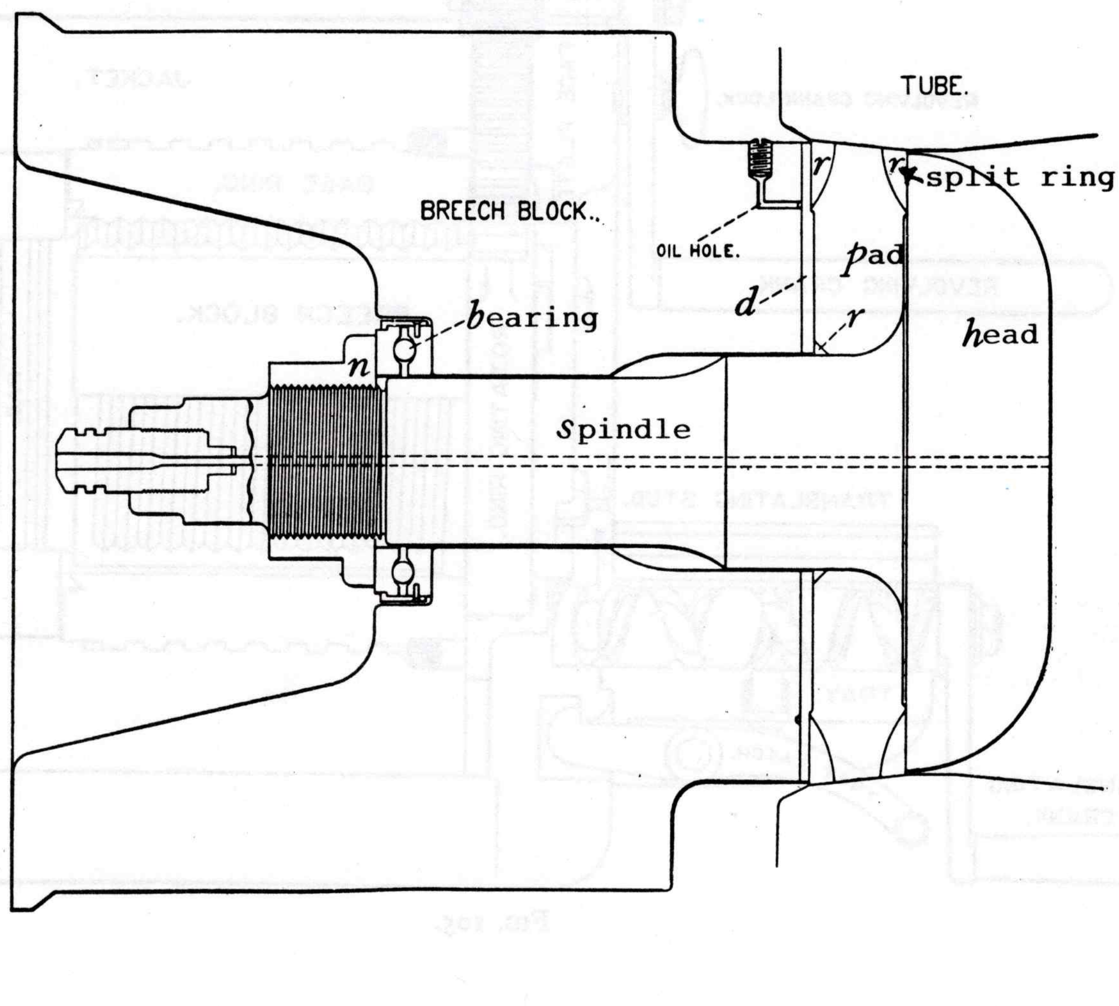
FIG. 105.

OBTURATORS

Sealing the breech from escaping gasses was accomplished with a mushroom shaped piston on the front of the breech block that was forced back during firing, expanding split rings and an asbestos pad against the walls of the bore. This device was called an obturator.

Seacoast guns used obturators of the DeBange type exclusively, shown in the drawing below.

The face of the obturator had a hole in the center for the primer to fire through and two holes towards the perimeter for crusher-type pressure gauges to measure breech pressures. The gauges were rather interesting having an outer section that collapsed on firing exposing a stationary rod in the center which was then measured with a micrometer to determine pressure exerted.



FIRING MECHANISMS

Firing mechanisms consisted of devices to fire the primer and safety devices to prevent accidental firing. Primers could be fired with percussion (being struck), friction (wire being pulled), or with electricity. Firing had to take place only when the breech was fully in place and locked. Several types of mechanisms evolved (see illustrations).

Below is an example of a breech mechanism for heavy guns. Note the simple electric contact block at the top which breaks the path for current. Below the electric wire is a lanyard cord, which when pulled fires the primer. In this illustration the breech is not fully locked and since the safety bar is not in the correct place, the primer cannot fire.

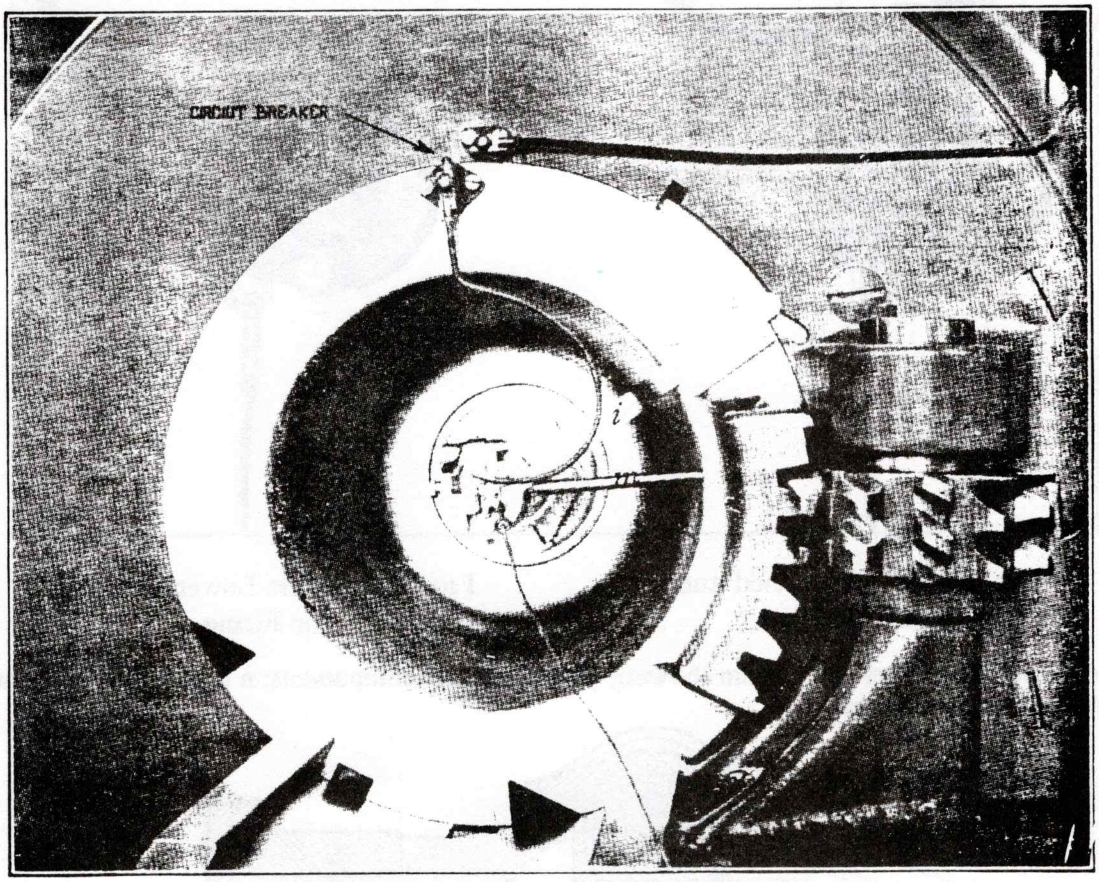


FIG. 120.—Breech Partially Unlocked. Safety Bar Forced in by Cam Slot, and Electric Circuit Broken.

This is an example of a friction primer. When the wire is pulled the friction causes ignition to take place.

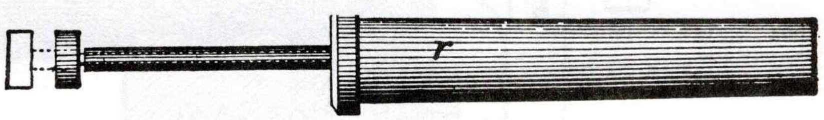


FIG. 117.

This illustration is the firing plate of another mechanism:

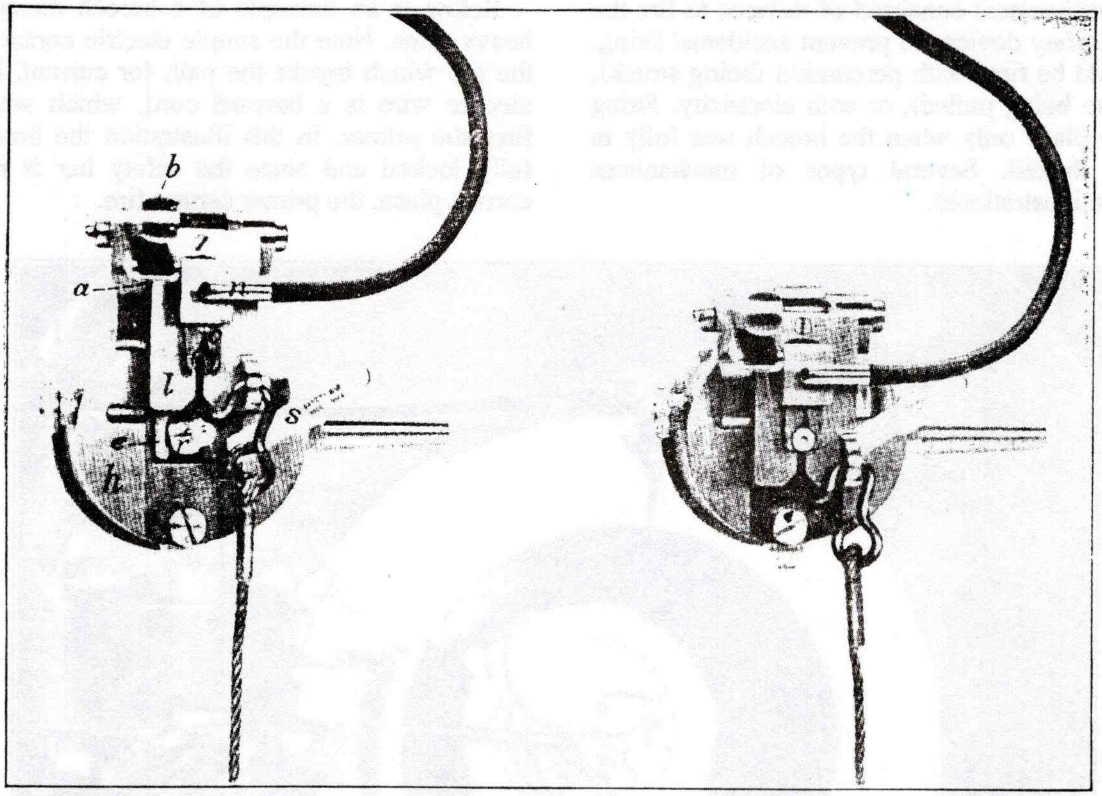
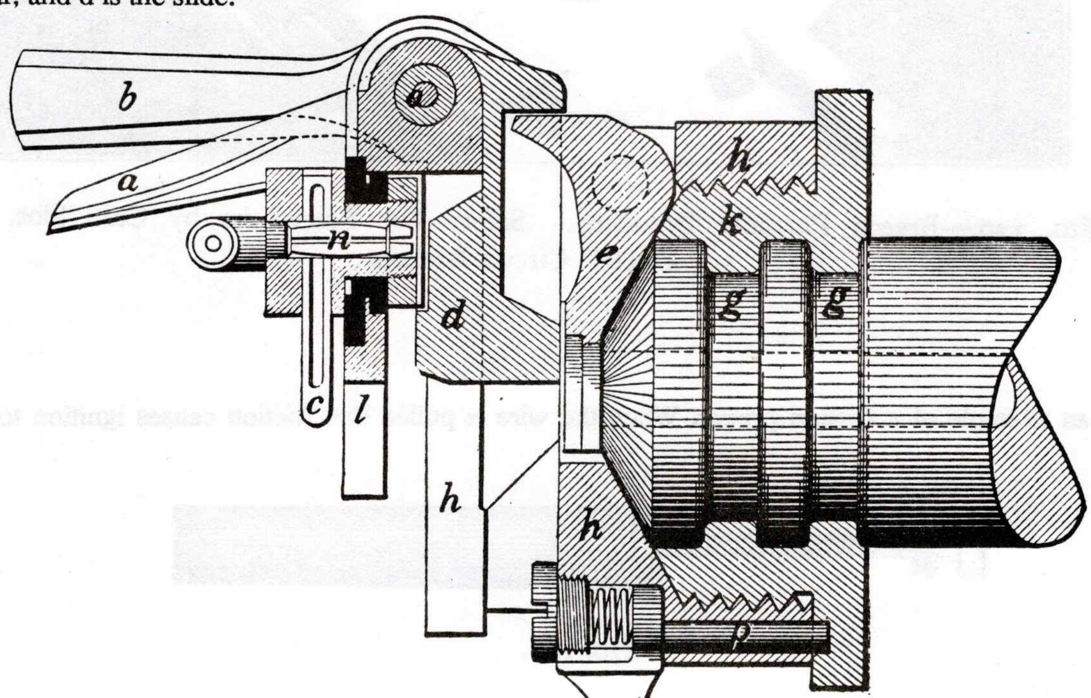


FIG. 118.—Slide Raised and Primer Inserted.

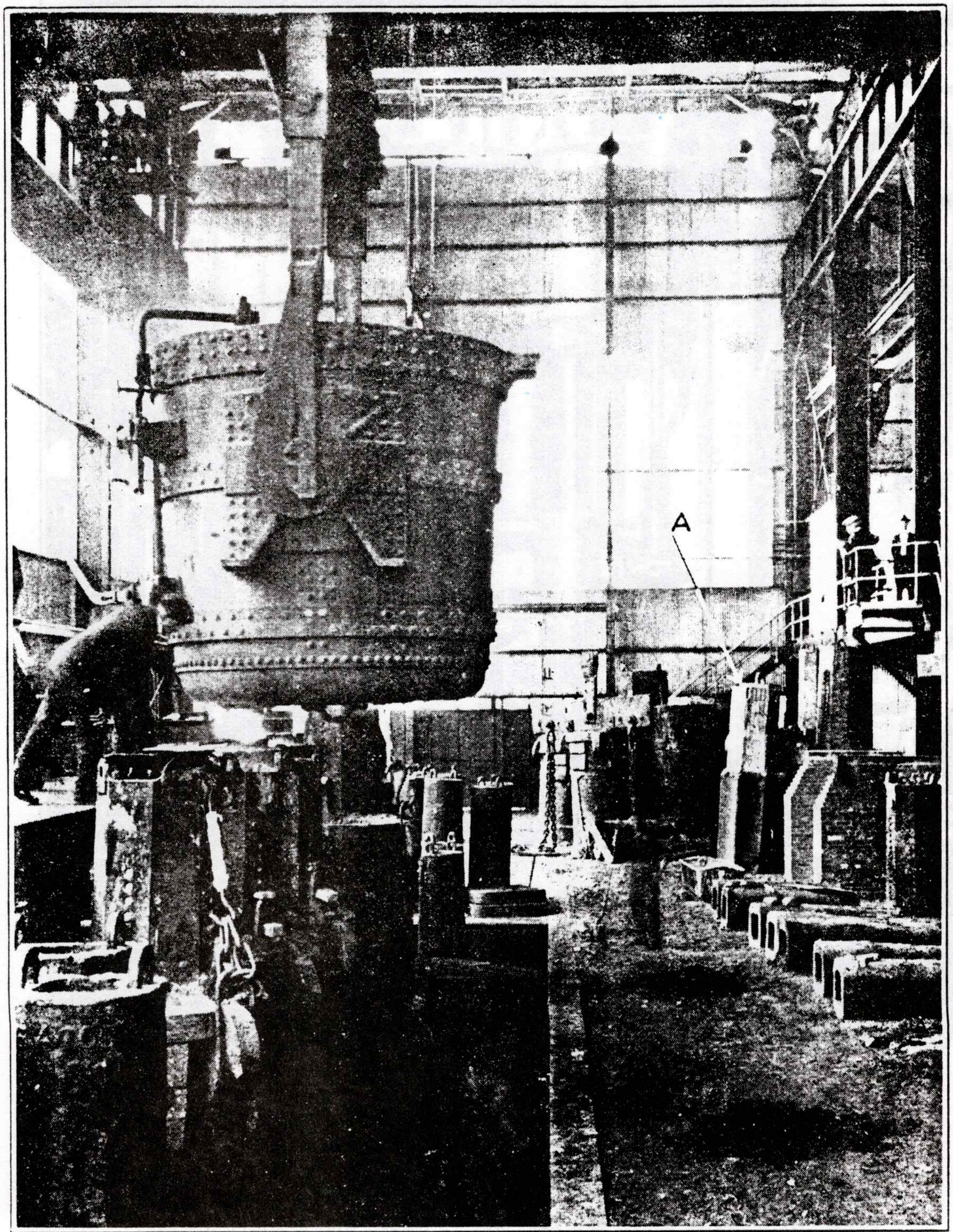
FIG. 119.—Slide Lowered Ready for Firing.

This is a cut away of another mechanism showing the mechanical components: n is the electrical contact, l is the lanyard leaf, and d is the slide.



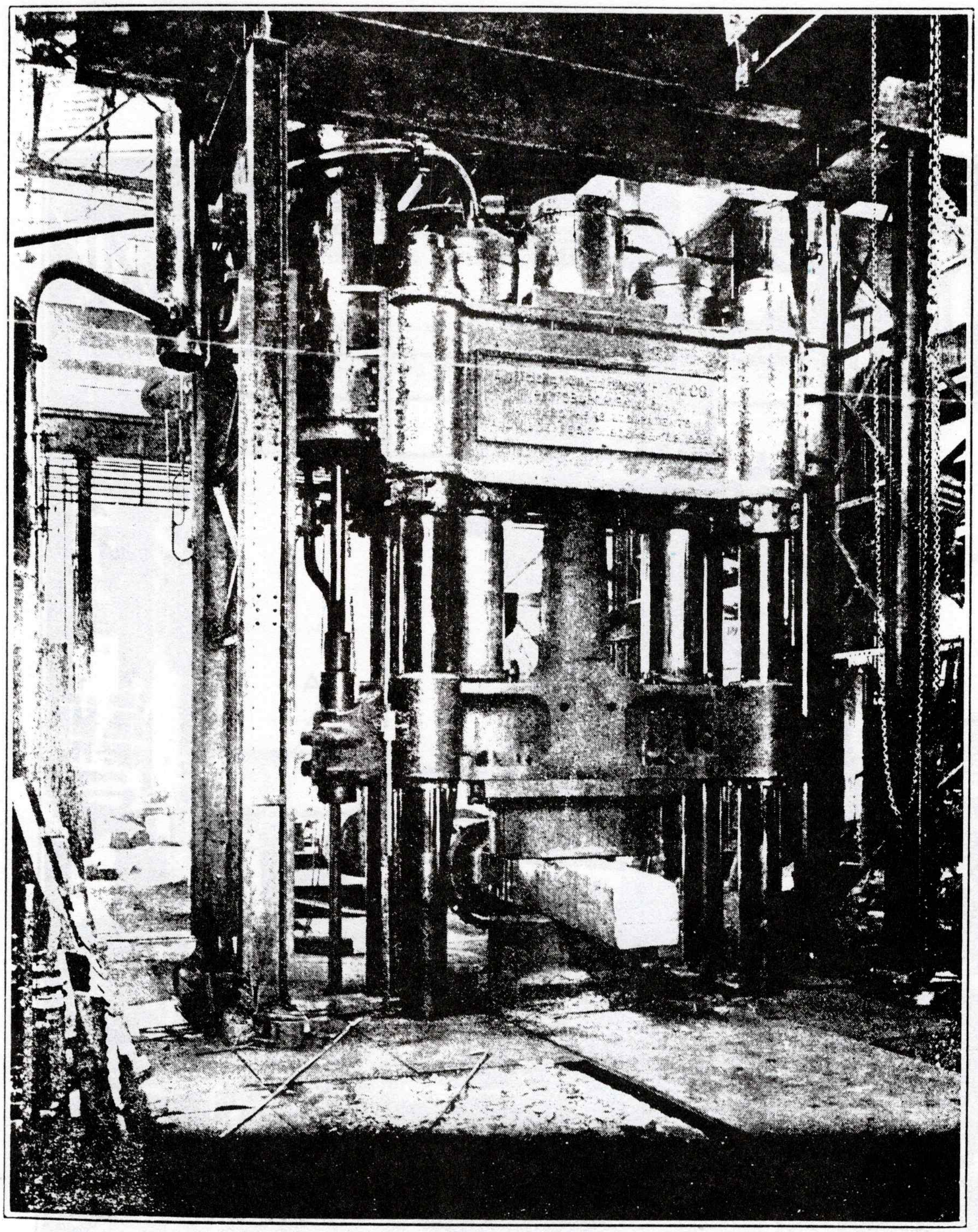
GUN BARREL MANUFACTURING

(Illustrations taken from "America's Munitions 1917-1918" GPO 1919)

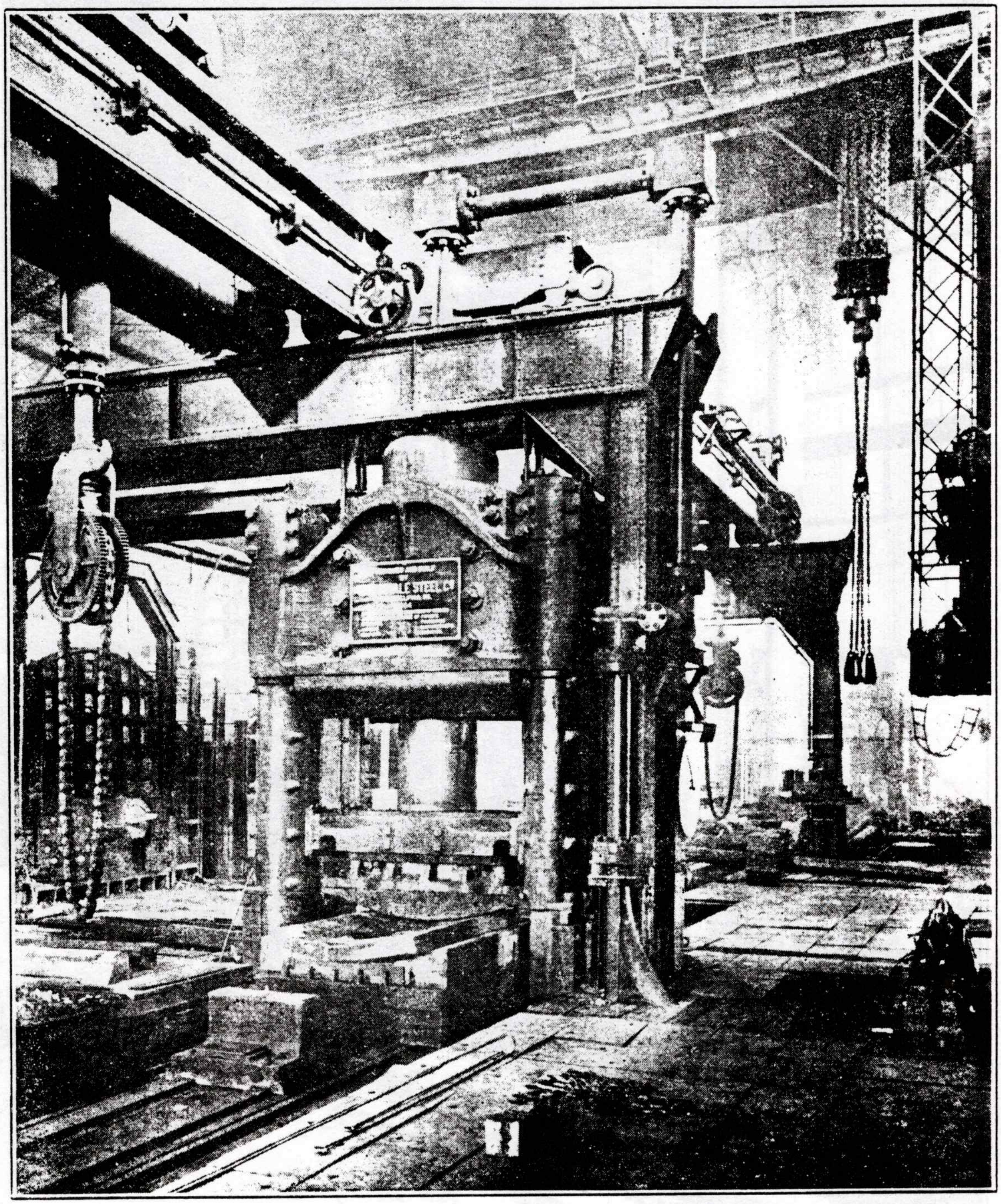


Molten steel being poured from ladle into mold, which is of heavy cast-iron construction, at the Tacony Ordnance Corporation.

