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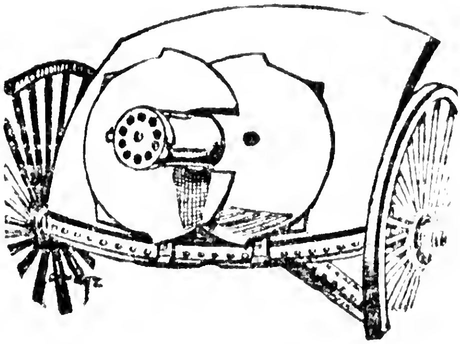
THE

WAR DEPARTMENT



AT THE

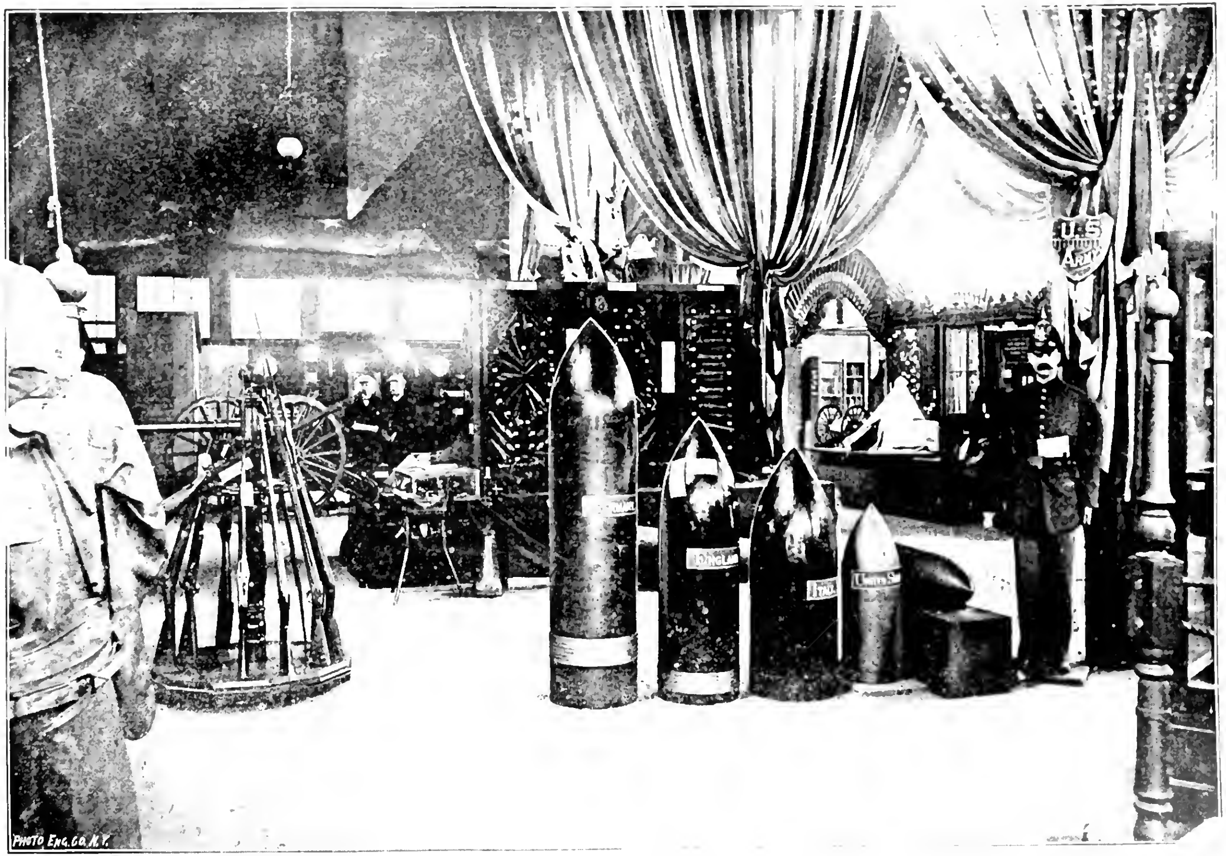
Centennial Exposition

OF THE

OHIO VALLEY AND CENTRAL STATES,

CINCINNATI, OHIO.

JULY 4 TO OCTOBER 27, 1888.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CATALOGUE OF THE EXHIBIT

OF THE

WAR DEPARTMENT

AT THE

CENTENNIAL EXPOSITION OF THE OHIO VALLEY AND CENTRAL STATES,

AT

CINCINNATI, OHIO, JULY 4 TO OCTOBER 27, 1888.

ACT OF CONGRESS, MAY 28, 1888.

THE HON. WILLIAM C. ENDICOTT,

SECRETARY OF WAR.

CAPTAIN A. H. RUSSELL, ORDNANCE DEPT. U. S. A.,
WAR DEPARTMENT REPRESENTATIVE.

LIEUTENANT E. S. BENTON, 3D ARTILLERY, ASSISTANT.

INDEX.

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EXPLANATORY REMARKS.

The Ordnance, Quartermaster and Signal Departments are regularly represented in the exhibit, but the greater part is made up of ordnance stores.

The main object sought is to present an historical series, outlining the development of fire arms from the earliest period, and illustrating the latest improvements, whether American or foreign, so that fair estimate can be made of our armament in comparison with that of other powers.

Besides fire arms, a collection of swords, sabres, lances, etc., is shown. A very full exhibit of small arm cartridges is made. Examples of range finders and testing instruments are seen, including instruments operated practically for determining the velocity of projectiles. Many relics of the Revolution, Mexican War, and the War of the Rebellion are exhibited.

The Quartermaster's Department contributed the field office wagon used by General Geo. H. Thomas during the war; models of various forms of tents used in service; and lay figures showing the uniforms of different periods. It furnished, too, a quantity of United States flags used for decoration. The boards of bayonets used in decoration were prepared at the National Armory. The flags of different nations hung in the War Department section, were loaned by the Navy Department.

The Signal Service exhibits many instruments illustrating the processes of observation for forecasting the weather; with flags, torches, etc., used in military signaling. Weather maps and reports are displayed daily.

The main supply of arms, etc., came from the Military Academy, the National Armory, and the Frankford Arsenal; but articles also came from Allegheny Arsenal, Watervliet Arsenal, Rock Island Arsenal, Fort Monroe, the Ordnance Office, and the Ordnance

Proving Ground, Sandy Hook. Many objects of interest were drawn from the Museum of the Military Service Institution on Governor's Island; and the Engineer Department, though not formally represented, sent a loan of models of torpedoes, gun carriages, etc., from Willets Point and New York. Contributions were also made by private parties.

Attendants are always on hand ready to explain and illustrate the use of the various articles. No enlisted men are on duty in the War Department here. The following, all civilians, are employed for this duty and instructed for the purpose: Charles Becht, Captain 1st Regiment Infantry, O. N. G.; Edward Schlesinger, 1st Lieutenant 1st Regiment Infantry, O. N. G.; Geo. W. Vanduzen, Newport, Ky.; W. B. Hitchcock, National Armory, Springfield, Mass.; Kinney Lowe, Newport, Ky.; attendants. Albert H. Wendt, Newport, Ky., messenger.

It is a noticeable fact that in recent years the greatest improvement in military weapons has been due to American inventors, but that the advantage of the inventions has been chiefly developed by foreign nations from the want of funds for carrying out public experiments in this country. This is true of powder, shot, cannon, machine guns and small arms; and many things of American invention, now used in our service, have been re-imported. Witness: Rodman's perforated cake powder; the slotted breech screw for large guns, etc.

In regard to fire arms, the very remarkable point is illustrated that the earliest arms made were breech-loaders, and that all nations have returned to this principle after long abandonment of it and use of muzzle loaders. The collection of carbines and rifles comprises nearly 150 varieties. It is shown that some very early forms were breech-loaders, but that it was only by the American invention of metallic shell ammunition that breech loaders, now general, became efficient. Magazine guns were also made practicable by the above improvement in cartridges, and the first effective gun of this class, the Spencer, used in the War of the Rebellion, was an American invention. The more recent forms of magazine gun adopted by foreign powers—those fitted with detachable magazines, or with fixed magazines made to fill rapidly by prepared packages—also owe their inception to American inventors. In machine guns the influence of American invention is very prominent, and automatic recoil guns were invented here, though developed abroad.

The history of small fire-arms shows a decrease of calibre from 70-100ths of an inch to 29½, but in big guns the opposite tendency is noticed. Our heaviest rifle shot weighs 800 pounds, while Krupp is making for Germany a gun to throw a projectile weighing 3,300 pounds. The frontispiece view of the exhibit shows the remarkable contrast in size of shot.

In preparing this catalogue, great assistance has been derived from the excellent catalogue, made by Captain Henry Metcalfe, Ordnance Department U. S. A., of the Ordnance Exhibit at the Philadelphia Centennial of 1876; and the descriptions of many of the instruments, and of most of the earlier cannon, machine guns, and small arms, have been condensed from those given there. The order of arrangement has been changed, however, particularly by classifying the repeating arms together, and grouping the true magazine guns according to the form and position of the magazine.