Letter "A" denotes ingot.

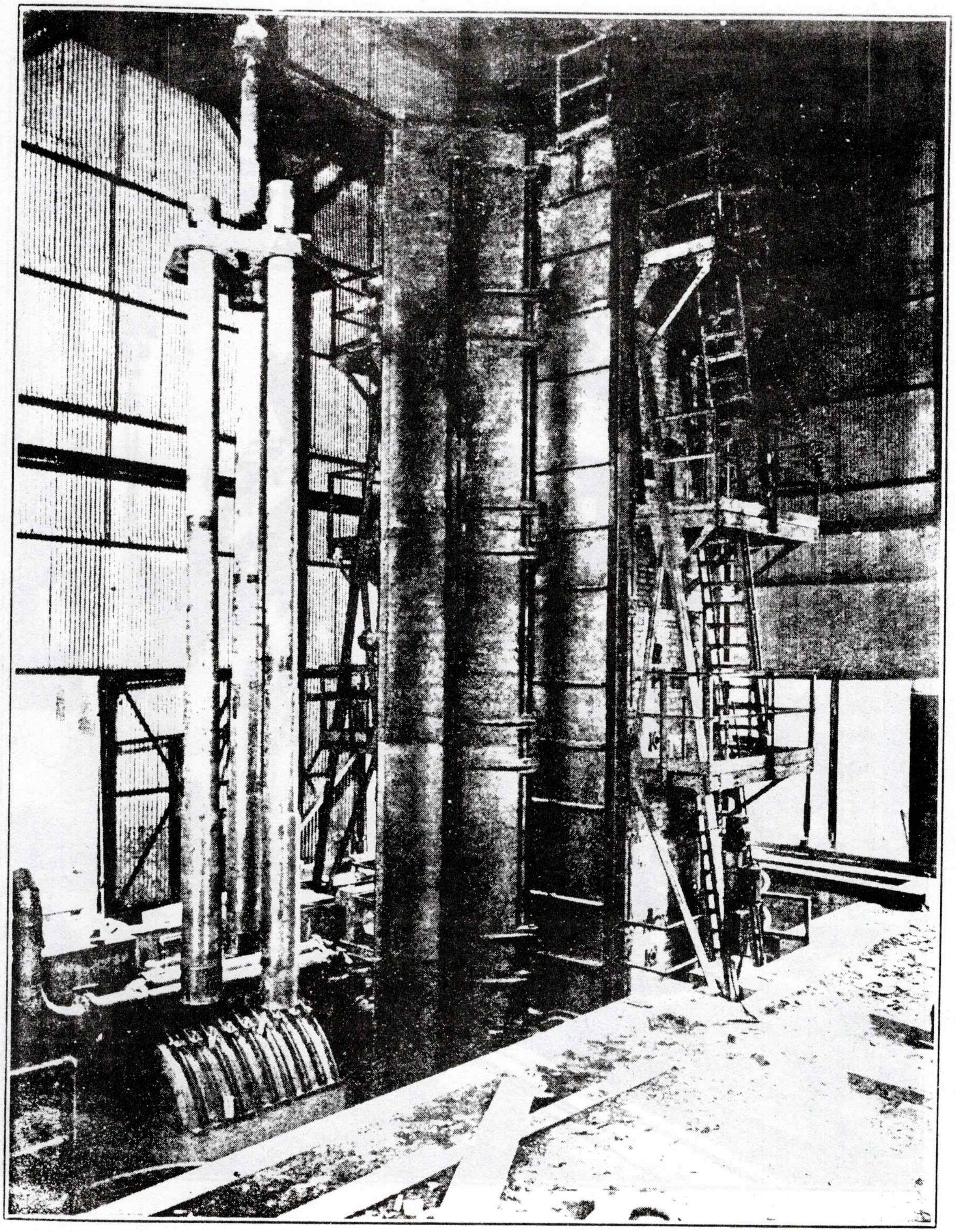


A 2000 ton forging press at the Tacony Ordnance Corporation Plant.
This press can forge ingots up to 45 inches in diameter. The ingot under the press is shown in a partly forged state. Note that the original octagonal shape of the ingot as it came from the mold has been forged down into a square shape and later will be forged into a round shape. After coming from the mold, the ingot has been subjected to a careful chemical analysis to determine its fitness for use as a gun barrel.



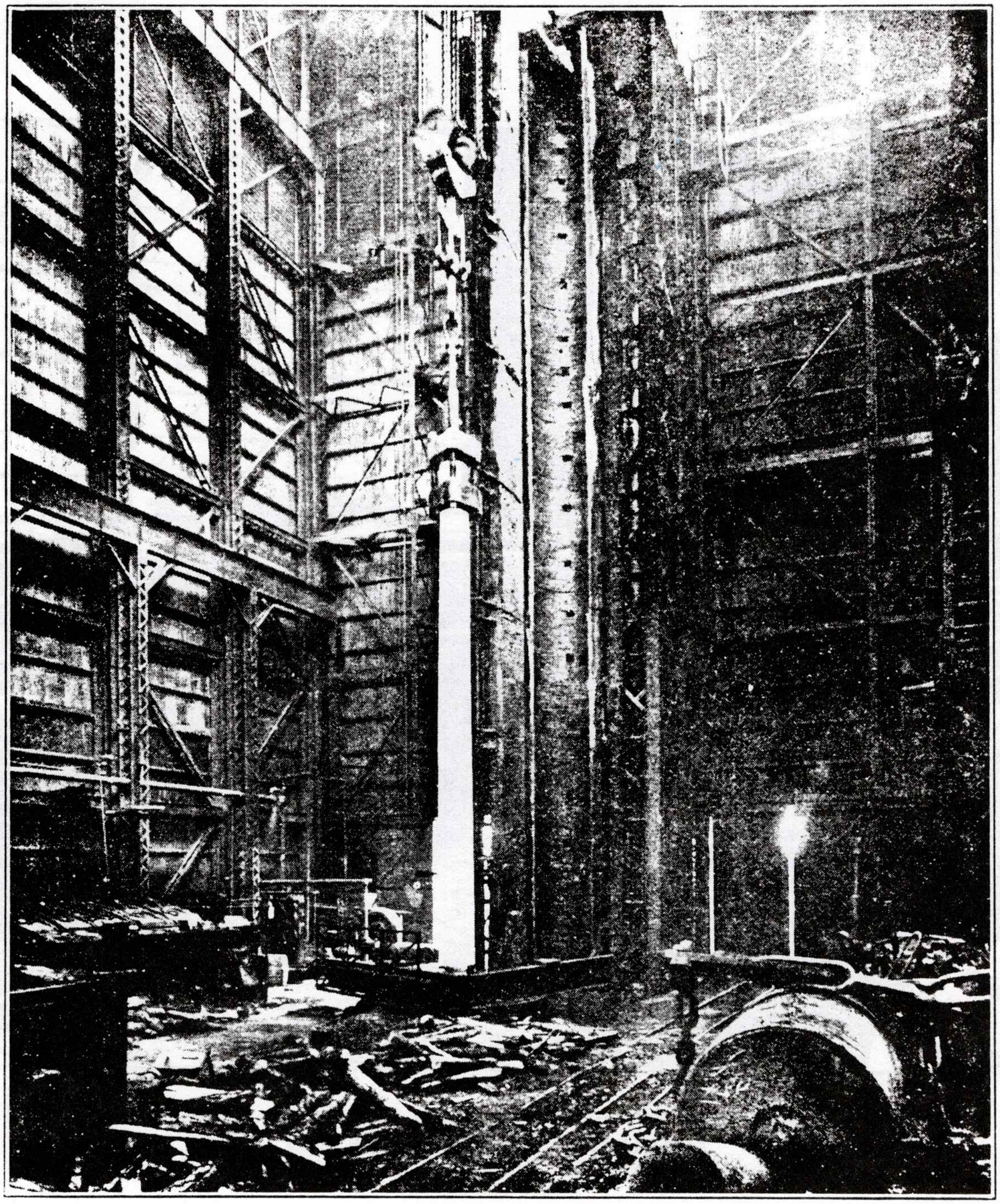
A 9000 ton hydraulic forging press in the plant of The Midvale Steel Co.

This press is needed for such large caliber guns as the 14-inch and 16-inch guns. The piece of forging under the press is armor plate and not a gun forging.

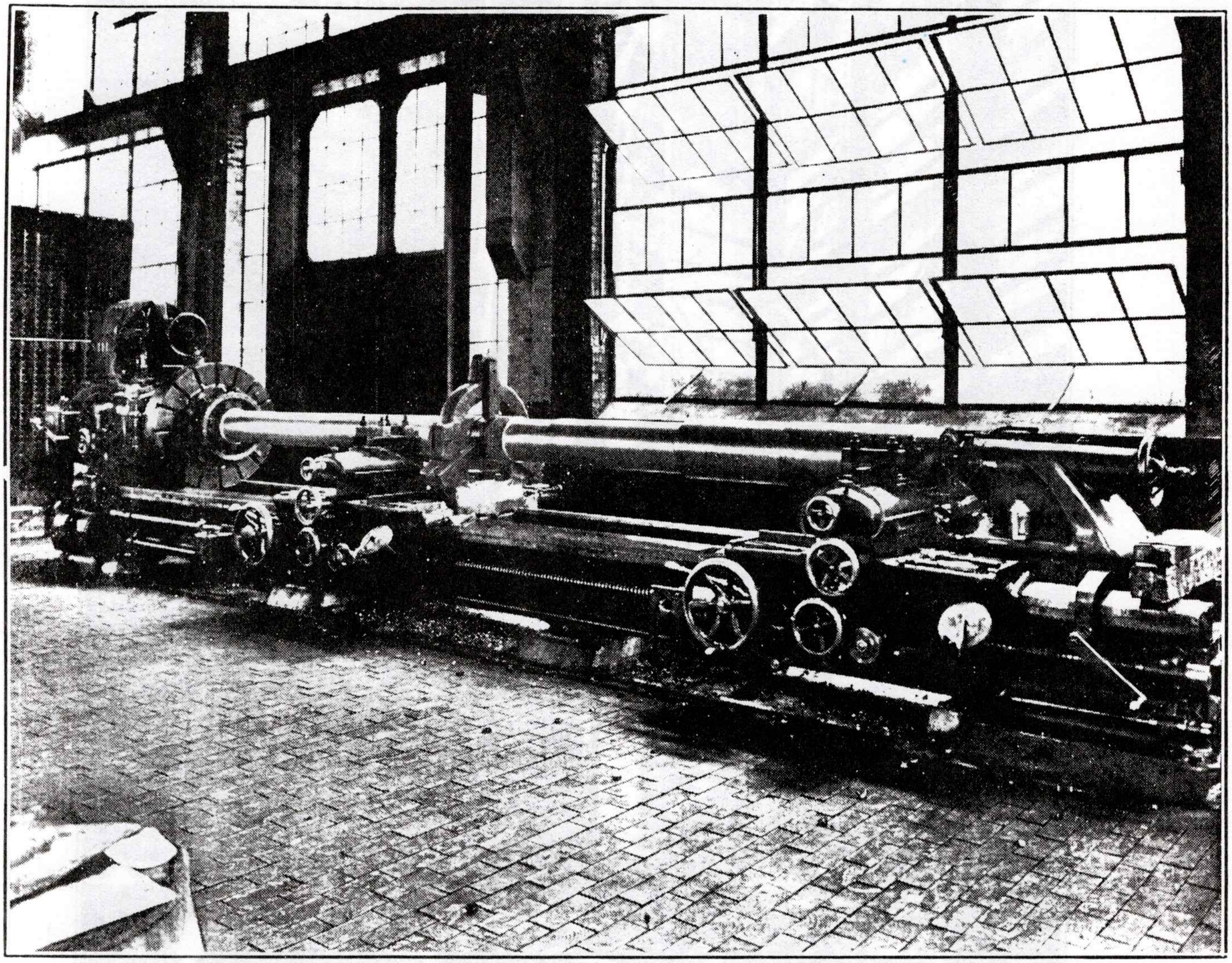


Three tubes of the 155 millimeter guns suspended at furnace.

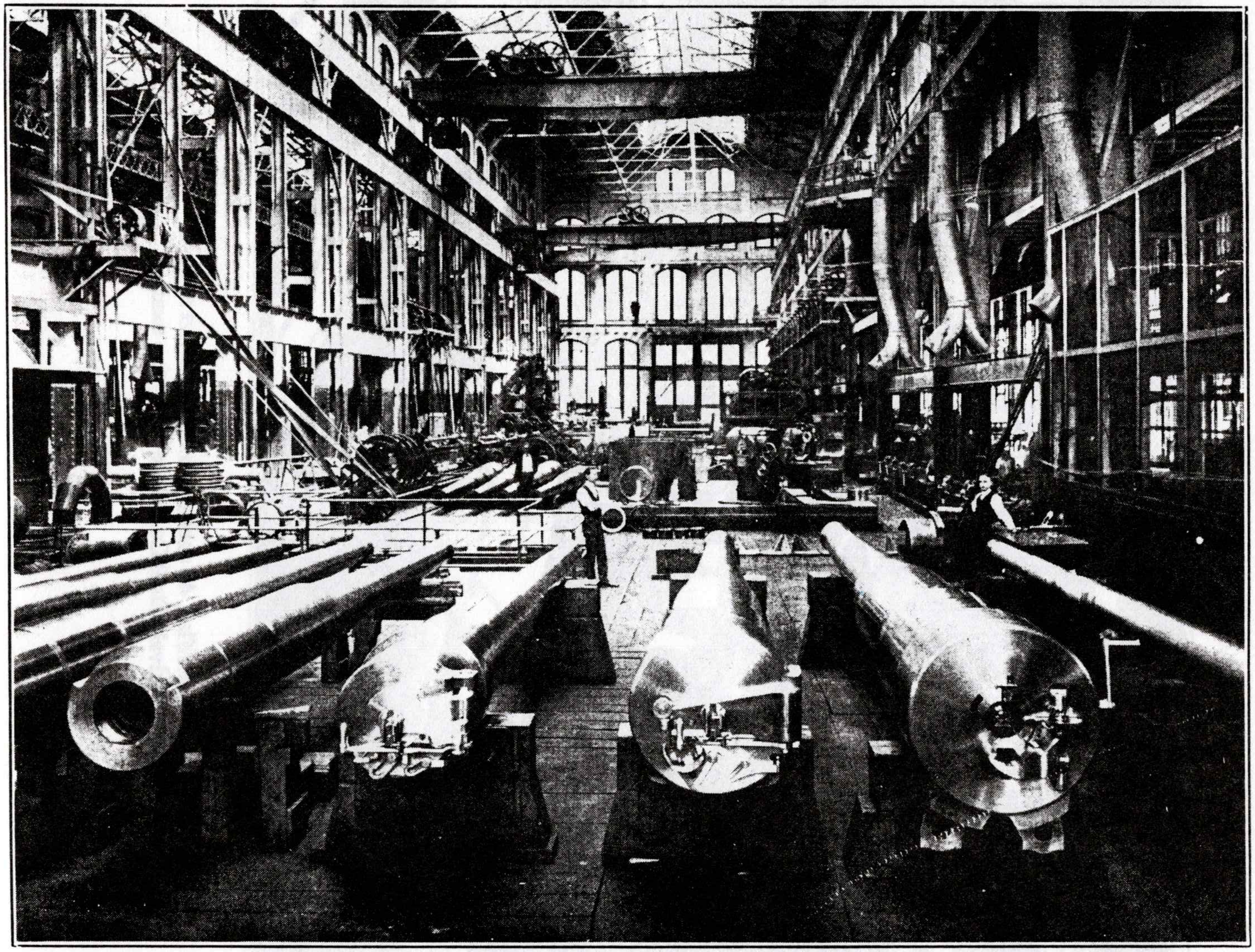
Three tubes of the 155 millimeter guns suspended at furnace ready and quenching to give them the necessary combination of hardness and toughness. The door of furnace is open. The tubes remain in this furnace for perhaps eight hours at a temperature of 1,500° Fahrenheit or until a bright yellow color, uniform in every part.



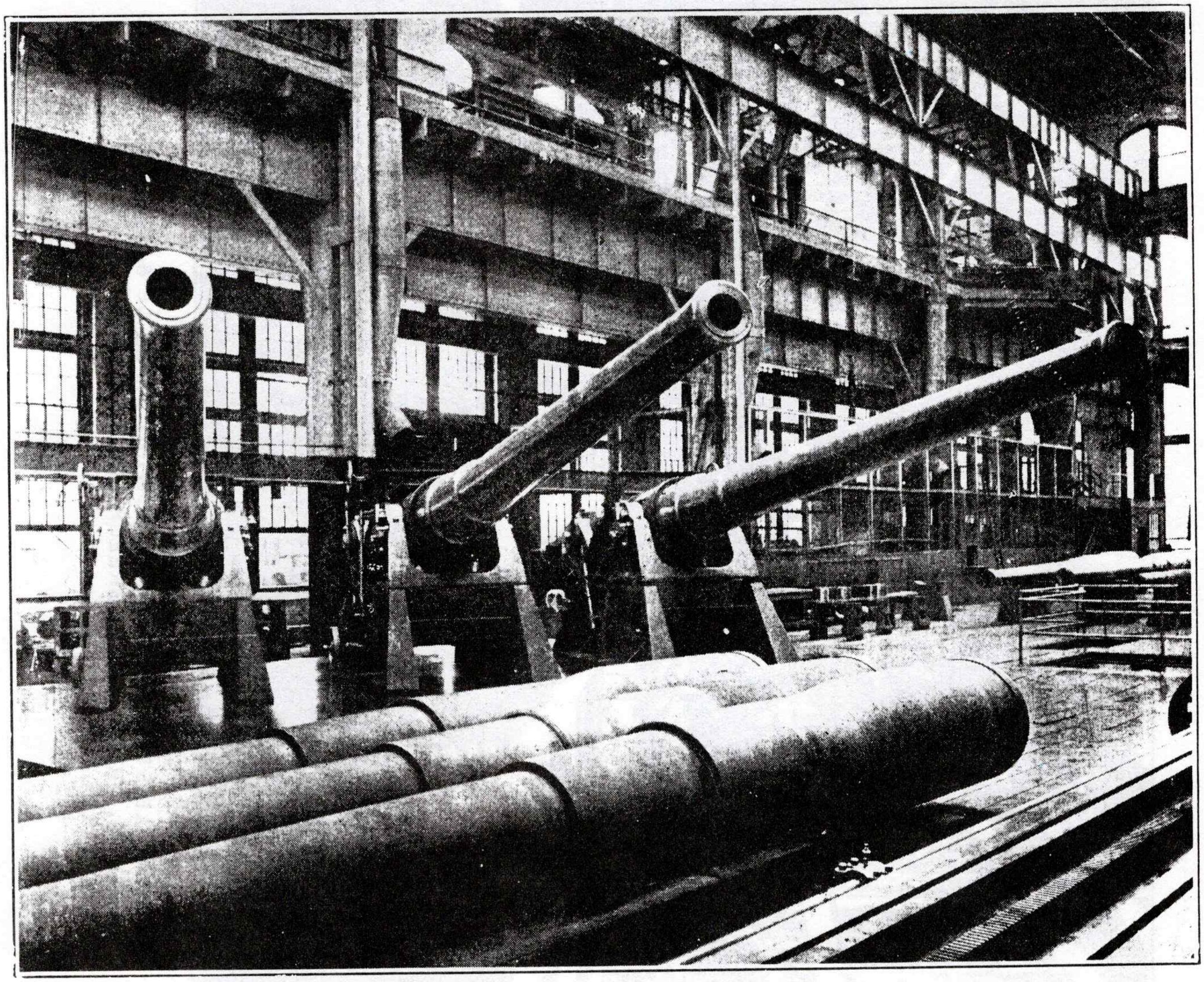
A tube for a 12-inch gun just out of the furnace where it was tempered at white heat and is now ready for quenching in the plant of the Midvale Steel Co. (the gun tube is 41 feet long).



TUBE OF A 155-MILLIMETER GUN BEING TURNED, PRIOR TO BORING, AT THE TACONY ORDNANCE CORPORATION PLANT.



A SECTION OF THE MIDVALE STEEL CO. PLANT, SHOWING TYPES OF 6-INCH, 7-INCH, AND 8-INCH, NICKEL-STEEL, BREECH-LOADING RIFLES.



Three finished 8-inch rifles, 45 calibers, set up on turret mounts in the plant of the Midvale Steel Co. where they were made.

CHAPTER TWO

AMMUNITION: PRIMERS, POWDER, AND PROJECTILES

Guns smaller than 5 inches in bore generally use fixed ammunition resembling an oversize rifle cartridge, but some very early smaller models did use separate ammunition. Larger caliber guns use separate ammunition exclusively consisting of a primer, silk bags of powder, and a projectile loaded with explosives and a detonating fuse.

PRIMERS

Guns are fired either electrically or mechanically. Mechanical firing involved pulling a lanyard cord which caused the mechanism to pull the pin on a friction primer or strike the pin of a percussion primer. Electric primers are fired by subjecting them to electric current which is supplied by dry storage batteries or magnetos installed on the gun carriage. Single stroke hand magnetos similar to those used to set off dynamite were used to fire the weapon, or in the case of a battery of mortars, four guns at once. Cables ran from the magneto, down the barrel of the gun, to the breech and can be seen in many photos of disappearing rifles.

Below are examples of primers. For those interested, the physical dimensions are approximately 3½ inches long, .5000 inch diameter head, .3875 inch diameter body. The head width and button width is .1250 inch.

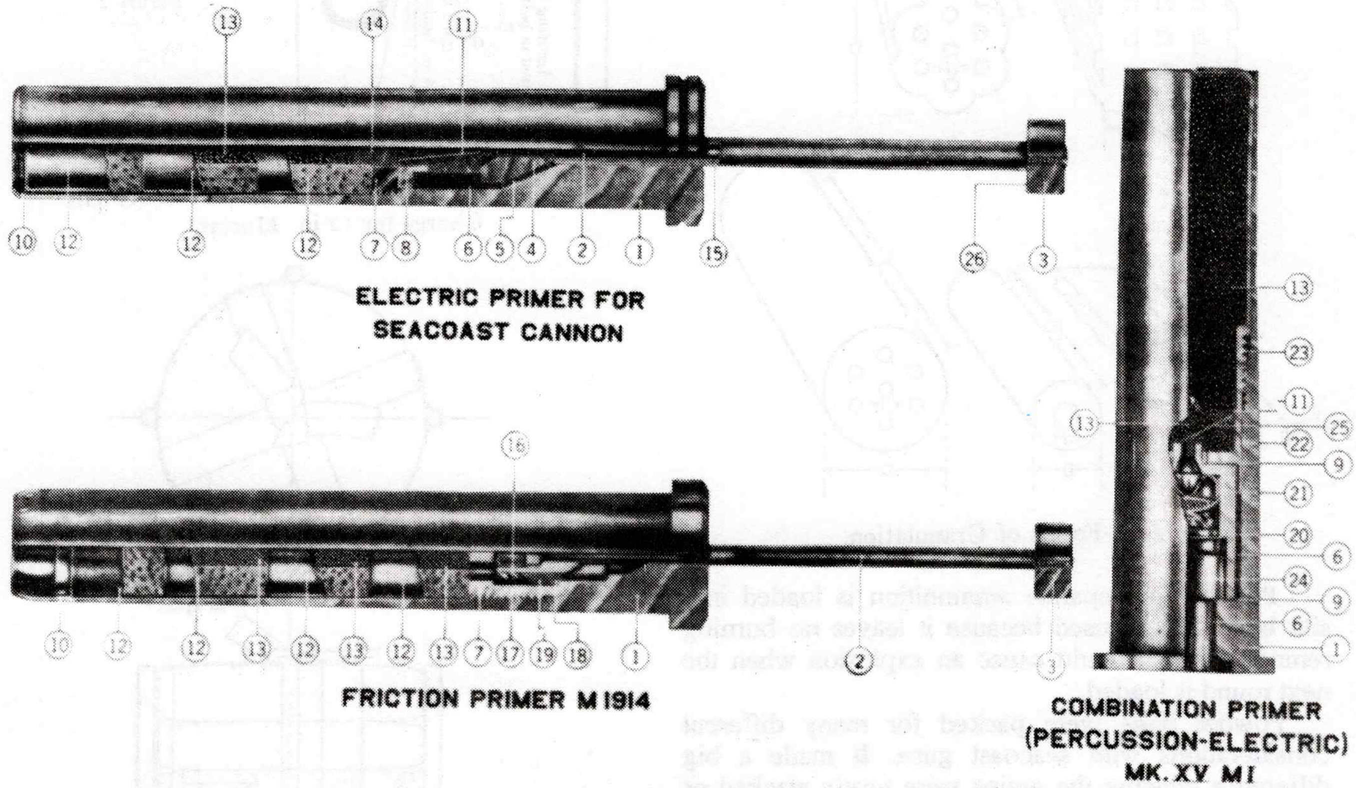


Fig. 323.

1. Primer Body.
2. Primer Wire.
3. Button.
4. Contact Plug.
5. Plug Insulator.
6. Insulator.
7. Closing Screw.
8. Contact Sleeve.
9. Insulating Disc.
10. Closing Cup.
11. Contact Wire.
12. Powder Pellet.
13. Loose Black Powder.
14. Fibrous Guncotton.
15. Paper Insulation.
16. Gas Check.
17. Housing.
18. Insulating Washer.
19. Friction Composition.
20. Plunger Cup.
21. Commercial Primer.
22. Ignition Cup.
23. Metallic Seal.
24. Plunger.
25. Wisp of Guncotton.
26. Paper Disc.

POWDER

Nitrocellulose powder was officially adopted for use by the US Army in 1899, and was used in seacoast guns.

Manufacture of this powder is rather simple, treating cotton with nitric acid. The resulting mass has a consistency like putty and is extruded into grains like macaroni.

Varying the size and shape of the grains gives different burning rates and pressure characteristics. Some examples of grain shapes are below:

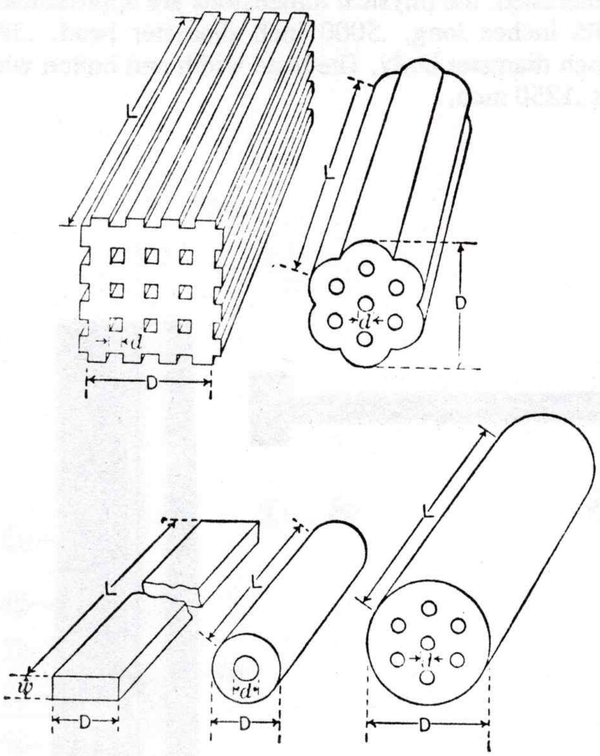


FIG. 42.—Forms of Granulation.

Powder for separate ammunition is loaded into silk bags. Silk is used because it leaves no burning remnants which could cause an explosion when the next round is loaded.

Powder bags were packed for many different considerations with seacoast guns. It made a big difference whether the grains were neatly stacked or poured in at random, for example. Stacked grains give a more uniform charge and consistent pressure. Different length bags using more or less powder gave varying ranges, which was especially important to the older models of 12 inch mortar that had very limited high angles of fire. Using different zone charges the mortars could cover a large field of fire. Some examples of powder loads are shown in fig. 18 & 19:

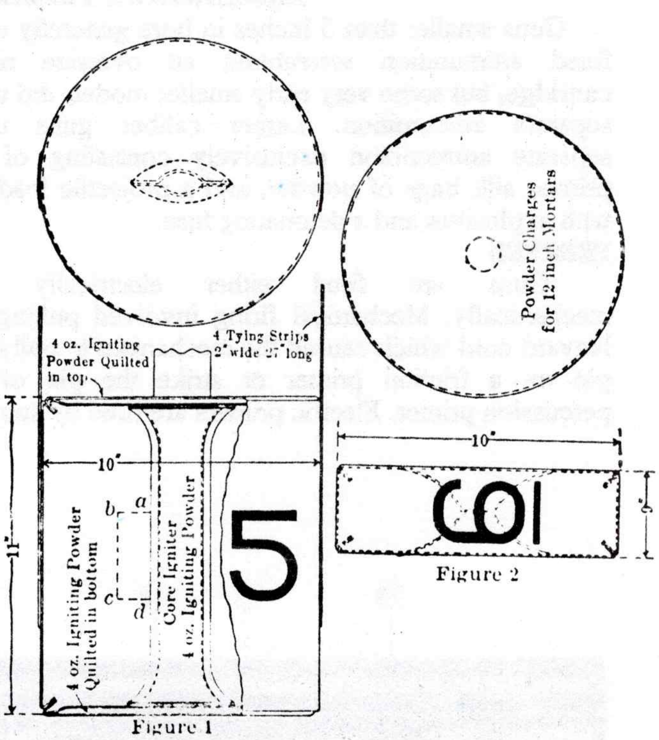


FIG. 18.—Bags for Base Charge and Increment Charge for 12-in. Mortar.

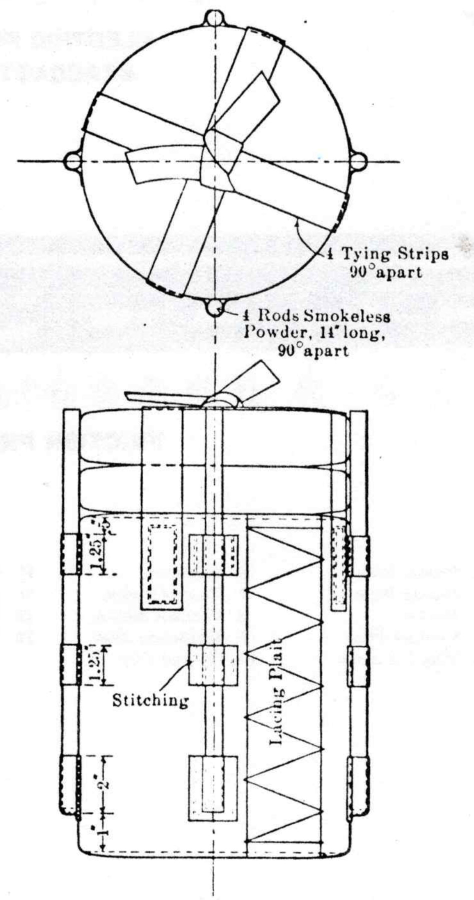


FIG. 19.—12-in. Mortar Bag Showing Rods of Powder for Increasing Rigidity.

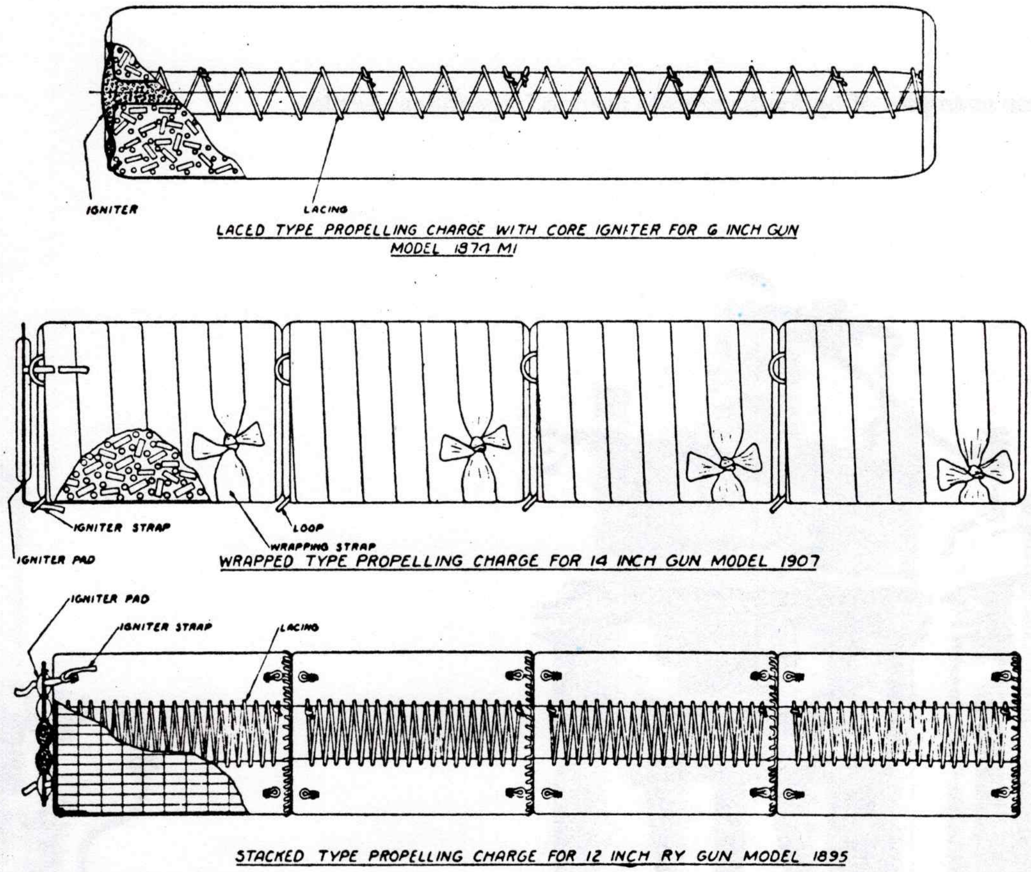


FIG. 13.—Propellent Charges, Laced, Wrapped and Stacked for Major Caliber Cannon.

You will note at each end and through the center of the powder bag is an igniting pad. This was usually made of black powder which ignites more readily than nitrocellulose.

The top charge in fig. 13 is continuous whereas the two following charges are built up composites, adjustable for zones of fire.

It is obvious that preparing these charges took a great deal of time and effort utilizing much manpower as did so many tasks associated with operating heavy artillery.

PROJECTILES

Projectiles used in seacoast guns could be either steel or cast iron. The projectiles were hollow and had plug type fuses in the base to detonate the charge. Cast iron shells were generally filled with a mixture of sand and plaster of paris and used for practice firing. Steel projectiles were either armor-piercing or high explosive.

Manufacture of the projectiles involved sand casting for cast iron and hydraulic forging of hot ingots for steel. Iron shells were purchased from various manufacturers while steel projectiles were produced by arsenals. Watervliet Arsenal was credited with producing very high quality armor-piercing shells. Fig. 318 below show a cut away of a hydraulic fixture for pressing a hot ingot into a steel shell:

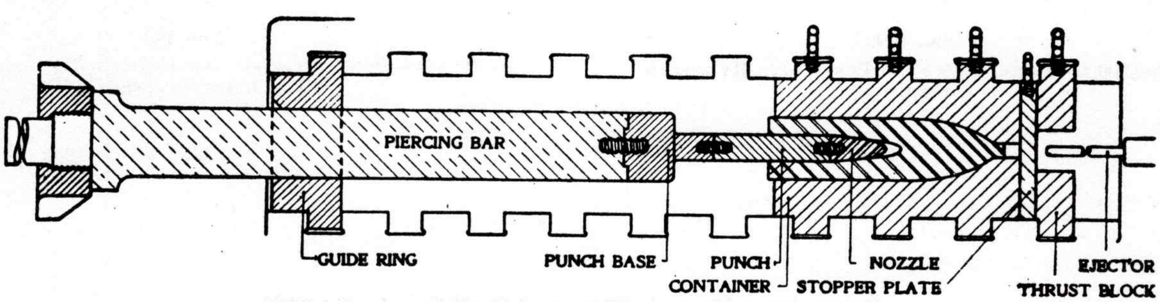


FIG. 318.—Fixture for Shaping and Punching Large Shell.

Below are some examples of hydraulic presses used to forge the projectiles:

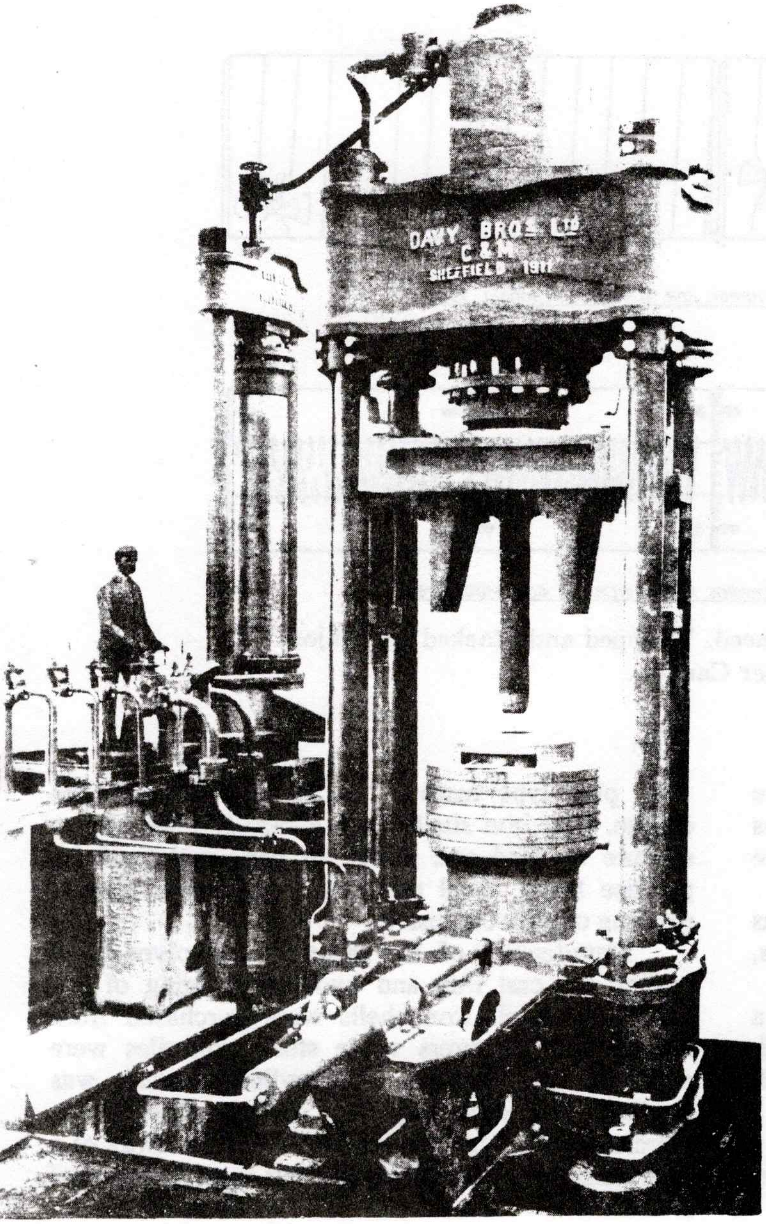


Fig. 109.
800-1,200 tons Shell Piercing Press with Hydraulic Intensifier.

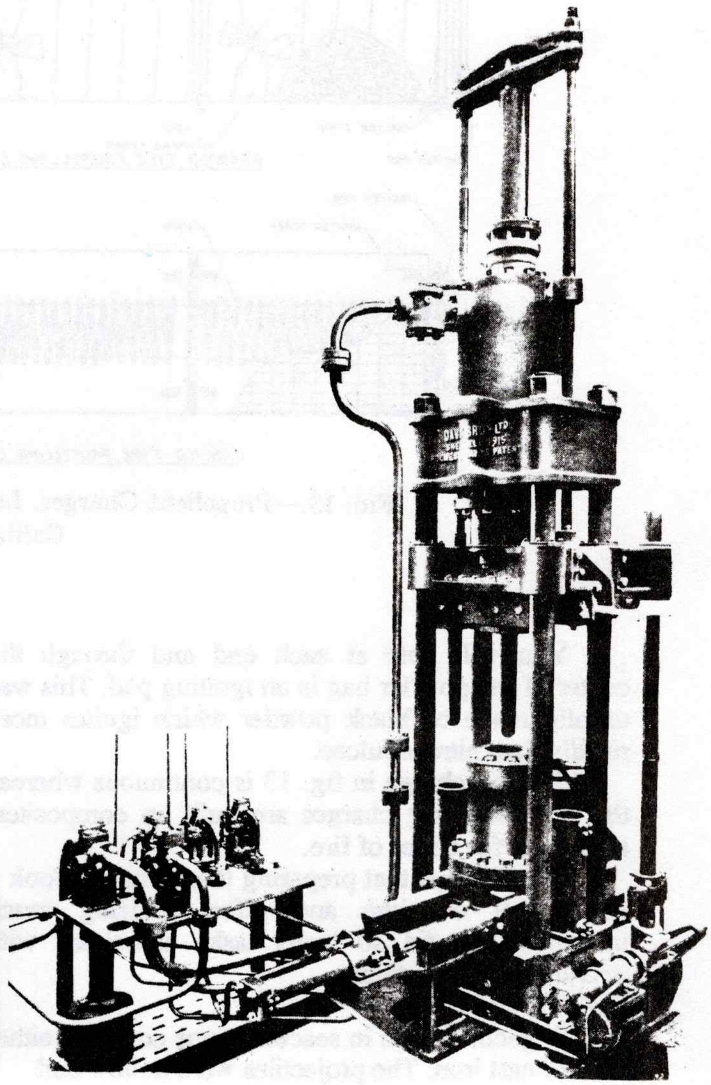


Fig. 105.
300 tons Shell Piercing and Drawing Press, with Sliding Table and Crosshead.