The plates of the Mauser magazine gun, verified from the gun itself, together with much of the information regarding foreign tests of the new small calibre cartridges, have been taken from the "Information Series," published by the Office of Naval Intelligence at Washington, there being no corresponding office in the War Department.

Lieut. E. S. Benton, 3d Artillery, Assistant, has charge of the transportation department, receiving and shipping stores.

A. H. Russell, *Captain of Ordnance U. S. Army,*
Representative of the War Department.

CANNON, ARMOR, AND TORPEDOES.

Field guns are the largest shown in the Exhibit, but by means of models and projectiles, the collection serves to indicate the progress made in the construction of cannon from the earliest forms—breech loading smooth bore guns of light weight, of date of the 14th century—to the largest Krupp rifle guns of to-day. The forms of field gun carriage illustrate the progression of construction from the Gribeauval system, used in the Napoleonic Wars, and the stock trail system (wooden carriage) used during the Rebellion, to the steel gun carriage now used. Illustrations are also given of the revolving turrets and depressing gun carriages now deemed necessary in many positions for heavy guns, and of torpedoes for additional defense.

EARLY CANNON.

1. Chinese Cannon, Bronze.

This gun was captured from the Coreans, June 10-11, 1871, by the U. S. Naval Squadron, commanded by Rear Admiral John Rodgers, U. S. Navy. Presented to the Museum of the Artillery School, U. S. Army, by Major W. F. Randolph, Third Artillery. It is a short breech-loading wall-piece, two inches in calibre. The piece bears an inscription in Chinese characters. A translation made by the Chinese Minister shows that the piece was manufactured in 1312. The charge was contained in a hollow block, with a handle at the top, by which it was placed in position. This breech-block had projections at the lower part of the rear end, and these, with the assistance of a key driven above them, through mortises in the side of the breech, held the block in place for firing. The guns of that period in Europe were made of wrought iron, like the next gun described, and cast guns were unknown. This gun, with other articles mentioned below, was contributed to the exhibit from the Artillery School, through the courtesy of Brevet Brigadier-General J. C. Tidball, commanding Fort Monroe.

2. Old Breech Loading Gun, 4-pounder.

Brought up by a dredging machine, from the bed of the Hudson river, at Albany, in 1879. Though the date of the manufacture of this piece is not known, its form is precisely that of the earliest English cannon of the fourteenth century, and it doubtless dates back to that time. It is made of wrought iron, with projecting bands around the barrel. It has a short handle extending to the rear from the cascabel. The bore runs from a calibre of two inches at the breech to four inches at the muzzle. The exterior increases in diameter towards the muzzle, but the iron is so badly rusted that the original dimensions can hardly be determined. The breech-closing arrangements were practically the same as in the Chinese gun described above. This gun, with many other articles mentioned below, was sent from the Museum at Governor's Island, through the courtesy of Major-General J. M. Schofield, President of the Military Service Institution, and Bvt. Brig. Gen. T. F. Rodenbough, Secretary.

TROPHY CANNON OF THE REVOLUTION.

3. Revolutionary Gun and Carriage.

Heavy twelve-pounder, bronze gun, muzzle loading; mounted on a Gribeauval carriage; captured from the British in the Revolutionary War, at the battle of Saratoga, October 17, 1777. From Governor's Island.

4. Bronze Gun; calibre, three inches; English.

Captured at Saratoga. From West Point.

5. Two Bronze Guns of same pattern; English.

Captured at Saratoga; one bent in chase to render it useless.
From Alleghany Arsenal.

6. Three Coehorn Mortars, Bronze.

Two of $4\frac{3}{4}$ and one of $5\frac{3}{4}$ inches calibre. Surrendered by British at battle of Saratoga. Coehorn mortars are light pieces, which can be readily carried for use in the trenches during siege operations. The 24-pounder Coehorn mortar of our service could be transported by two men, and it was particularly useful on account of its plunging fire for shelling points protected by embankments. From West Point.

7. Two Coehorn Mortars, $4\frac{3}{4}$ inches calibre.

Captured from British at Stony Point.

8. Two Bronze Boat Howitzers, 24-pounder; English.

Place of capture unknown. From Alleghany Arsenal.