(taken from Bower's "Practical Shell Forging" 1919)

This drawing shows a sand casting mold for producing cast iron shells:

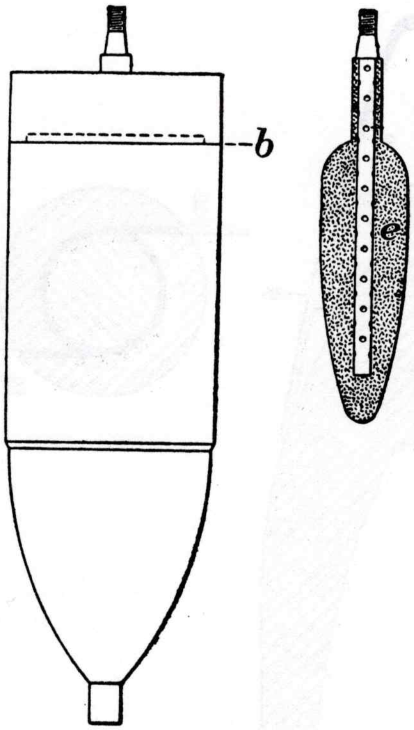


FIG. 211.

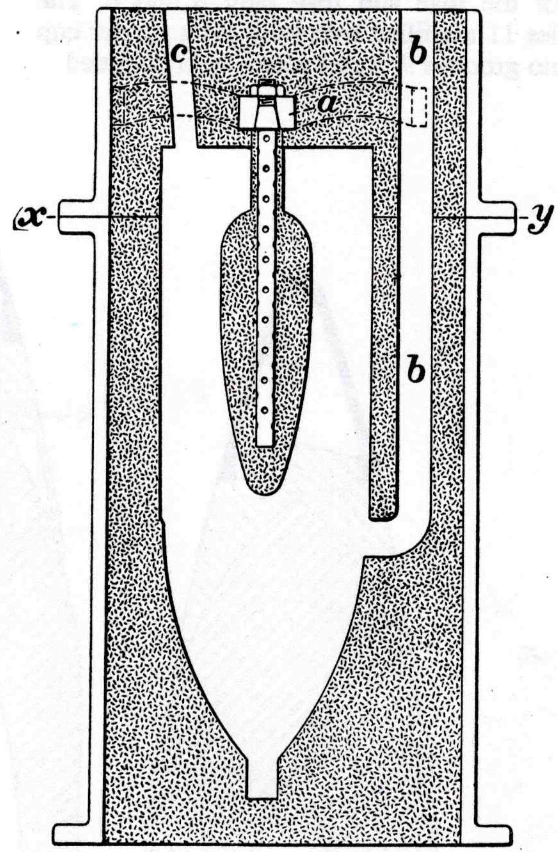


FIG. 212.

Fig. 211 - b is the projectile, e is the core shape which melts away during casting.

Fig. 212 is the cutaway of the mold cavity with passages for the molten iron.
Note the core shape is suspended in the mold from a bracket.

Sand casting is a relatively simple process that involves using two outside "frames". First, a frame is placed on a flat surface, and a bed of wet sand is shaken into the frame with a sifter. A model of the object to be cast is placed onto the bed of sand and the frame is filled and packed with sand. Then the second frame is placed on top of the first and filled and packed with sand. When the halves are lifted off and the model removed, they are reassembled and molten iron is poured into the cavity creating the object needed.

SHOT AND SHELL

Below are two examples of 12 inch shot and shell, armor-piercing. These are similar except for length, size of cavity, and wall thickness. Fig. 199 is the shot, Fig. 200 is the shell.

After the projectile is filled with explosive, the steel base plug is screwed in. The base plug is threaded for the fuse and fuse plug 5 and 6. The wrench holes 11 are filled with lead and a copper cup is placed into grooves 9. Lead wire is also pounded into the groove to secure the cup, which covers the projectile base to prevent gasses from igniting the charge. Two methods of fastening the windscreen 3 to the projectile are either by pressing the cap onto interlocking edges or by driving a securing wire 12 through the cap. 2 is the armor-piercing cap, which is made of soft steel to allow for alignment so the hardened body of the projectile 1 can penetrate the armor. Brass band 8 expands into the rifling grooves.

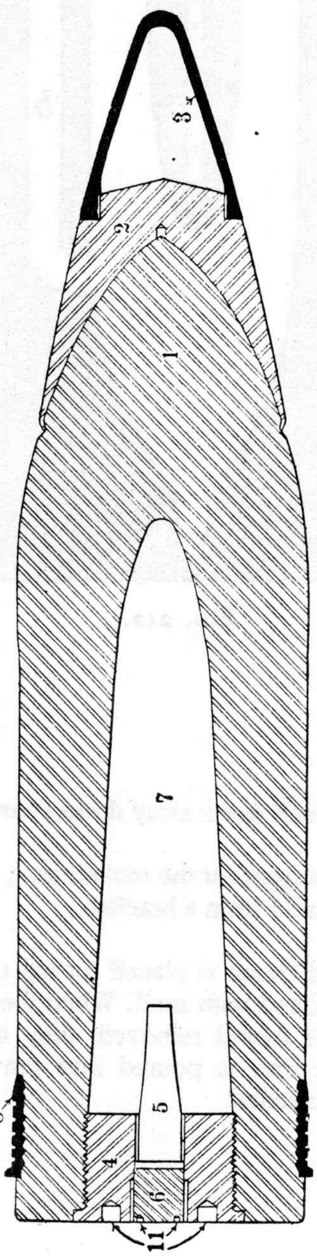


FIG. 199.

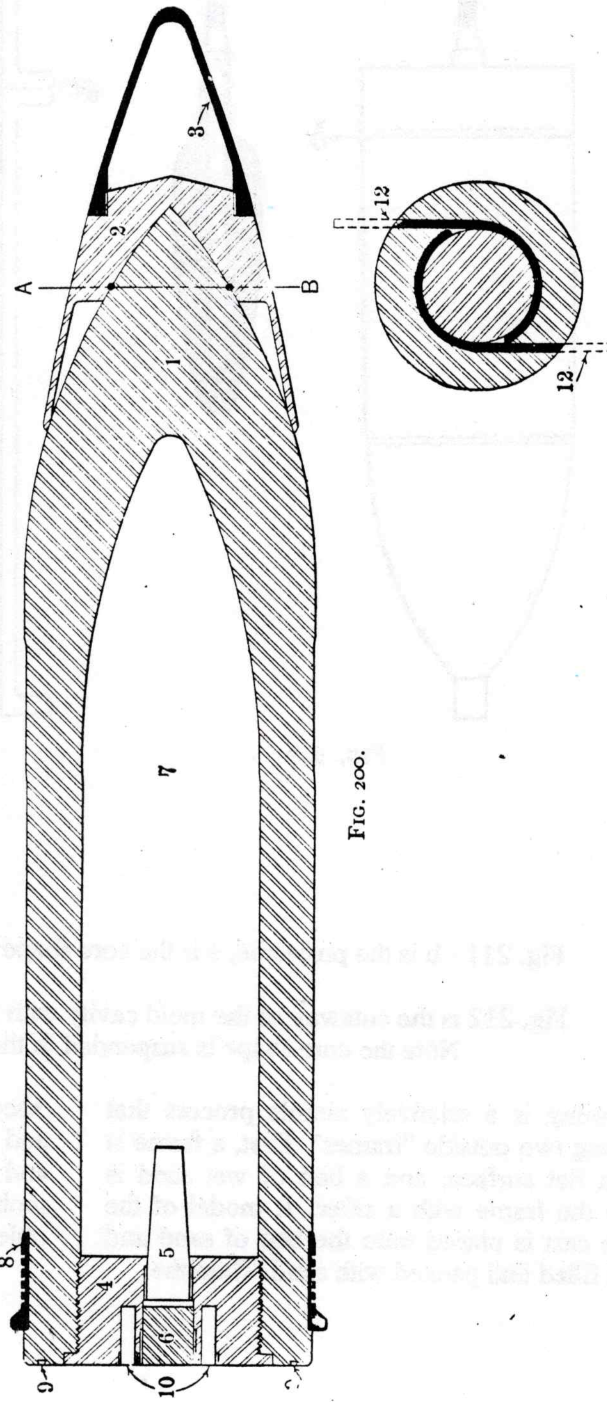


FIG. 200.

FUSES

Fuses are plug type devices screwed into the base of the projectile to detonate the charge. Fuses have to be "bore safe", that is they cannot be armed until the projectile has left the bore so the projectile is safe to handle and load.

The Semple Centrifugal Plunger kept the fuse unarmed until it was rotated sufficiently by the rifling upon being fired. Below is a drawing of the Semple mechanism:

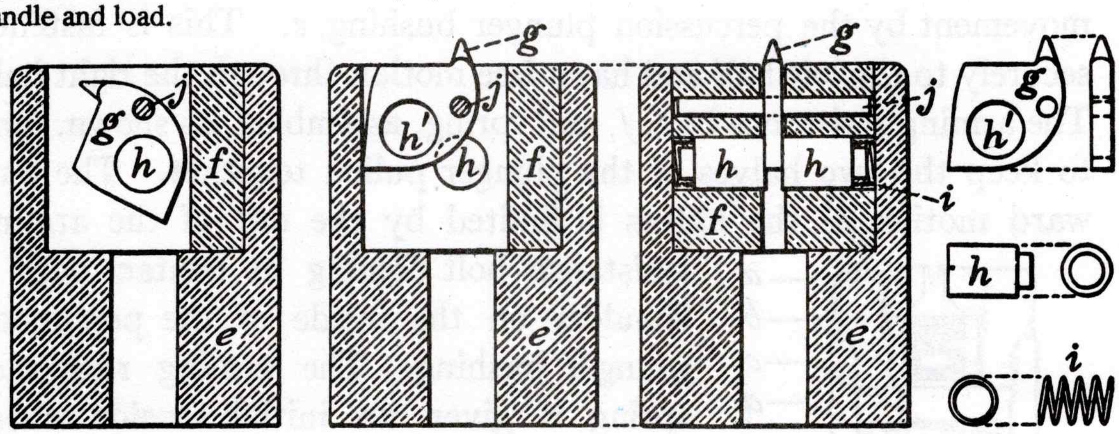


FIG. 245.—Semple Centrifugal Plunger.
g is the firing pin, h is the safety lever.

Some of these features are also included in the mark X fuse below:

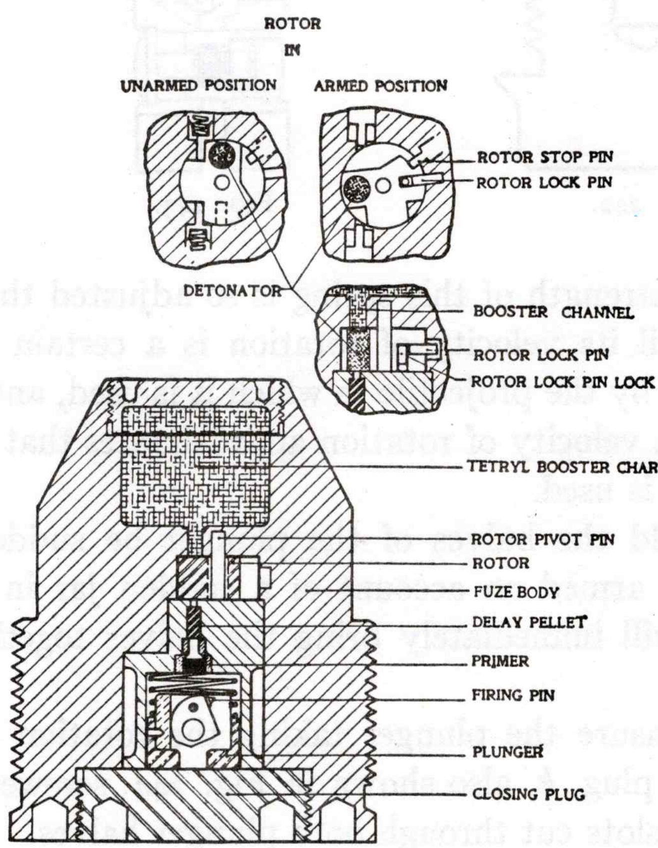


FIG. 331.—Mark X Base Detonating Fuze.

This diagram and text, taken from Tschappat's "Ordnance and Gunnery" 1917, shows an early fuse design of the Semple type with explanation:

The two halves of the plunger are guided in their outward movement by the percussion plunger bushing, *e*. This is fastened securely to the left half and has a free motion through the right half. The arming resistance bolt, *f*, and spring, assembled, as shown, tend to keep the two halves of the plunger pulled together. The outward motion of the halves is limited by the nut of the arming resistance bolt coming in contact with a shoulder on the inside of the percussion plunger bushing. The arming resistance spring is given an initial tension whose amount depends upon the arming resistance the fuse is required to have.

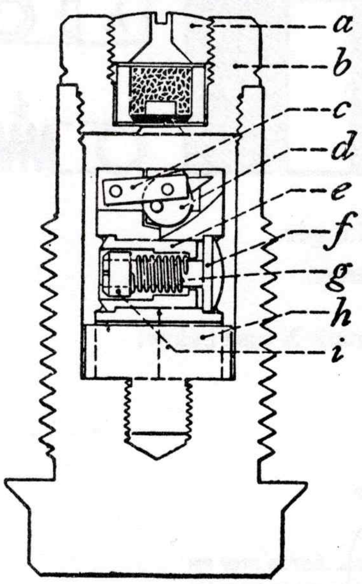


FIG. 242.

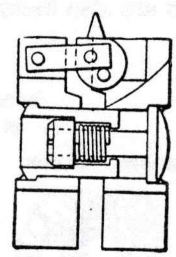


FIG. 243.

FIG. 244.

The strength of this spring is so adjusted that the fuse will not arm until its velocity of rotation is a certain percentage of that attained by the projectile in which it is used, and will certainly arm when its velocity of rotation approximates that of the projectile in which it is used.

Should the halves of the plunger be suddenly separated and the fuse armed on account of a sudden jar in transportation the spring will immediately bring the halves together and unarm the fuse.

To insure the plunger taking the rotation of the projectile, a rotating plug, *h*, also shown in Fig. 244, screwed in the fuse body, engages slots cut through both plunger halves.

PRACTICE FIRING

Constant training was necessary to keep gun crews ready for action, but actually firing the weapons was expensive and caused wear on the rifling lands and mechanisms. To overcome this, loading practice with dummy shells and sub-caliber firing practice with adapters was used.

Drill projectiles were generally made from wood and brass so as not to damage the rifling. Simulated powder bags and blank primers completed the practice load. Wooden cartridges for fixed ammunition guns were used for loading practice.

Below is a drawing of a drill projectile used for separate loaded guns:

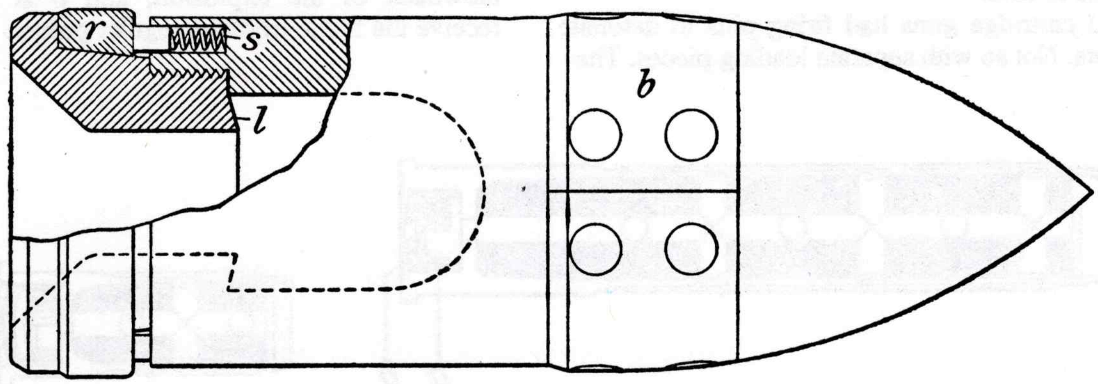


FIG. 179.

The bronze band b, prevents wear on the rifling. The rotating band r, is spring loaded to facilitate removal. The base has a recess to allow a hook to pull the shell back out.

In sub-caliber firing, adapters were used which fired the .30 caliber rifle cartridge for fixed 3 inch guns (fig. 176), one pounder cartridge for larger guns and an 18 pounder (75 mm) for the 12 inch mortar (fig. 177).

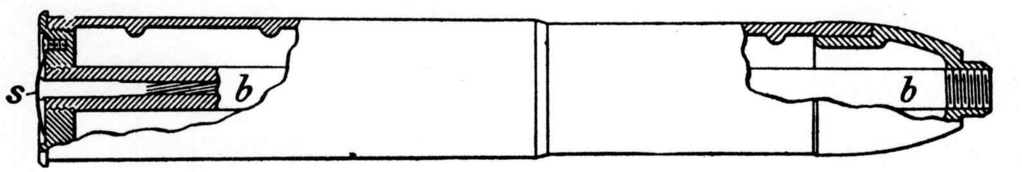


FIG. 176.

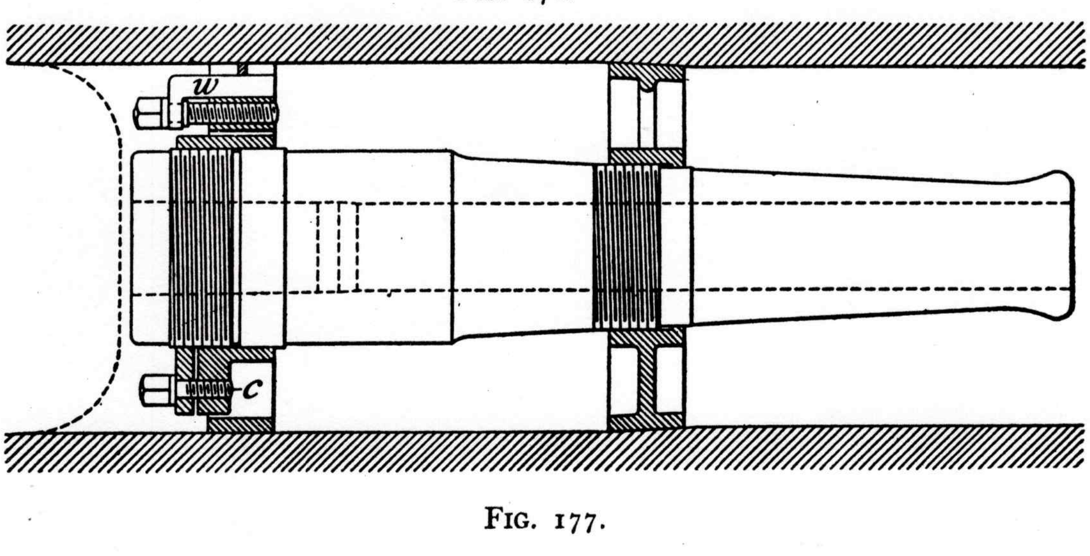


FIG. 177.

The adapter in fig. 176 was simply loaded as a regular load. The adapter in fig. 177 had to be fitted to the gun it was used on by first choosing the right size adapter ring, making the adjustments and finally tightening the bolts c to clamp the back ring tightly against the powder chamber wall. This adapter had to be in the proper position against the obturator face. By using different size rings, this adapter could fit many sizes of rifle.

Fixed cartridge guns had firing pins to detonate the primers. Not so with separate loading pieces. The one pounder or 75 mm cartridge for practice used an igniting primer, which had an exposed powder face that took ignition from the regular primer in the breech block. So the fig. 177 adapter was sort of like a cannon within a cannon, with a two-stage ignition.

Shown below are the 110 grain igniting primer (fig. 237) and the 20 grain igniting primer (fig. 238). In this illustration, a is the obturator cup to prevent blowback of the explosion, and b is the vent to receive the flame from the regular primer.

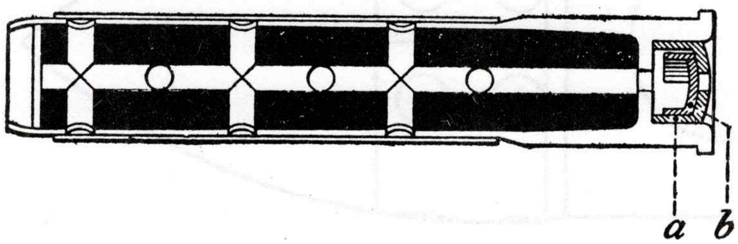


FIG. 237.