9. Bronze Gun, 6-pounder; English.

Made in 1761. Bearing inscription, "Surrendered by Cornwallis at capitulation of Yorktown, October 19, 1781." It is called the Ligonier gun, because it bears the initial of Ligonier, an English field marshal, who was Master of Ordnance at the time it was made. Length, four feet ten inches. Weight, 516 pounds. From Fort Monroe.

10. Bronze Howitzer, 24 pounder; English.

Surrendered by Cornwallis at Yorktown, October 19, 1781.

11. Bronze Howitzer, 3 inches calibre; American.

Made by D. King, Philadelphia, 1793. From Alleghany Arsenal.

12. Three Bronze Howitzers, 2¾ inches calibre; American.

Two bearing inscription, "D. King, Germantown." From West Point.

13. Wall Howitzer, 4-pounder, cast iron, very old.

Fort Marion, St. Augustine, Florida. From Governor's Island.

14. Old Spanish Piece, wrought-iron, 4-pounder.

Used at the siege of the Alamo in 1836. Buried by the Mexicans on the evacuation of the place after the battle of San Jacinto, and found by workmen while digging a cellar.

MEXICAN TROPHY CANNON.

15. Mexican Cannon, 8-pounder.

Muzzle indented by cannon ball. Captured at the battle of Monterey, September 23, 1846. From West Point.

16. Mexican Howitzer, 4-pounder.

Captured at the battle of Monterey, September 23, 1846.

U. S. MUZZLE LOADERS.

17. Old Ship Gun, cast iron.

Fitted with rings for carrying.

18. U. S. 12-pounder Field Gun and 24-pounder Howitzer.

Model with carriage and limber. This illustrates the stock trail system of wooden gun carriage, used during the war of the Rebellion. The 12-pounder gun here referred to was adopted in 1856, and modeled after the gun designed by Napoleon III. to take the place of the variety of calibres used before in the French field service. It was used more extensively than any other field gun during the war of the Rebellion, and it was particularly effective where the character of the country required the fighting to be carried on at short range. Weight of gun, 1,226 pounds; weight of shot, 12 pounds; weight of charge, 2¼ pounds; velocity, 1,495 feet per second; extreme range, 2,090 yards; elevation 10 degrees; weight of carriage, 1,175 pounds; contents of chest, packed: shot, fixed, 20; spherical case, 8; canister, 4; spare cartridges, 2; friction primers, 48; slow match, yards, 1.5; port-fire, 2.

From Governor's Island.

19. Three-inch Wrought-Iron Muzzle-Loading Rifle.

Represented only by its projectile. This gun was used extensively during the war, and was one of the earliest of modern wrought-iron guns. Gun made at Phœnixville, Pa., by wrapping boiler-plate around an iron bar, so as to form a cylindrical mass. The whole is brought to welding heat in a furnace, and then passed between rollers to unite the bar and layers solidly together. The trunnions are then welded on and the piece is finished to the proper size. The bar forming the core is large enough to leave some metal outside the bore, and add longitudinal strength to the gun. The projectile here shown is a 10-pounder shell, fired. It has the Eureka sabot at the base to take the rifling and give rotation. This sabot is a soft metal cup placed on the base, concave side to the rear, fitted with a ring-lip projecting forward over the sides of the projectile, which is beveled off to receive it. The gas pressure flattens the cup, pressing the lip forward and outward into the rifling. With large shell difficulty has been experienced from weakness at the base where the sabot is fastened by an axial screw. The fuze plug is fitted with the Laidley igniter (see fuzes) for starting the paper time-fuze.

Shot loaned by Col. J. W. Abert, formerly of Corps of Engineers, U. S. A., now living in Newport, Ky.

20. Model of 13 inch Cast Iron Mortar, and Bed.

21. Model of 13 inch Mortar.

A center pintle chassis replaces the old wooden platform protected by iron plates formerly used with this mortar, and this saves much time in pointing. By means of the eccentric axle at the center of the chassis the weight is thrown on the traversing wheels while pointing. Before firing, the chassis is thrown out of gear. Weight, 17,120 pounds; weight of shell, 200 pounds; weight of maximum charge, 20 pounds; extreme length, 51 inches; length of bore, 2.7 calibre; range, 15 degrees elevation, maximum charge, 4,200 yards; time of flight, 30½ seconds; weight of chassis, 2,000 pounds; length of rail, 120 inches. The mortar can be elevated and depressed, either by a single handspike working in the ratchets cut in the breech, or by two hand spikes fitted on to the arms attached to the trunnions.

From Ordnance Office.