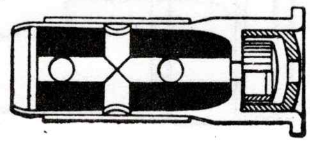
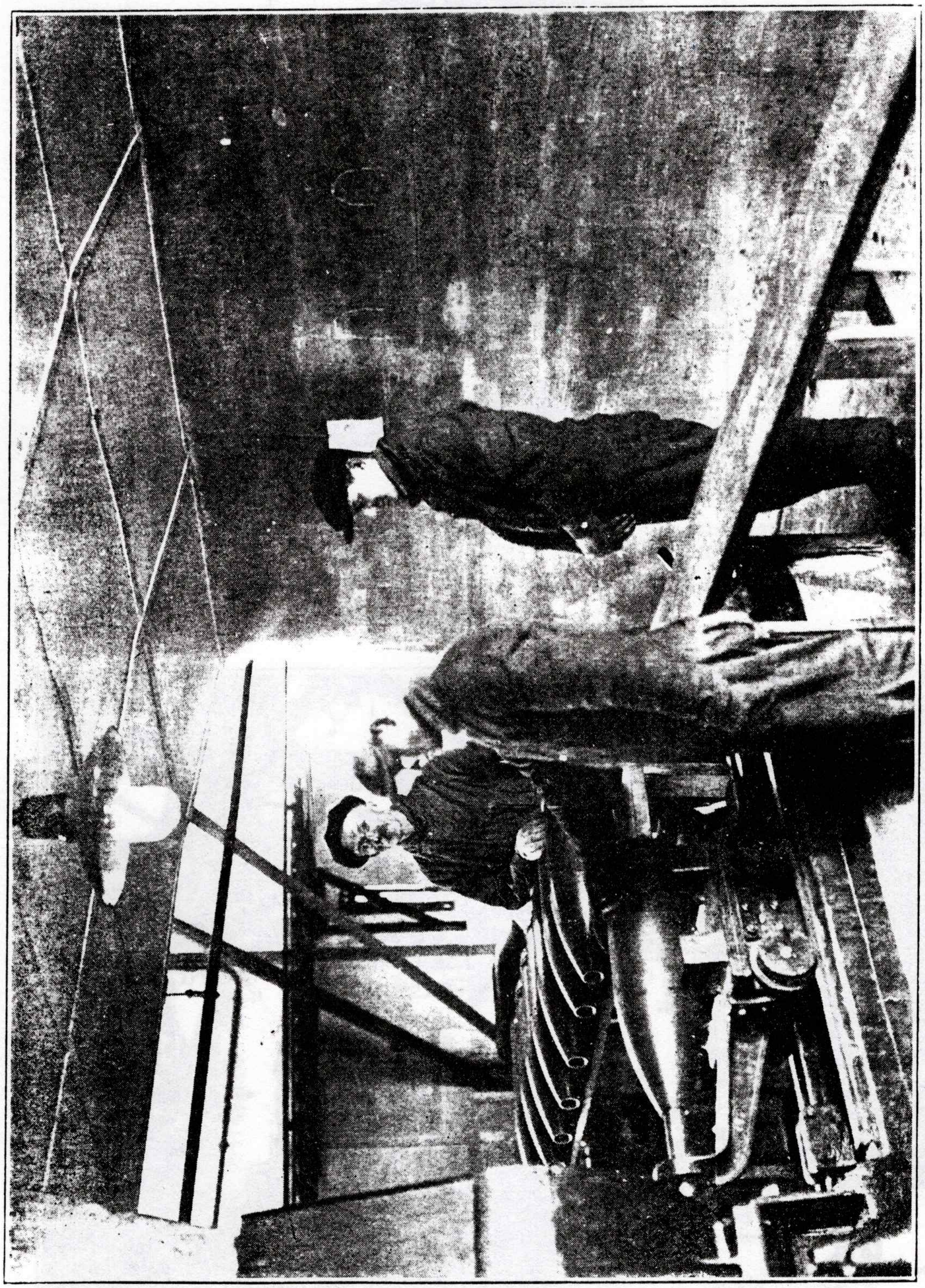


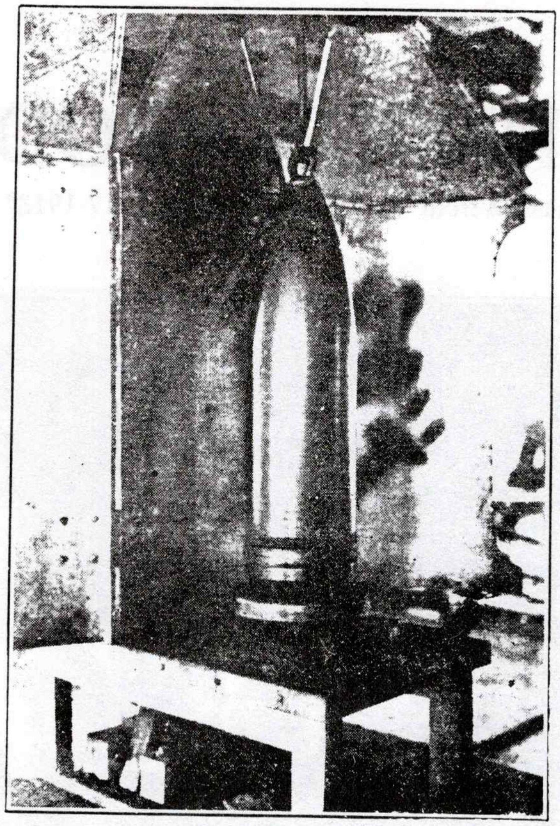
FIG. 238.

AMMUNITION PRODUCTION

(Photos taken from "America's Munitions 1917-1918" GPO 1919)

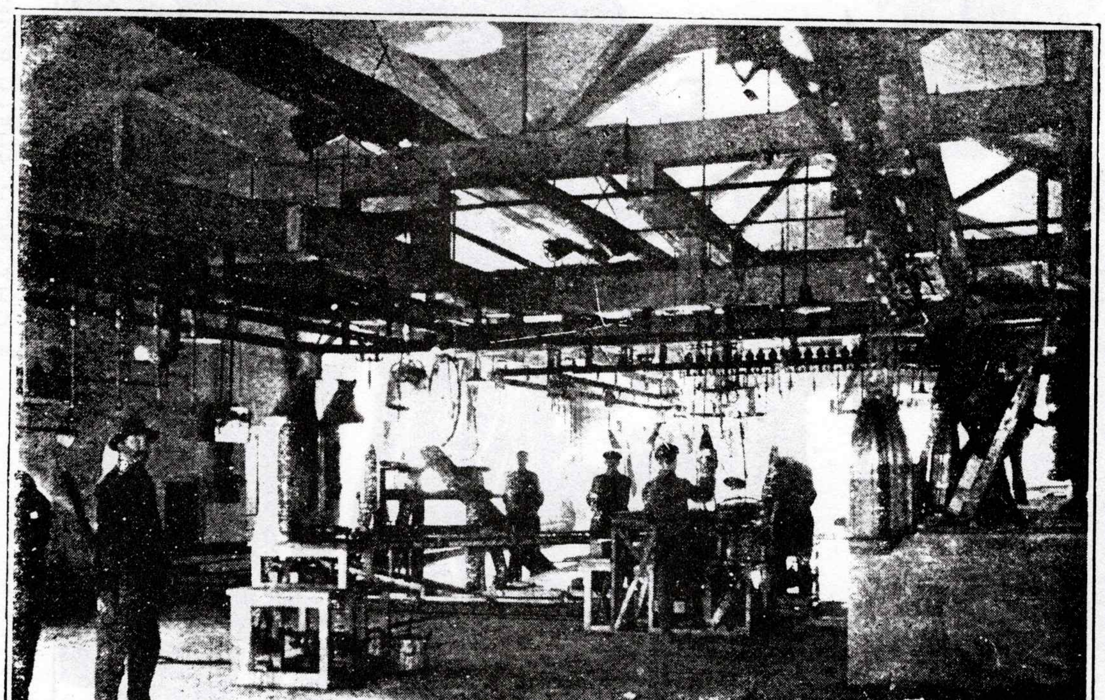


EIGHT-INCH SHELL BEING LOADED WITH AMATOL.
View of extruding machine bulkhead in background.

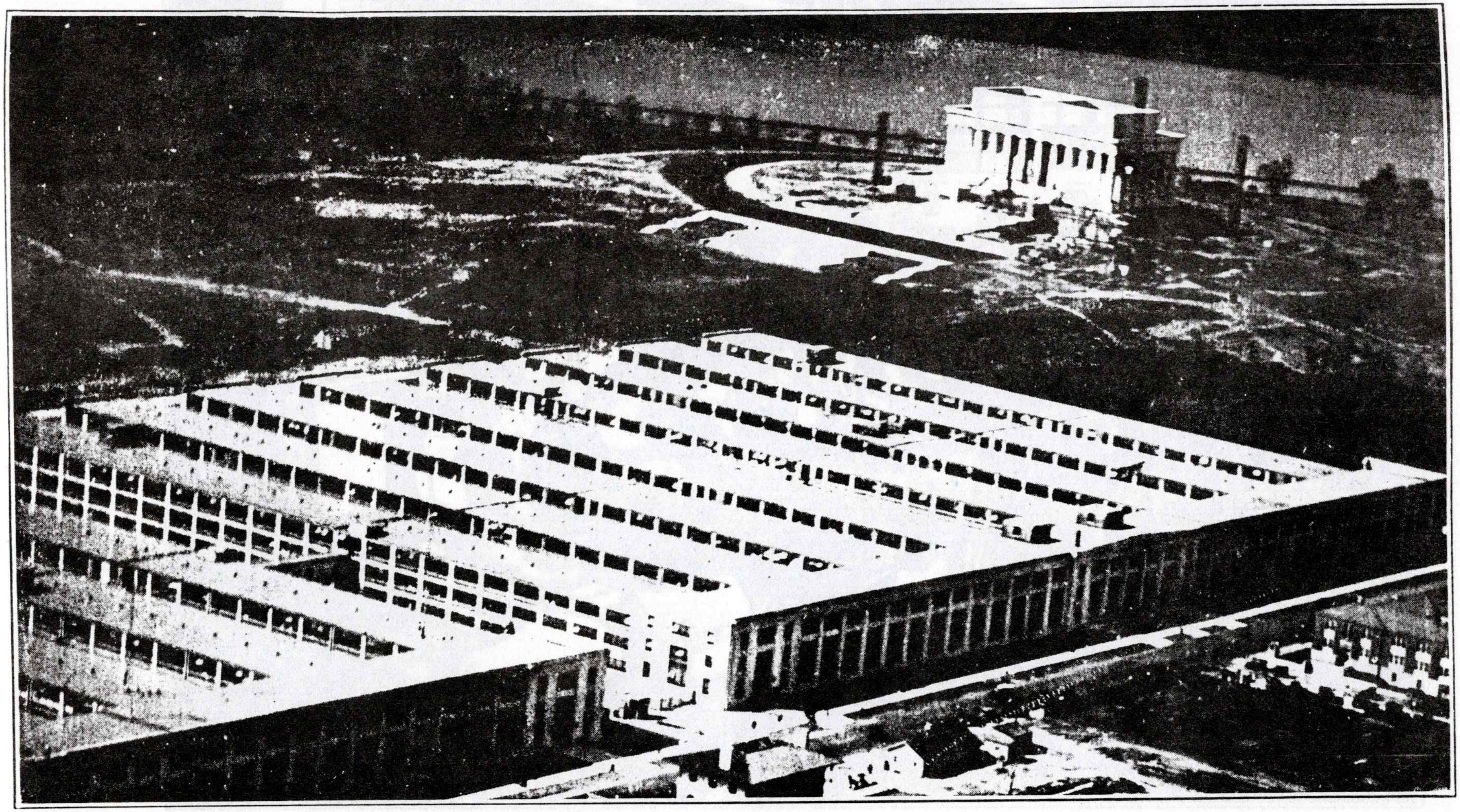


SHELL PAINTING.

This view shows the exhaust hood open and turntable lowered. Operator raises turntable by foot lever and closes hood before spraying.

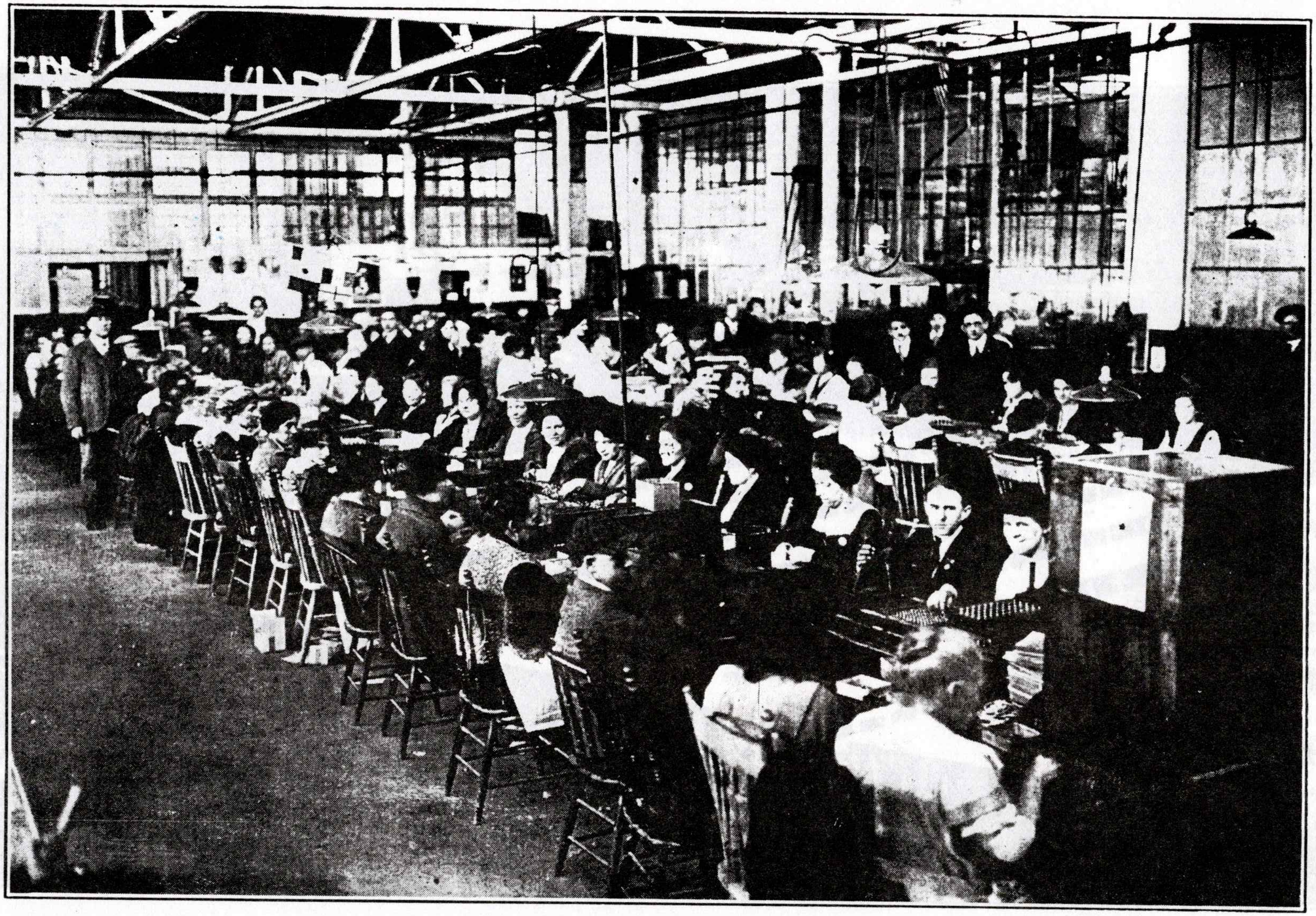


GENERAL VIEW OF SHELL-PAINTING ROOM.



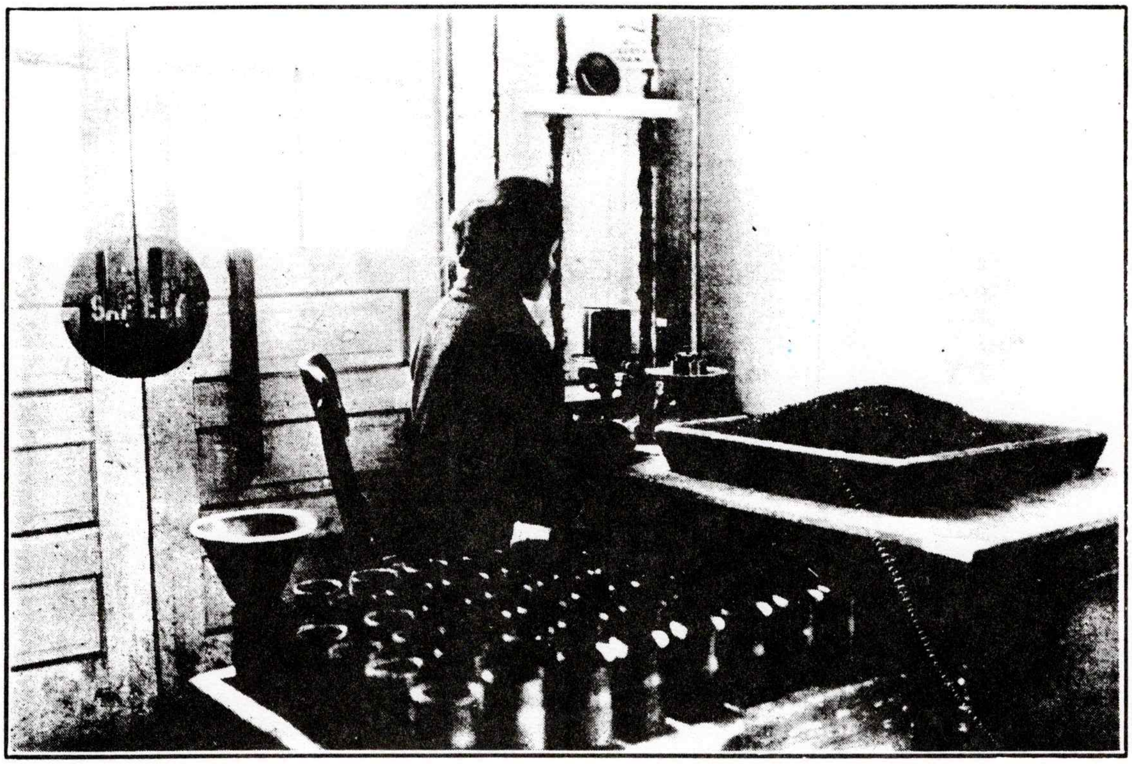
THE MUNITIONS BUILDING, WASHINGTON, D. C.

The Lincoln Memorial and the Potomac River in the background.



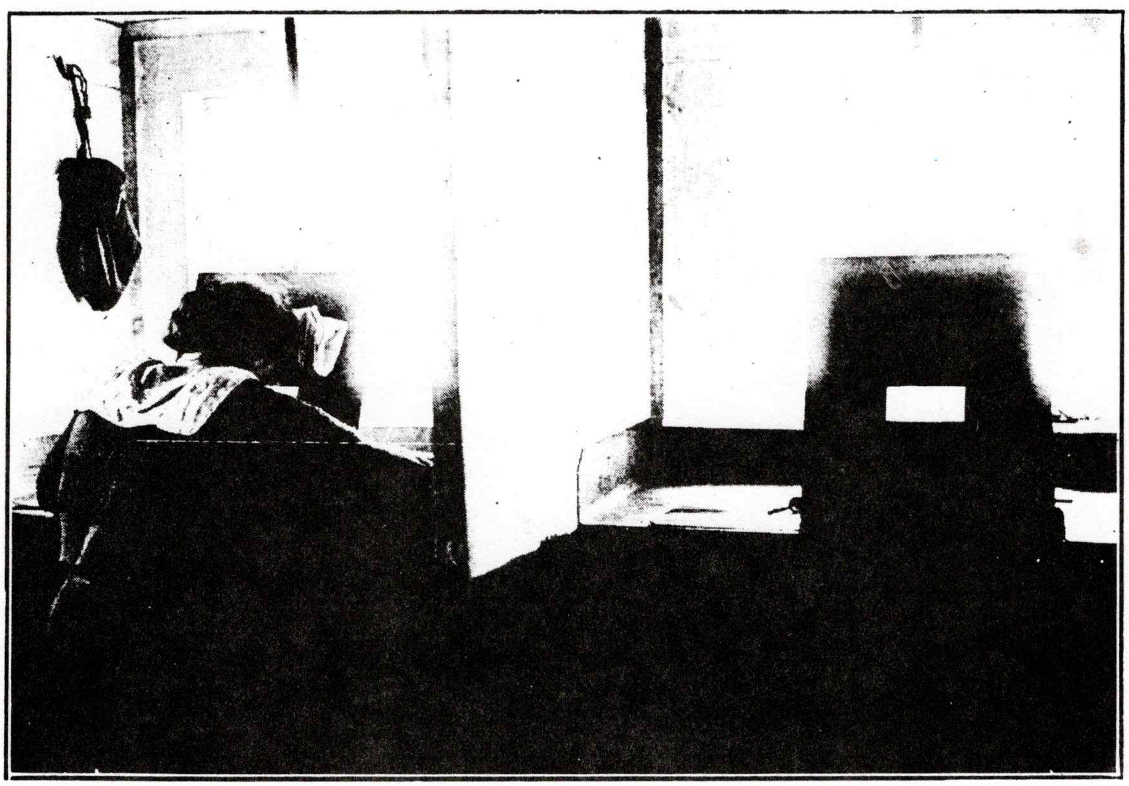
MARK V FUSE ASSEMBLY.

This picture shows two complete units for this assembly work. The operation begins in the foreground with cap assembly and progresses toward background, the fulminate detonator being inserted midway down table. The protecting bulkhead for cap supply is shown in the foreground.



LOADING SMOKELESS POWDER.

Notice safety door at the girl's elbow. A flash in this room will not communicate to an adjoining room. The room is heated by overhead hot-air heating system.



FULMINATE COMPOSITION CHARGING, STEEL SHIELD, WITH WINDOW OF HEAVY GLASS TO THE RIGHT.

Girl operating the same device on the left. The view shows the bulkhead between the operations.

CHAPTER THREE
GUN CARRIAGES AND MOUNTINGS

The word "carriage" usually brings to mind some sort of wagon. A gun carriage is the fixture the gun tube is mounted on. Fixed seacoast guns used two principal classes of carriages, Disappearing and Barbette.

DISAPPEARING CARRIAGES

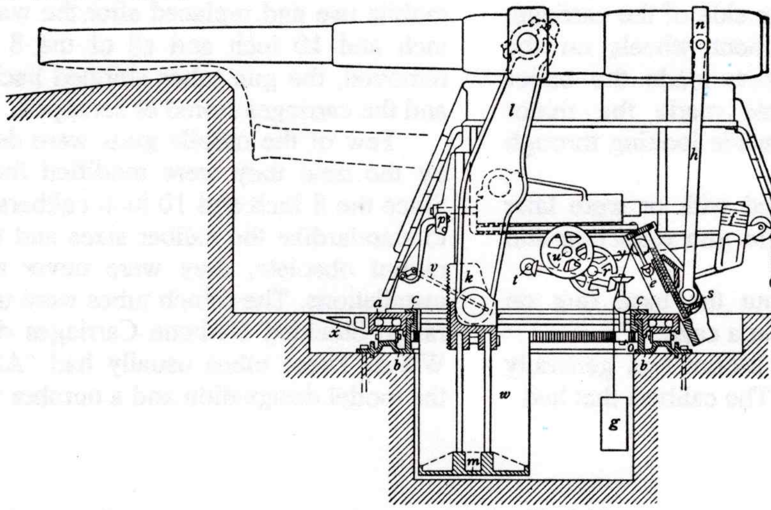


FIG. 148.—12-inch Gun on Disappearing Carriage, Firing Position.

Disappearing carriages allowed the gun to raise into firing position and retract down behind the protection of a parapet of sand and concrete after being fired. When this carriage was designed in the 1890's, the only threat came from surface based sources. With the rapid advancement of air power the design soon became obsolete.

The unique design brought the breech level down to 52 inches off the loading platform no matter where the elevation was set for firing, allowing the use of steel wheeled ammunition trucks at a fixed height to service the gun with heavy projectiles.

Operation was as follows: the gun was loaded at platform height and a lever was pulled releasing a counterweight which caused the weapon to raise into firing position, or "in battery". After the gun was fired, the recoil from the explosion pushed the gun back down raising the counterweight. The recoil was absorbed partly by the counterweight and by two hydraulic recoil cylinders, one on each side of the carriage.

The counterweight was quite heavy. For example the counterweight for the 12 inch M1901 was in 102 pieces of mostly lead and weighed 164,700 lbs.

The gun was locked in the loading position by a ratchet pawl bearing on notched teeth at the "elbow" of the trunnion levers, and held in the raised position by the counterweight.

Should the gun be tripped into battery and not fired, a hand winch assembly in the carriage was used to bring it back down. This however required a team of men turning the crank for 10 to 15 minutes to lower the gun and raise the tremendous counterweight. To pull the gun down, cables were brought up and attached to the trunnion arms at the barrel. When not in use, the cables were retracted.

The two recoil cylinders were adjustable in their retarding action by controlling the relief pressure. They traveled back and forth on a train of rollers between the cylinders and side frames of the mount.

Early models (M1894) had the rollers built into the side frames, and the cylinders traveled back and forth over the rollers on a machined surface on the underside of the cylinder. Later models had machined surfaces on both the side frame edge and the underside of the cylinders and the rollers were held in a train by long side plates. This train of rollers was free to travel as a unit in between the cylinder and the side frame. This caused problems due to slippage and the roller train would sometimes get out of position and prevent the gun from going fully into battery. The latest models prevented this by putting a gear along side the lead wheel running on a rack on the inside the side frame to hold the train in position.

Elevating the barrel in the firing position for aiming was accomplished by using a gear rack assembly which raised or lowered the elevating band at the rear of the barrel.

Traversing, or turning the gun was accomplished on the earliest models (M1894) by using a link chain mechanism which pulled on a chain laid in a track at the rear of the mount. Later models (M1896) used a precise mechanism consisting of a pinion gear attached to the underside of the front of the carriage turning against a fixed ring gear cut into the inside of the base.

Control of these turning mechanisms was by a large crank or handwheel on the side of the carriage. Most models had fine adjustment wheels on the sighting platform. The gun crew made the major adjustments while the operator made the minor adjustments for precise aiming while looking through the sighting device.

Many models were equipped with or were later modified with electric motors for gun retraction and traversing.

The carriage revolved about the base ring on tapered rollers which were held in a cage.

The Disappearing Carriage Mount was generally considered obsolete after 1916. The calibers that had been mounted included 6 inch, 8 inch, 10 inch, 12 inch, 14 inch, and 16 inch.

It was decided in 1917, in order to provide heavy artillery for the war effort as quickly as possible, that some of the seacoast guns would be "borrowed" for mobile use and replaced after the war. Some of the 6 inch and 10 inch and all of the 8 inch rifles were removed, the gun tubes shipped back to the arsenals and the carriages stored or scrapped.

Few of the mobile guns were delivered, because by the time they were modified the war was over. Since the 8 inch and 10 inch calibers were eliminated to standardize the caliber sizes and the Disappearing mount obsolete, they were never replaced in their installations. The 6 inch tubes were used in the longer range Shielded Barbette Carriages developed during WWII. These tubes usually had "A2" stamped after the model designation and a number were installed.

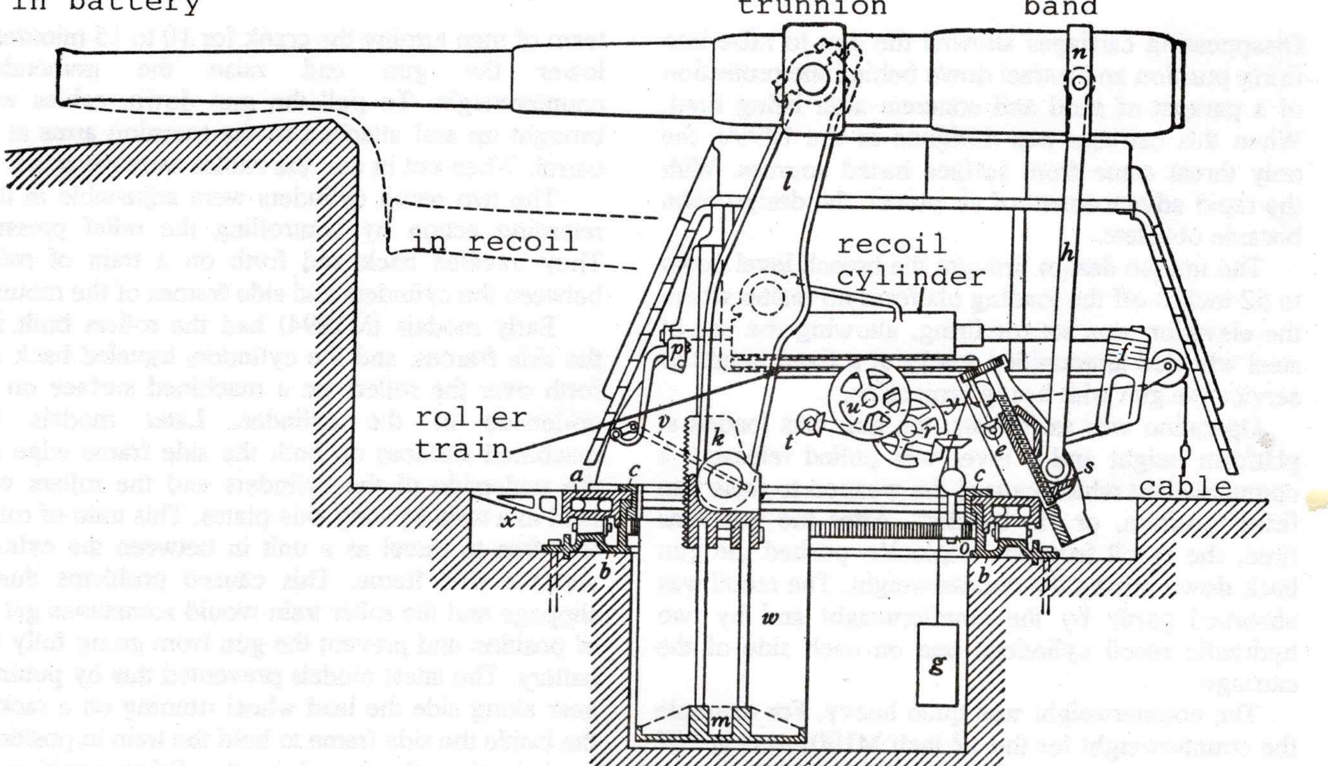


Fig. 148.—12-inch Gun on Disappearing Carriage, Firing Position.

b is the base ring, k is ratchet block, l is the trunnion lever, w is the counterweight, t,u,and y are the traversing gear train, e is the elevating gear train, f is the shock absorber pad made from balata, a substance like rubber.

BARBETTE CARRIAGES

Barbette mounts consist of a fixed base and a superstructure capable of elevation and rotation.

Seacoast guns up to 6 inches in caliber were mounted on cone shaped pedestal bases such as fig. 143. This mount was shielded with a curved shield 4½ inches thick. The recoil was absorbed by hydraulic cylinders and return to battery was by spring action. Elevating and traversing was accomplished with gears. Elevation was limited to +15°. Dry batteries in two boxes secured to the platform supplied power for firing the piece and for the sight illumination lamps. Loading was by powder tray and shot truck.

A variation of the Pedestal mount was the Balanced Pillar mount shown in fig. 144. and was used for guns up to 5 inch. This mount allowed the gun to be raised above the parapet for firing and lowered out of view after the session was finished. The construction was one cylinder telescoping inside another cylinder by means of a counterweight and hoist mechanism. The cylinders were locked together by means of a clamping lever at the base. This mount was soon declared obsolete and the installations were modified with a fixed Barbette Pedestal.

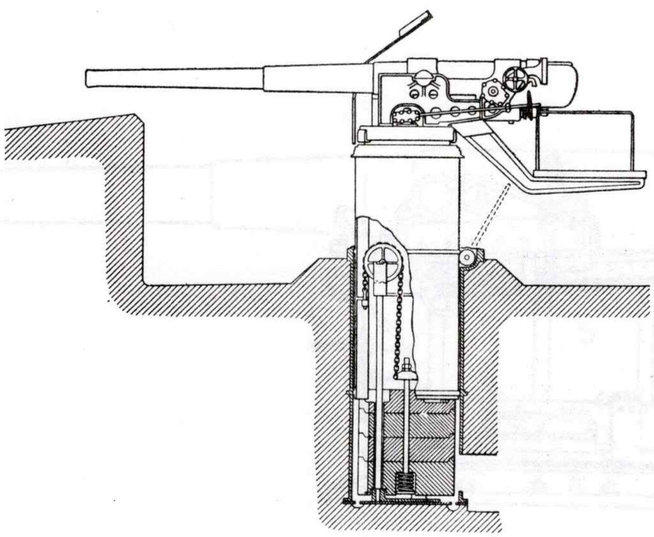


FIG. 144.—5-inch Seacoast Gun on Balanced Pillar Mount

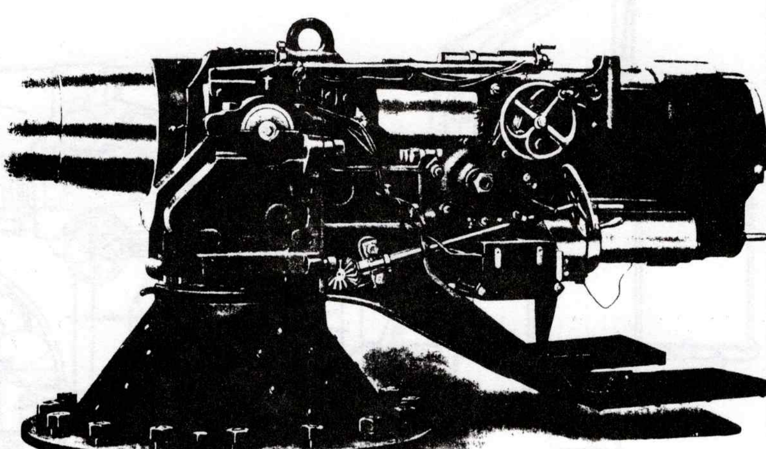


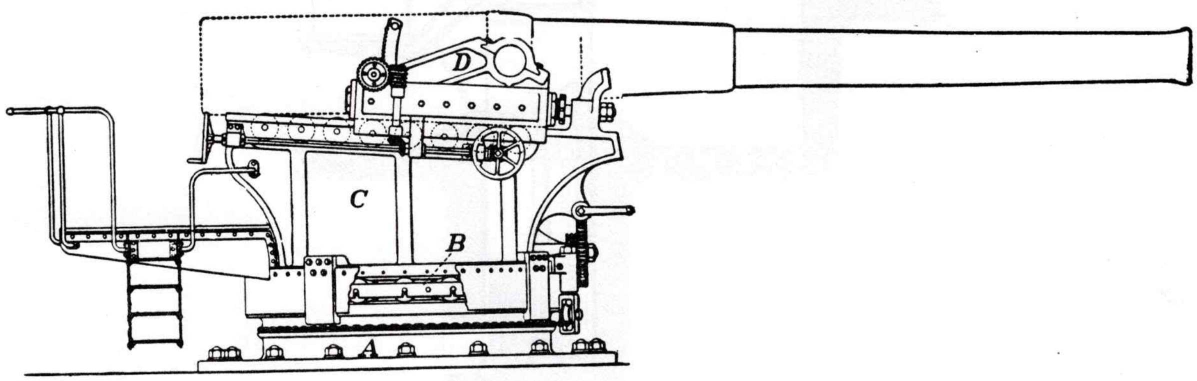
FIG. 143.—Pedestal Mount for 6-inch Gun, Shield Removed.

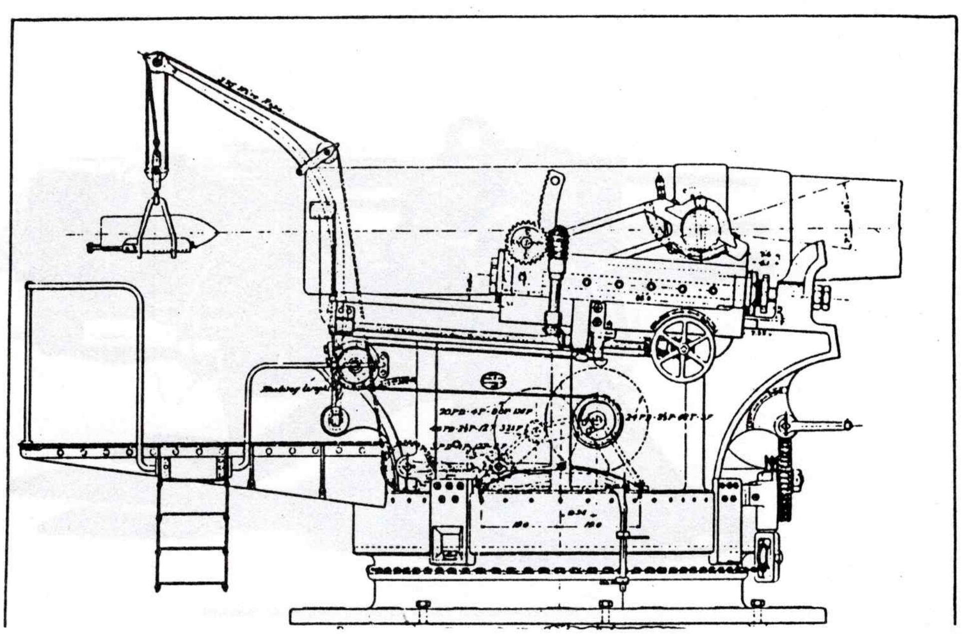
Guns from 8 inch to 12 inch were mounted in carriages similar to below. These carriages were much like Disappearing carriages in that they used two hydraulic cylinders riding on a roller train to absorb recoil. Like Disappearing carriages, the earliest models (1892) had the rollers built into the side frames with the underside of the cylinder riding on the fixed position rollers, whereas later models (1896) used an independent roller train traveling back and forth between the underside of the cylinder and the top edge of the side frame. After firing, the cylinders traveled backwards up a 4° incline to slow the travel, which was limited to about 5 calibers by the stops. The gun returned to battery by gravity.

Traversing on early models was accomplished by a mechanism pulling on a link chain wrapped around the base of the mount and secured at one point. Later models used the more precise method of a pinion gear mounted to the upper carriage turning against a ring gear fixed to the inside of the base ring. All carriages revolved on tapered rollers.

Elevation was controlled by a handwheel by the breech turning a shaft to a gear rack which tilted the barrel up or down. Elevation was limited to -7° to +18° on earlier models but was increased to +35° on later models to give greater range.

Loading these weapons was rather awkward with the projectiles being lifted to the breech by electric hoist from the shot truck.





Later models were mounted in a well with the traversing and elevating controls below grade to facilitate easier loading such as the 12-inch model 1917 carriage shown below. Note that the gun tube is a model 1895 that has been taken from another carriage and remounted.

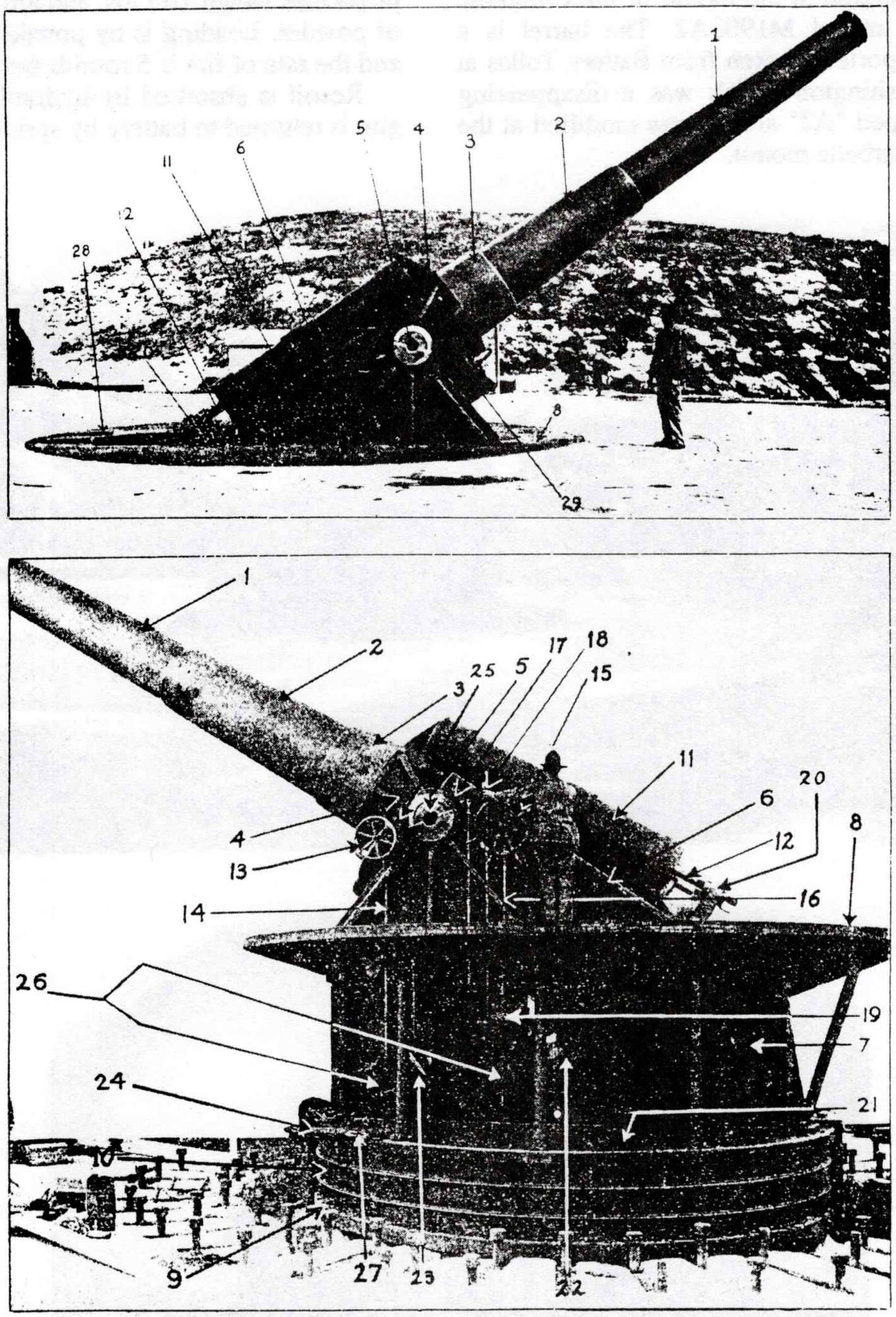


Figure 15. 12 Inch Gun, M1895, on Barbette Carriage, M1917.

1. "C" hoop
2. "D" hoop
3. "A" hoop
4. Cradle
5. Cradle trunnion
6. Side frame
7. Chassis
8. Top platform
9. Base ring
10. Distance ring
11. Counterrecoil spring cylinder
12. Piston rod
13. Slow motion traversing handwheel
14. Slow motion traversing shaft
15. Elevating handwheel
16. Elevating shaft
17. Speed controller
18. Speed indicator
19. Electric elevating controller
20. Yoke
21. Racer
22. Elevating crank
23. Traversing crank
24. Auxiliary platform
25. Shoulder rest
26. Gear boxes
27. Azimuth indicator
28. Shot truck guide
29. Recoil cylinders

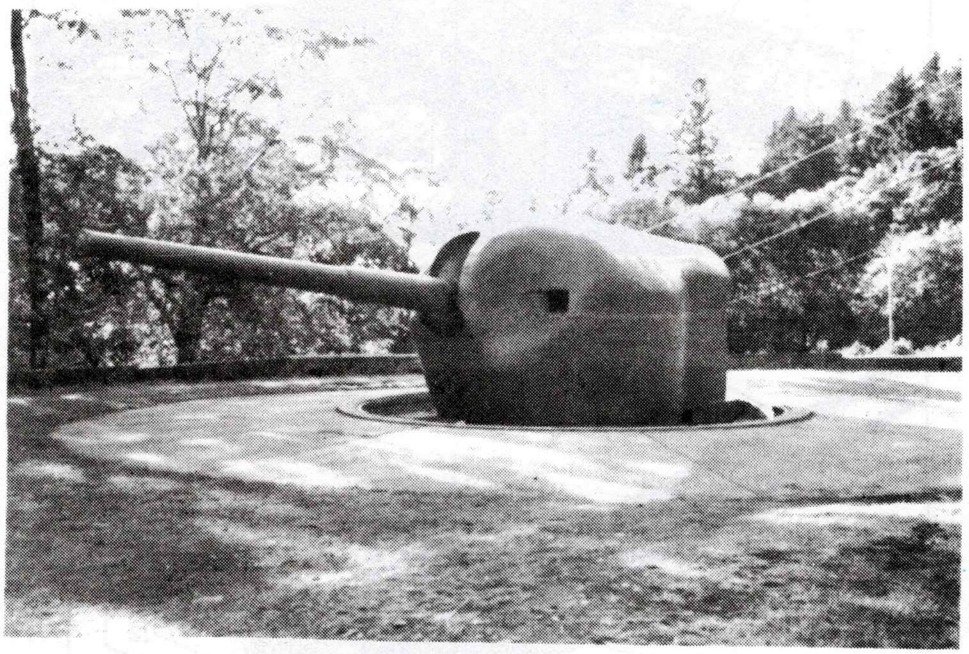
SHIELDED BARBETTE CARRIAGES

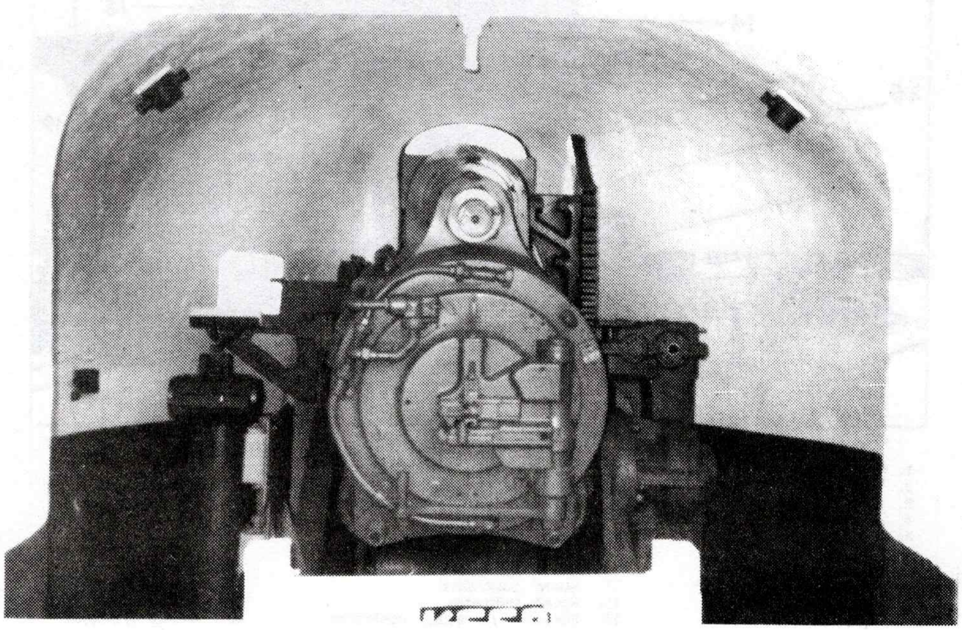
These weapons were developed during WWII and installed as a replacement for many of the obsolete disappearing carriage guns. The gun tubes were recycled from stocks at the arsenals taken from installations at the start of WWI although some were new.