22. Model of 200 pounder Parrott Rifle.

This was made from pieces of the metal used in making the guns of the first Monitor. This is a cast-iron gun, re-enforced by a coiled wrought-iron jacket, shrunk on over the seat of the charge; 10, 20, 30, 100, 200 and 300 pounder Parrott rifles were used during the war of the Rebellion. The larger calibres were cast hollow on the Rodman principle. Though never adopted as a part of the system of our artillery, they were largely used. They were the first high-power rifled guns used extensively in war, and they attained a range of over five miles. They are interesting as early examples of guns formed of two metals. The larger calibres had but short life. The brass base-ring of the projectile for giving rotation by expansion into the rifling was liable to strip and tear off.

Model presented by Mr. Howard S. Winslow, Cincinnati.

23. Cast Iron Rifles, 12 and 12.25 inch calibre.

Lined with a tube of steel or coiled wrought iron. These large calibre breech-loading guns are represented by a Butler shot, weighing 700 lbs. for a 12.25-inch gun. The Butler shot, invented by Captain J. G. Butler, Ordnance Department, has for sabot a soft metal ring screwed on the base, the ring having a groove in the rear surfaces, forming a narrow lip on the outer edge, and a wider one on the inner. The powder gases acting on the outer lip force it out into the rifling to give rotation to the shot, and check the flow of gas past the shot, at the same time tending to press the inner lip more firmly on the shot, and prevent stripping of the sabot. It was the first base sabot fully answering the conditions for muzzle-loading rifles of large calibre, as all others proposed before had worked irregularly, resulting in great variation of the powder pressures in the gun.

Americans have taken the lead in inventions for giving rotation to a shot in muzzle-loaders by means of sabots. The English used studded projectiles (represented in the exhibit by an Armstrong 8¾-inch shell), and long after the sabot had been used, the U. S. adopted a sabot merely as gas check in addition to the studs, finally abandoning the studs and relying on the sabot alone. The Eureka sabot described before is another form sometimes used with large guns.

Muzzle-loading rifle guns of large calibre have been made in large numbers in our service, by conversion from smooth bores of larger calibre, the old gun being bored out and lined with a tube of steel or coiled wrought iron. Many of these guns are now in service, notably 8-inch rifles converted from 10-inch Rodman guns. Though extremely useful within certain limits, the bore is too short to give the best effect demanded from guns of that calibre.

24. Model of 12-inch Cast-Iron Rifle.

Mounted on Barbette Carriage. The upper carriage has two sets of wheels, front and rear, placed between the plates composing the cheeks of the carriage. The carriage starts in its recoil on sliding friction, and, after a distance of about one foot, finishes the remainder of its recoil on rolling friction, the rollers moving up wedge-shaped pieces, which form steeper inclines toward the rear of the chassis. The gun is caught at the end of its recoil by couplings, and spring buffers at the rear and front of the chassis relieve the shock if the top carriage strikes. The gun is loaded when drawn back, and when released runs promptly forward "into battery." The ordinary crane and differential pulley are used for loading. The muzzle of the gun is raised and lowered by means of two circular racks, fastened to the breech, and moved by cog-wheels on the carriage. Steps and rails are placed about the carriage, so as to make easy access to all parts. The points of special interest in this carriage are the arrangements for checking recoil. This is accomplished by means of a hydraulic buffer, 9 inches in exterior diameter, and long enough to secure a recoil of seven feet. The effect of the force of discharge, communicated to the chassis through the buffer, is borne by the pintle in front, and by two sets of grooved wheels attached to forks supporting the rear end, thus distributing the strain over the entire extent of the foundations. The hydraulic buffer is composed of a strong cylinder, partly filled with glycerine and water, and attached at the front of the chassis, between the rails. A piston-rod projects from the rear, the outer end of the rod being attached to a fork, extending downward from the rear of the top carriage. Perforations in the piston head allow the flow of liquid as the piston is drawn out during recoil, or pushed in by running the gun forward. The resistance to rapid flow checks the recoil, and allows the use of a shorter chassis than without the buffer. It transmits the force to the chassis, but in a comparatively gradual manner without severe shock.

In the English Vavasseur carriage, two cylinders are used, filled with liquid, and arranged so that the piston of one is being drawn out while that of the other is being pushed in, connection between the cylinders allowing compensation of the amounts of water in each. The piston-heads are composed of two parts, both perforated, one fixed to the rod and one turning on it, the motion being controlled by a projection on the circumference working in a spiral groove on the inner surface of its cylinder. This motion is so adjusted as to progressively close the openings and graduate the resistance of the liquid in its flow to the decreasing velocity of recoil as the gun runs back. (See Report of Chief of Ordnance for '77 and '86. Report of Board on Fortifications and other Defenses, 1885.)