The gun pictured below is emplaced at Ft. Columbia, Washington at the mouth of the Columbia River, and is a model M1903A2. The barrel is a model M1903 reportedly taken from Battery Tolles at Ft. Worden, Washington which was a disappearing battery and stamped "A2" after it was modified at the arsenal into the barbette mount.

This gun is a 6 inch rifle with a 50 caliber barrel and a Bofors breech mechanism. The carriage has an elevation from -5° to +47° and can be traversed 360°. The shield is an average of 5½ inches thick and weighs about 39 tons. Traversing and elevation can be controlled either manually or by electric motor. Range is about 15 miles. The armor-piercing projectiles weigh 105 lbs. and are propelled by 37 lbs. of powder. Loading is by powder tray and shot truck and the rate of fire is 5 rounds per minute.

Recoil is absorbed by hydraulic cylinders and the gun is returned to battery by springs.



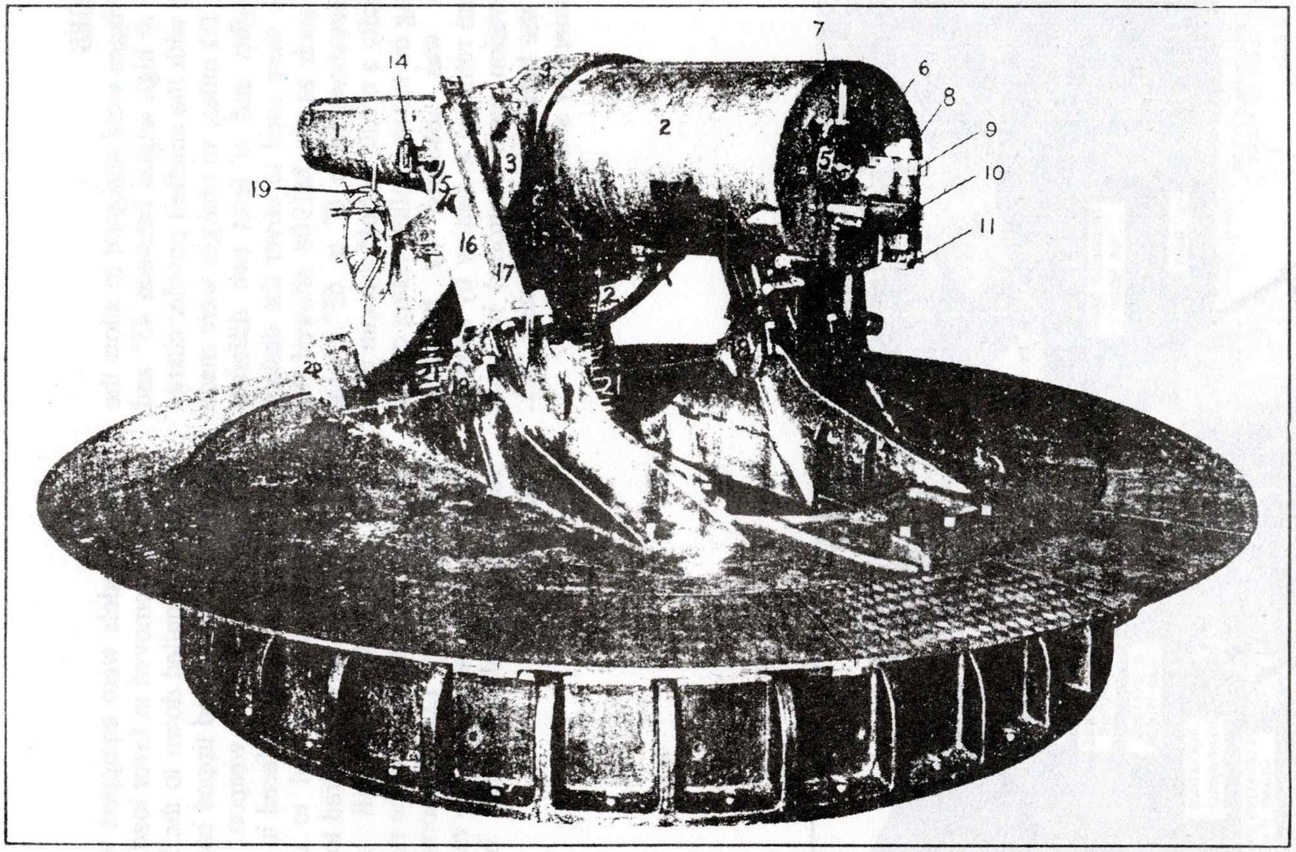


MORTAR CARRIAGES

Early mortar carriages were designed to allow the weapon to fire only at high angles between 45° and 65°. The least range with the smallest powder charge provided was about 1½ miles, so charges were made up of different weights and at least two different weights of projectile were used to cover the desired area. Later models such as the M1908 allowed the mortar to fire at elevations from 0° to 65°.Mortar mounts were essentially a cradle to hold the gun tube on a platform rotating on tapered rollers riding on the base ring. Recoil was absorbed by hydraulic cylinders and the gun returned to battery by springs. Traversing and elevation were controlled by hand wheels to gears on the base ring and elevating rack. Loading was by powder tray and shot truck. Very early models were equipped with shot hoist which was later removed in favor loading by shot truck. The barrel was pulled down to the horizontal position by hand for loading and tipped back up by hand due to the fine balance of the weapon.

Mortars were first placed in groups of 4 per pit, 8 per battery. This proved to be quite awkward as nearly 50 men were required to service the 4 guns in each pit and even well trained crews found coordination difficult and the rate of fire suffered. By the 1920's many 12-inch mortars had been removed for service on mobile railway mounts and many of the remaining installations had been reduced to two mortars per pit.

Figure 17. 12 Inch Mortar, M1890 MI, on Spring Return Carriage, M1896.



1. Chase hoop
2. Jacket
3. Trunnion hoop
4. Breech bushing
5. Breechblock
6. Firing mechanism seat
7. Locking bolt
8. Hinge-pin nut
9. Compound gear
10. Tray
11. Hinge pin
12. Elevating rack
13. Top carriage
14. Quadrant
15. Crosshead
16. Piston rod
17. Crosshead guide
18. Cylinder trunnion
19. Elevating handwheel
20. Fulcrum pins
21. Counterrecoil springs
22. Racer

Figure 18. 12 Inch Mortar, M1912, on Mortar Carriage, M1896 MIII.

CARRIAGE PHOTOS

(photos below of a 6-inch Barbette pedestal mount taken from Tschappat's "Ordnance and Gunnery" 1917)

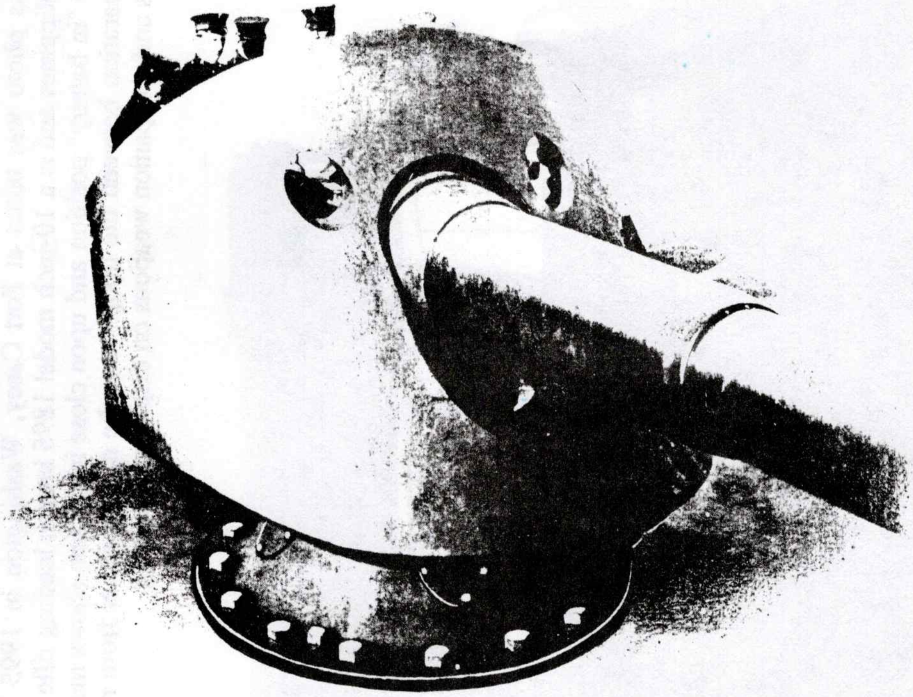


FIG. 223.—6-inch Gun on Pedestal Mount with Shield.

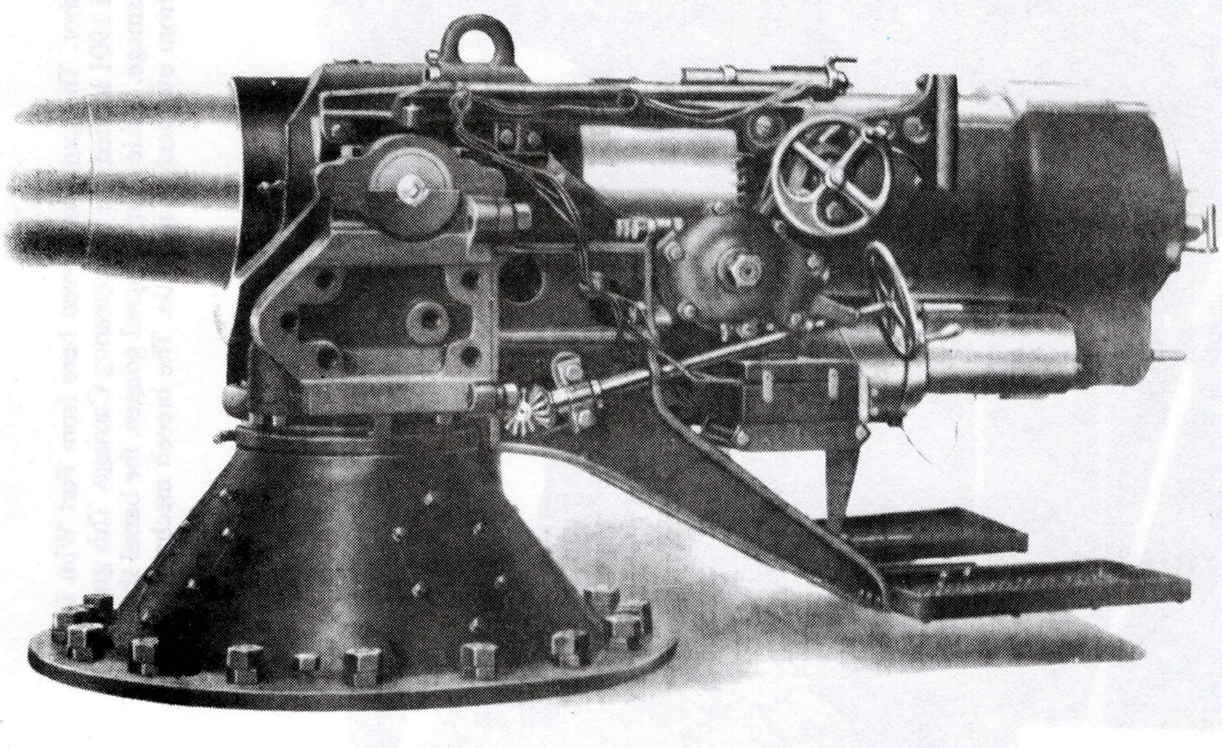
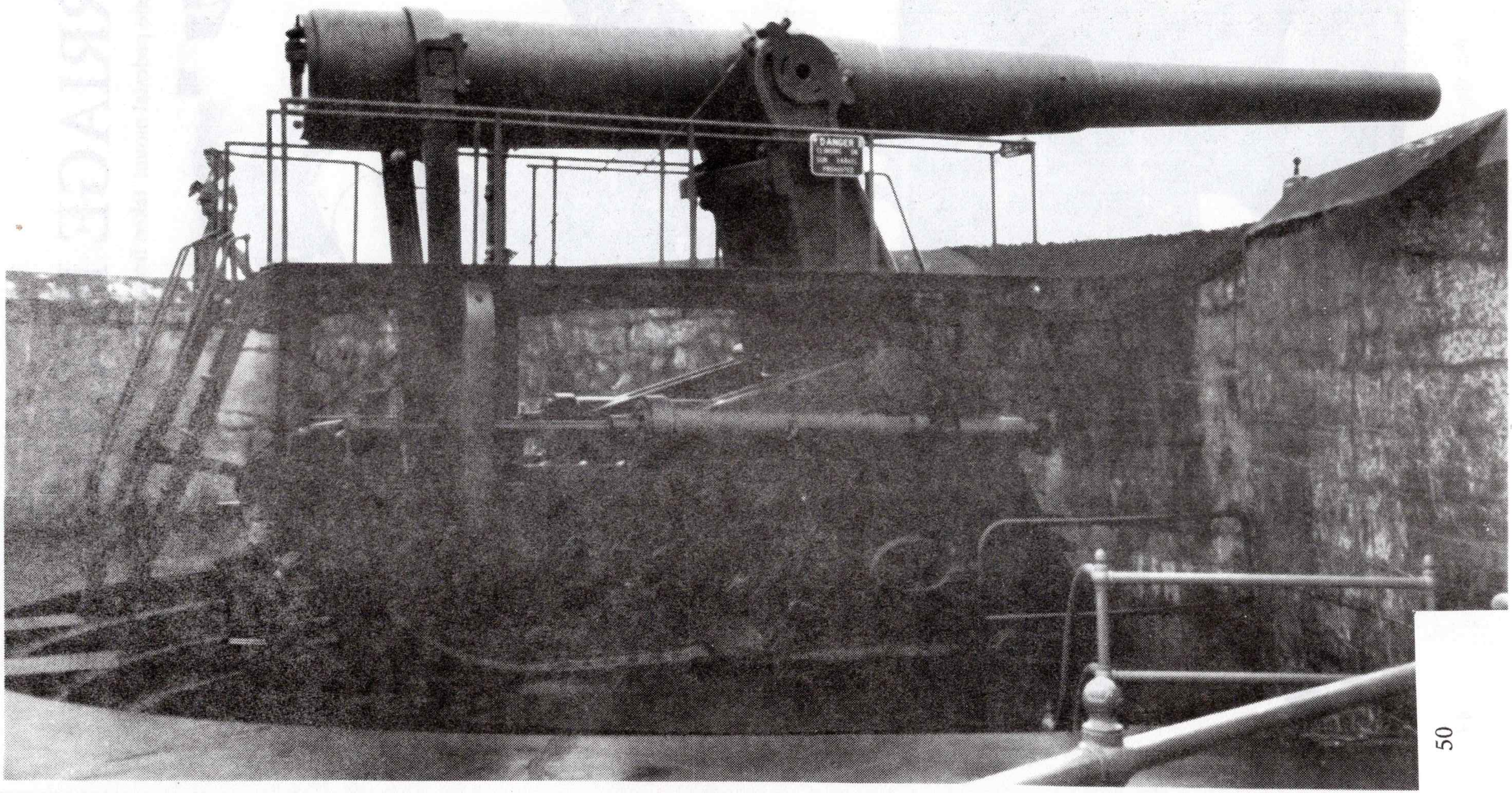
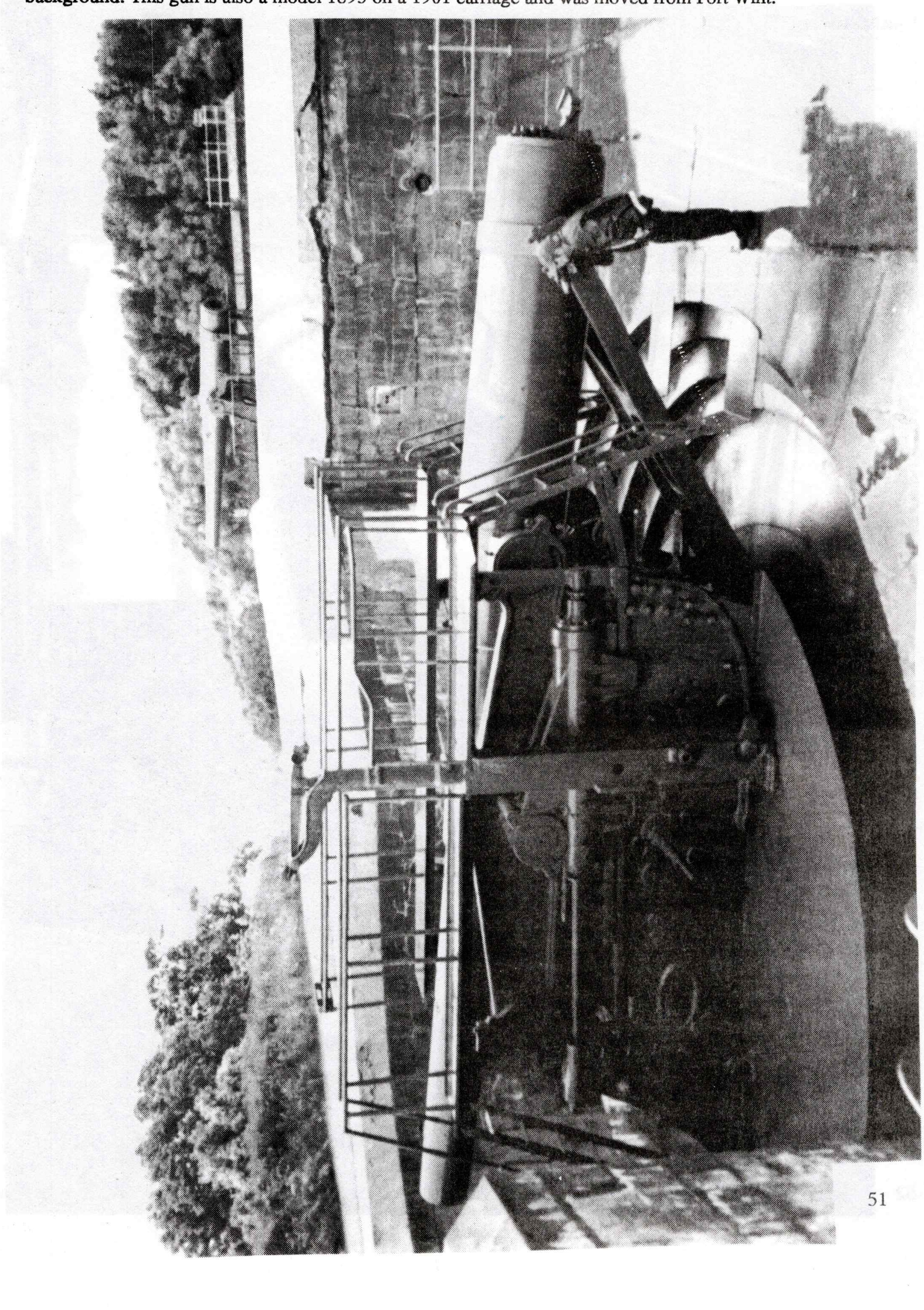


FIG. 143.—Pedestal Mount for 6-inch Gun, Shield Removed.

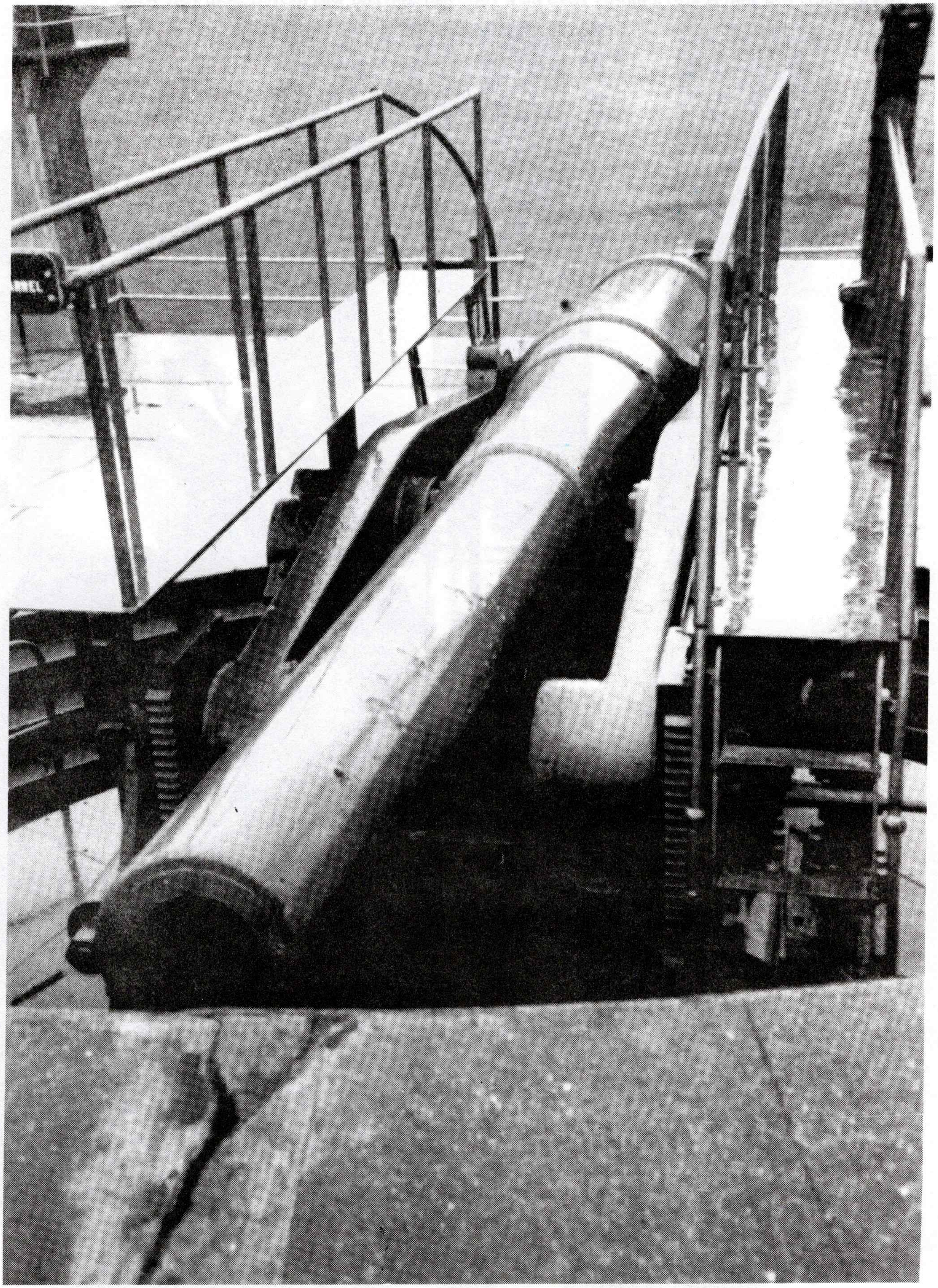
This photo was taken at Fort Casey, Washington in 1995 by the Author. The gun was moved here from Fort Wint in the Philippines and is a 10-inch model 1895 breech loading rifle on a model 1901 limited fire Disappearing Carriage. This gun is in the "in battery" position and upon close inspection shows much battle damage. Aside from shrapnel gouges, the barrel shows a separation between the hoops near the muzzle either from moving or from overheating in battle. The breech mechanisms on this and companion weapons on display are missing.



This photo shows the Author video taping the second gun in the "recoil" position with the "in battery" gun in the background. This gun is also a model 1895 on a 1901 carriage and was moved from Fort Wint.



Note the shrapnel gouges on the barrel in this photo.



CHAPTER FOUR
INSTALLATION AND MAINTENANCE

INSTALLATION

Installation of the guns was done largely by hand. The units were transported from the arsenal to the emplacement site by barge or rail. Each site had its own particular obstacles, but upon reaching the site movement into place was mostly by manpower, obviously no easy task.

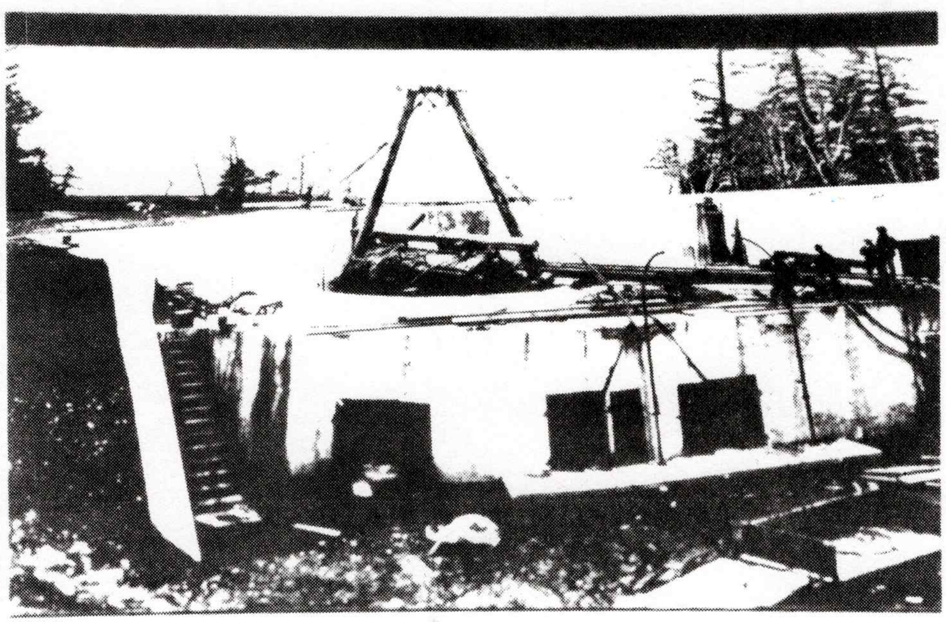
These weapons were tremendously heavy and great care had to be taken to prevent damage to the machinery or personnel. For example, the 10-inch disappearing gun and carriage on the previous pages weighed approximately 300,000 lbs.

Gun tubes were shipped independently of the carriages and the unit was assembled on site. Hoisting was by block and tackle suspended from gin poles lashed to points such as the anchor rings still on many installations. Some times accidents happened, like the photo below which shows an 8-inch model 1896 Disappearing carriage on its side as it was dropped and broken at Battery Ord, Fort Columbia, Washington during installation.

Raising the heavy sections to the level of elevated batteries involved jacking up the section and placing cribbing underneath (uniformly stacked timbers), moving the object with long pinch bars, jacking up the section further and placing more cribbing underneath, etc. until the section was finally in place.

After the major pieces were in place there was still much assembly and alignment to be done. All parts had to move freely and properly. All areas of the gun had to be free from burrs and rust. There could be no binding in the motion of any parts.

Once installed correctly, the weapon was "proof fired". This involved personnel from the Ordnance Department inspecting the installation and then firing the weapon with a above maximum powder charge to ascertain the gun was safe to operate. When certified, the gun was ready for operation.



MAINTENANCE

It was recommended that the carriage be traversed from time to time through its entire movement and not be allowed to stand for any length of time at one azimuth as it was felt that this would cause uneven settlement of the platform.

The gun had to be kept free of rust at all times, and if it did accumulate sandpaper was forbidden to be used as it would increase clearances. Emery cloth No. 1 (extra fine, polishing) was the only abrasive allowed and if the rust was stubborn it could be softened with kerosene.

Recoil cylinders were to be emptied every 3 months and thoroughly cleaned every 6 months. The cylinders were to be refilled with oil of specific gravity about 0.85 such as the "hydroline" then issued.

When used for daily drills, the gun was to be completely lubricated twice a week. The gas check pad in the obturator was to be lubricated with a mixture of graphite and grease.

During firing the bore was cleaned with sponging solution, a mixture of 1 lb. of castile soap to 4 gallons of water. Water only was used when soap was not available.

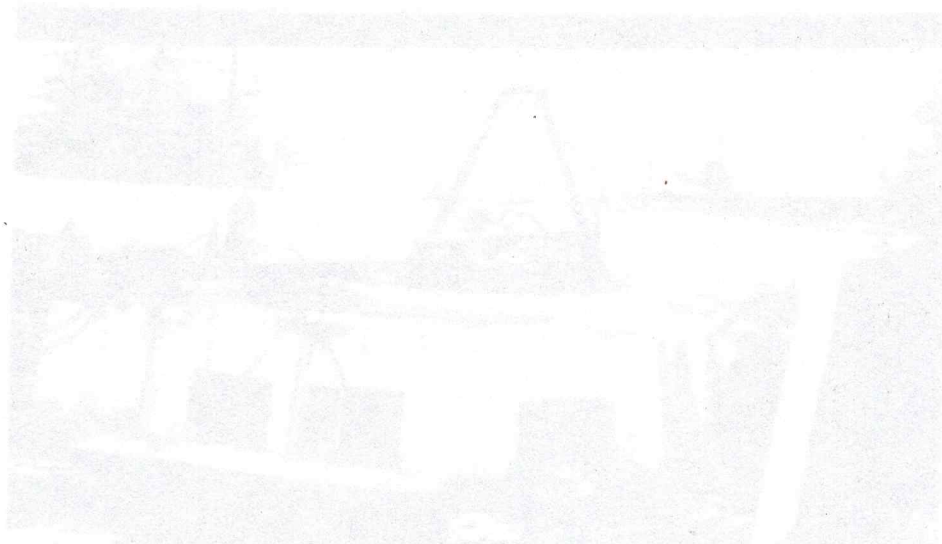
After firing, the bore was cleaned with hot water, or cleaning compound (½ lb. of sodium carbonate dissolved in one gallon of boiling water) used hot. Then the bore was allowed to dry and engine oil applied. It was advised to never try to clean the bore with oil. The bore was to be cleaned the same way the next day and again a few days afterwards to remove the "sweating" which would accumulate. (moisture coming out of the metal).

The mushroom head of the obturator had to be checked and adjusted for firing before the gun was ready. The clearance was crucial and the condition of the sealing rings and pad very important.

When not in use, the muzzle was plugged and canvas hood pulled over the breech and muzzle to keep out dirt and moisture.

The packing in the stuffing boxes of the hydraulic cylinders was changed as needed and any leakage of oil from the cylinders called for immediate attention with the recommendation that "skilled labor" be called in if such leakage occurred.

Frequent attention to the oil holes and grease cups was recommended to keep the weapon properly lubricated at all times.



AIMING DEVICES

Early artillery pieces used direct- laying sights such as notched open sights or peep sights. Later models used an indirect method of a range drum or slide geared to the gun, and made to move past a fixed pointer. Telescopic sights were provided for better visibility although telescopic sights for seacoast artillery were not of the panoramic type such as used for mobile artillery. The model 1898 telescopic sight was used on 8-, 10-, and 12-inch barbette carriages and for disappearing carriages of earlier models. The model 1904 telescopic sight was used on many of the guns mounted on disappearing carriages and barbette carriages. On disappearing carriages, the sight was fixed to the sight standard, while on barbette carriages the sight was somewhat different in shape and was bolted to the cradle and moved with the gun in elevation.

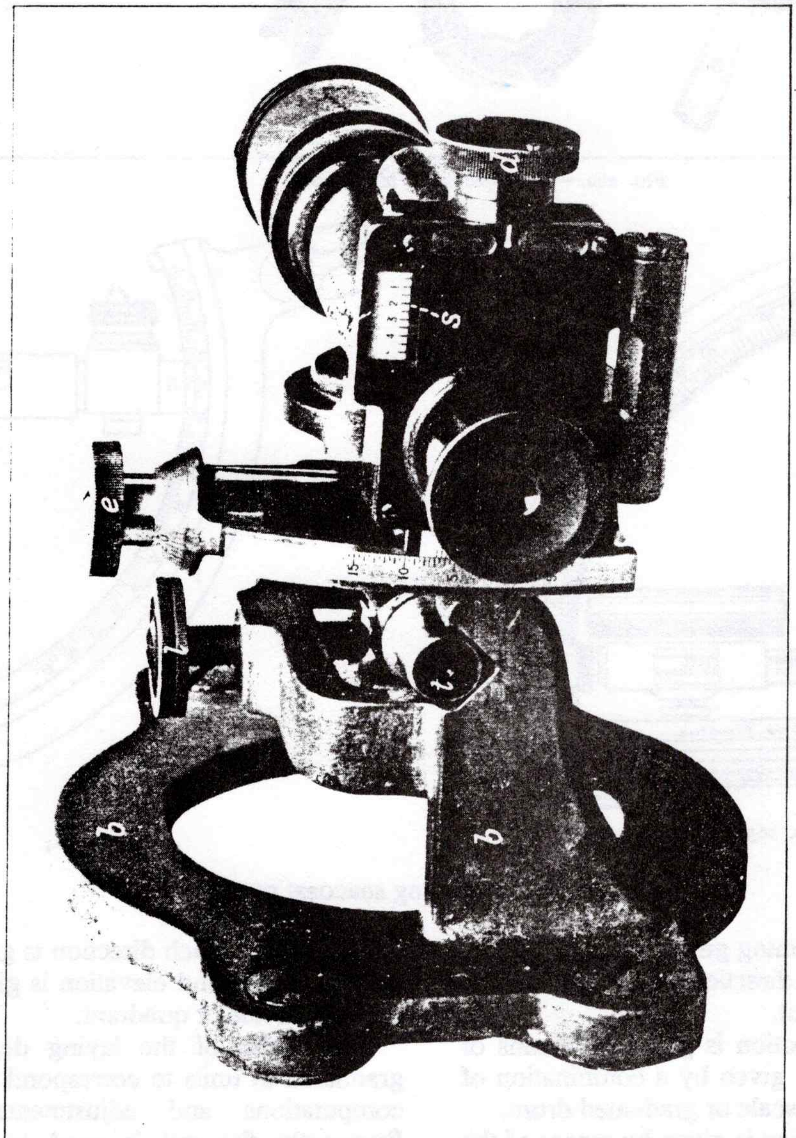


FIG. 200.—Telescopic Sight, Model 1898.

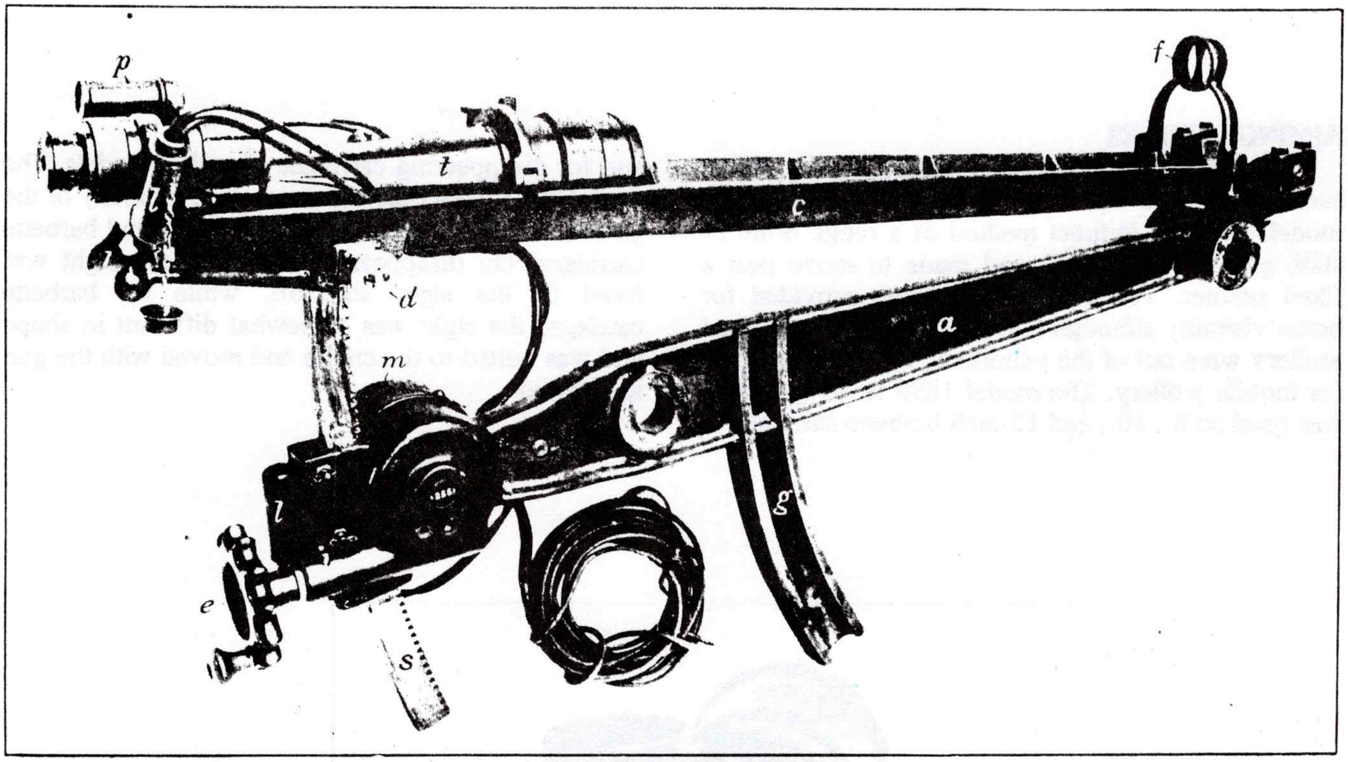


Fig. 262.—Telescopic Sight, Model 1904.

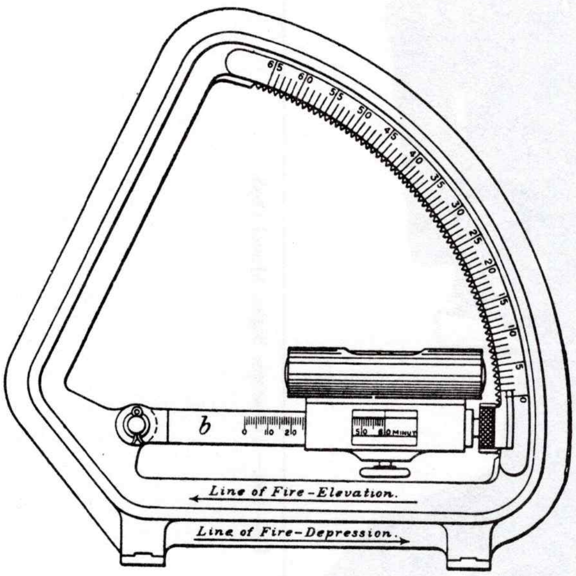


Fig. 265.

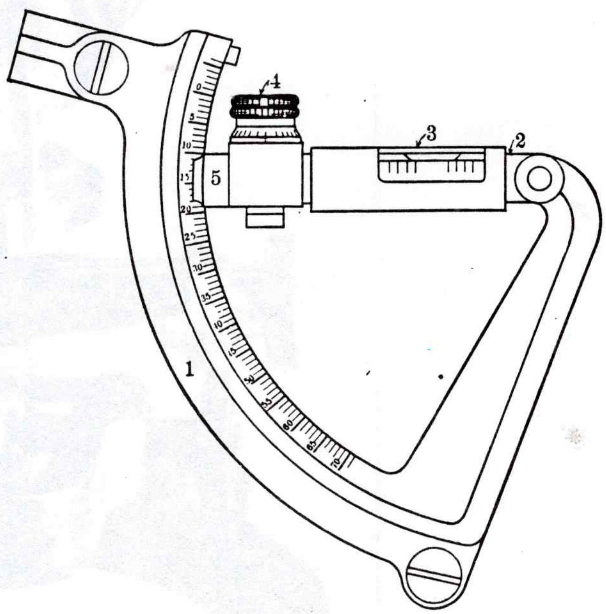


Fig. 267.

Quadrants used in aiming seacoast mortars.

The various methods of aiming guns are:

Case I.-In which both direction and elevation are given by means of the sight.

Case IA.-In which direction is given by means of the sight, and elevation is given by a combination of the sight and an elevation scale or graduated drum.

Case II.-In which direction is given by means of the sight, and elevation is given by means of an elevation scale or quadrant.

Case III.-In which direction is given by means of an azimuth scale, and elevation is given by means of an elevation scale or quadrant.

The scales of the laying devices generally are graduated in units to correspond to those used in the computations and adjustments of firing data. Frequently the mil is used as a unit of angular measure. A mil is 1/6400 of a circle.

GUN CREWS

Operating the guns involved large crews of men working as a well trained team. For example, the following is a list of the positions and duties for the men servicing 12-inch or 14-inch disappearing carriage guns:

Gun Pointer - (NCO or Private) - takes care of sighting

Range Setter - (NCO or Private) - sets the range

Telephone Operator - handles information from plotting room

Recorder - posts data from firing

Chief of Breech - (NCO or Private) - supervises ramming and commands "in battery trip"

No. 1 (breech detail) - cleaning, ramming, sponging

No. 2 (breech detail) - cleaning, ramming, sponging

No. 3 (breech detail) - handles primers

No. 4 (breech detail) - opens and closes breech

Nos. 5 and 6 (elevating detail) - elevate the piece

Nos. 7 and 8 (traversing detail) - traverse the carriage

Nos. 9 and 10 (tripping detail) - trip the gun into battery

Nos. 11 and 12 (truck detail) - handle shot trucks

Nos. 13, 14, 15, 16 (powder serving detail) handle powder

No. 17 (sponging detail) sponges bore

Nos. 18, 19, 20 (rammer detail) ram in the ammunition

There are many people missing from this list, such as the men in the battery powder and shot rooms, people in the plotting rooms, people in the power generating rooms who all had to be there to make these weapons operate.

The 10-inch disappearing carriage gun required 21 positions while the 6-inch disappearing carriage gun listed 14 positions. The 6-inch barbette pedestal gun listed 13 positions while the 3-inch listed 7.

The 12-inch mortar used 12 positions per piece, so with 4 mortars per pit almost 50 men had to crowd in to service the weapons between firings. This was reduced in the 1920's to 2 mortars per pit and 24 positions for greater efficiency.

HARDWARE

Various hardware was used in operation. Projectiles were very heavy and often could only be handled by hoists and cranes. In the battery, overhead trolleys riding on rails fixed to the ceilings carried the projectiles to the shot hoist which were then transferred to the wheeled shot trucks for movement to the breech. The shot trucks were of varying designs depending on the caliber and type of the gun and had steel wheels to carry the weight. Many of the shot trucks were adjustable for height as this allowed for correction to the individual installation. Some shot trucks were equipped with loading trays built on to the front to cover the breech threads to prevent damage while loading.

Several different design cranes were used depending on the installation. Most batteries were equipped with "bent" cranes which were U-shaped round rods of steel attached to the concrete with a swivel base. These were multipurpose and were used for lifting many different items such as tools, heavy parts as well as projectiles and ammunition. Some barbette guns were equipped with pedestal cranes to hoist projectiles to the breech. Early mortars used a shot hoist similar in action to an elbow. The shot was wheeled up on a truck, loaded on to the hoist which was hinged to the base platform, then swung over to the breech. This hoist was discontinued in favor of wheeling the shot truck directly up to the breech.

Powder was carried to the breech on a long tray, and held in place for the rammers to push in. Many of the trays were made of wood so as not to damage the breech threads or to possibly cause sparks.

Various long ramrods were used to push in the charge or to sponge out the bore.

Some of the important smaller items used were extractors to remove primers which would not come out readily and pressure gauges installed on the obturator face to monitor the breech pressure.

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