The double piston-head here described is of American invention.

A device used on the carriage for the 100-ton cast-iron Italian gun, accomplishes this graduation of resistance without double piston-heads by means of wedge-shaped bars, fixed longitudinally on the inner surface of the cylinder. Slots on the outer edge of the piston-head run along these bars, which fill the openings more and more as the recoil progresses. A variation of this principle has tapering rods, with round holes in the piston-head, producing the same effect.

MODERN BREECH-LOADERS.

25. Williams' Breech Loading Rifle: calibre, 1.56 inches.

This corresponds to the class of quick-loaders, now exemplified by the Hotchkiss rapid firing guns, the latter, however, having the great advantage of using self-primed metallic-case ammunition, to which the Williams gun might readily be adapted for use with moderate calibres. The Williams gun has a breech-block moving back and forth in the line of the barrel. It is operated by turning a crank on the right side. Upon the crank shaft, which is perpendicular to the axis of the bore, is an eccentric which alternately withdraws and pushes in the breech-block to open and close the breech. A worm at the end of the shaft works on the end of the lever at the left side of the piece, the lever having a hammer at the other end. When the end of the worm is reached, the hammer thus raised is released and forced by a spring against a nipple on which a percussion cap is placed. The mechanism is so arranged that just after the breech-block is closed the hammer falls and fires the piece. The breech block is supported against the shock of the discharge by the eccentric, which transfers the strain to the shaft upon which it revolves. The gas check used in the Williams gun strongly resembles the Freyre gas check used in the new U. S. breech-loading field-gun described hereafter. The inventor, Mr. D. R. Williams, of Covington, Ky., took the gun South at the beginning of the Rebellion, and it was adopted by the Confederate Government. Some of the batteries are said to have done much execution. The inventor claims to have fired sixty-five shots per minute.

From West Point.

26. Model of Breech-Action of Sutcliff Gun.

Disk-shaped breech-block, supported by a pin attached to the front end of hollow-breech-screw, by the half revolution of which the block is lowered into a mortise in the body of the gun, and the chamber exposed. On closing, the screw sets up firmly against the block, and transmits the strain to the walls of the breech.

27. Krupp Breech-Loading Steel Rifle; calibre, 3.65.

This gun has the earlier form of breech-block, made in two wedge-shape parts, the whole block sliding at right angles to the axis of the bore in sockets in the breech. When the block is run in, turning a screw at its end forces the two wedges together and tightly closes the breech, the reverse action loosening the block and allowing it to be drawn out. The gas check is a copper ring of triangular section, fitting in a socket in the block and expanding under the powder pressure to completely close the crack which may be left between the face of the block and the end of the barrel. From Ordnance Proving Ground, Sandy Hook.

28. Hotchkiss Breech-Loading Steel Mountain Rifle.

Calibre, 1.65 inches. This has a breech-block sliding at right angles to the axis of the bore, after the manner of the later Krupp guns. It is locked, when closed, by a sectional screw within the block. Used in operations in a very rough, mountainous country, impassable to wheeled vehicles, as it can be packed on mule back or carried by two men. Calibre, 1.65; number of grooves, 12; depth, .075 inch; width, .30; weight of gun, 110 pounds; charge of powder, 269.5 grains; weight of shot, about two pounds. Mounted on steel carriage, to which shafts can be attached for hauling by one animal. The powder is contained in a metallic cartridge case, either of wrapped metal or with a soldered joint. Through the center of the iron head of this case is a flame hole, closed by an internal valve, which is lifted by the flame from the friction primer, but is closed by the pressure of the gas within the bore when the cartridge is fired. A wide band of thin brass encircles the projectile, and this is forced into the rifling to give rotation. Above the breech-block, in the body of the gun, is a sliding extractor, worked by an oblique groove in the upper surface of the breech-block, in which a stud on the lower surface of the extractor is engaged. Captain Frank D. Baldwin, Fifth United States Infantry, has devised an ingenious carriage for this gun. It is fashioned somewhat like a mortar bed, with cheek pieces, but no chassis. The lower parts of the cheeks can be turned outward, swinging on a horizontal hinge, to fit on an aparejo, so that gun and carriage can be packed together on a mule for transportation.

29. New Breech-Loading Field Gun, U. S. Steel.

Calibre, 3.2 inches. This gun is built up with a central tube, 85.2 inches long, varying in exterior diameter from 6 inches to 4.6 inches near the muzzle; and a jacket, length 25.9 inches, maximum diameter 9.56 inches, which is shrunk over the rear part of the tube, a shoulder on which prevents the jacket from working forward. The rear end of the tube abuts against a base ring, screwed inside of the jacket, which projects beyond the tube at the rear. The French, or "slotted screw," breech-block, works in this base ring. In front of the jacket, and bound to it by an overlapping locking joint, is the trunnion hoop shrunk on to the tube. Its width between rim bases is 9.5 inches, and its length 8.8 inches. In front of the trunnion-hoop, and bearing close against it, is the "sleeve," shrunk on to the tube—maximum diameter, 6.8 inches; minimum, 6.6 inches; length, 13.3 inches—and in front of that is the key-ring, which is screwed on to the tube, and set firmly against the sleeve: diameter of key ring, 6.5 inches; length, 3 inches. In front of that the tube is unsupported for a length of 38.7 inches to the muzzle. All the parts are thus bound securely together by shoulders and screw-threads, in a manner which presents no greater difficulty of construction than the shrinkage of plain, superposed cylinders usually offers.

The powder chamber is elliptical; the shot chamber, composed of two inclines and a straight surface, furnishes a place for the copper band at the rear end of the shot to rest, the forward end of the shot extending into the groove part of the bore, the band bringing up against the lands, which are beveled at their rear termination. The vent is radial, over the middle of the chamber.

The rifling is uniform, with a twist of one turn in thirty calibres, or an angle of six degrees. There are twenty-four grooves and lands. The total length of the piece is 90.7 inches; weight, 803 pounds; preponderance at end of breech, 57 pounds.

Breech Mechanism. The breech-block, 6.15 inches long, by 4.47 inches in diameter, is threaded and slotted, three sections being plain and three with threads. The base ring in which it works is threaded and slotted correspondingly. One sixth of a turn, therefore, serves to lock or unlock the block when in its place.

The last or rearmost thread on the block is not cut away, and this serves the purpose of closing the rear face of the breech against dirt and wet, and acts as a stop for the block when it is pressed into place. The block is held in a swinging carrier ring, 1.2 inches thick, hinged at the left side, which allows the block to be swung to the left when drawn out, and guides the block in entering the breech on closing, allowing the block to be freely turned. It serves, when closed, to fill the space between the jacket and the block. This ring is automatically locked to, and unlocked, by the motion of the block acting on a key-pin. The lever handle for turning the block, and the bronze handle for withdrawing it, are fastened to its rear end. Most of the guns thus far made have been provided with the Freyre (Spanish) gas check, which was found to be effective in the experimental gun; but the length of space in rear of the chamber allows the use of the De Bange (French) gas check, which is equally effective, and this is to be used in some of the guns.

The Freyre obturator, or gas check, placed in front of the breech-block, terminates in a head shaped like a truncated cone, small end towards the rear. A gas check ring of highly elastic steel, formed to fit the cone surface on the inside, but nearly cylindrical on the outside, surrounds this head and rests against the breech-block. The head is not in contact with the block, but nearly so, and the distance can be increased or diminished by the nuts screwed on to the rear end of a spindle which passes through the center of the breech-block. A strong spring intervenes to keep the head away from the face of the block, except when the great pressure of the powder gases presses it home, expanding the elastic ring against the walls of the powder chamber, and effectually cutting off all escape of gas.

When the pressure is removed the spring forces the head forward and the ring is allowed to contract. The expansion of the gas-check can thus be regulated to suit the character of the steel in the gas-check ring.

The Freyre gas-check closely resembles that used in the Williams gun above described. The latter differed only in having a split ring instead of a continuous ring, the conical rear surface of the head acting in the same manner to expand the ring. The Freyre system may therefore be considered an American invention, as is the case with the slotted screw breech-block itself.

The De Bange gas-check referred to works as follows: A breech-screw with an interrupted thread is used as described above. This is traversed in the direction of its axis by a spindle terminating in a head shaped like a mushroom. The head receives the pressure of the powder gases, and it is supported by a plastic ring surrounding the spindle and interposed between the head and the face of the breech-screw. This ring is composed of asbestos and tallow, contained in an envelope of cloth and sustained by two cup-shaped copper rings. The pressure of the head forces it out laterally against the walls of the gun chamber, so preventing the escape of gas.

The record of the gun is as follows: Initial velocity of projectile, 1,635 feet; extreme range, about $3\frac{1}{2}$ miles; charge of powder, $3\frac{1}{4}$ to $3\frac{3}{4}$ pounds; weight of shell, 13 pounds; pressure of powder gases in gun, 29,116 pounds per square inch. The Hotchkiss base fuze, described under head of fuzes, is used with the shell. The steel forgings for these guns were made at the Midvale Works, Philadelphia. The parts were finished and assembled for the first five guns at Watertown Arsenal, Mass.; for twenty made later, at the West Point Foundry, Cold Spring, N. Y. Future work of this kind will be done in the new gun shops at Watervliet Arsenal, West Troy, N. Y.

From West Point.

30. Buffington Field-Gun Carriage.

The carriage for the gun above described, and on which it is mounted, is made of steel The principal parts are the two flasks, connected by transoms, and the lunette; the two axle-plates, upper and lower; the axle-tree; the wheel-brakes; the wheels; the elevating apparatus, and the seats and steps. Each flask is formed by riveting together two plates with curved margins. The cross-section of the margin from the vicinity of the trunnion-beds to the tool-box is approximately semi-circular, the center of the semi-circle being in the plane of the inner surface of the plate. The cross section varies for the inner and outer plates, as the margin of the latter is prolonged in a direction tangent to the circle until it envelops the margin of the former for a portion of its length. The formation of this curved margin by a single stroke illustrates a remarkable use by Col. Buffington of the drop-hammer for very heavy work. Two large cast-iron dies are used, shaped to give the outer and inner curves required. The plate, cut to proper shape and heated, is placed on one die, and the other is dropped upon it by means of a steam hammer.

The trunnion-beds are re-inforced by bars of steel, which are inclosed between the margins of the flask plates and riveted to them. There are three front transoms, upper, lower, and rear, in the vicinity of the trunnion-beds and axle-plates, and three trail transoms at intervals between the axle-plates and the lunette. The axle-plates, two in number, which envelop the axle-tree, are made from plates formed by dies under a steam hammer. To insure an accurate fit, these plates are planed, bolted together, and bored out. The axle-tree having been turned to a true cylinder, the plates are riveted about it. The shoulder washers are octagonal in form; to each is fitt d a collar or band containing a stout eye, to which the brakes are attached. These collars have projections that embrace the axle-plates above and below, to prevent turning of the axle within the plates. The brakes supplied with this carriage were formed like a double-box pring, and furnished with a device for detaching them if necessary, when the wheel is locked. The axle-seats are mounted on flat springs and provided with steps. The elevating apparatus is that which was used with the carriage constructed at Watervleit Arsenal The elevating screw guide is secured to the under side of the upper front transom. A later form, introduced by Col. Buffington, gives the elevation by means of lazy tongs operated by a vertical screw. This form does not require any projection below the carriage, and the carriage is so constructed in other respects as to leave a clear space below the level of the axles, to pass over obstructions without touching. The total weight of the carriage complete, including steps, wheels, and brakes, is 1,301 lbs.

The limber will have a steel body with wooden ammunition chest, opening at the top like the present ammunition chests, steel chests opening in rear being found by experiment to be undesirable. The inside dimensions of chest are: Length, 12¾ inches; width, 24 inches; depth, 9 inches. It is divided into three compartments, the end ones 10 inches wide, for 21 projectiles in each, the middle one for cartridges 42 in number. Projectiles stand on their bases, in square compartments, separated by copper plates. The points of the projectiles are held in place by the cover when closed. A chest filled with dummy projectiles and c. rtridges is shown with the gun and carriage.

The caisson body will be of steel, and will serve for the traveling forge, the chests for the forge being of same dimensions as the ammunition chest.

A portable forge, made of dimensions to fit in this box, is shown in the exhibit in connection with the gun and carriage. Instead of bellows a blower is used, operated by a crank. Carriage from National Armory.

31. Five-inch Steel Breech-Loading Siege Gun, experimental.

This is represented by its shot, cast-iron, weighing 43 pounds. The gun is built up after the manner of the 3.2-inch field gun. The whole length of the gun is 145.50 inches; weight, 3,660 pounds; preponderance at end of breech, 275½ pounds; rifling uniform; twist, 1 turn in 35 calibres, angle 5 deg., 9 min.; number of grooves and lands, 32. The powder chamber is cylindrical, terminated in front by a curved surface. The shot chamber, composed of a cylindrical and a conical surface. The vent is axial, through the obturator spindle. The French breech-screw is used, with the DeBange obturator described under steel field gun. The powder charge is $12\frac{1}{2}$ pounds; velocity obtained, 1815 feet per second. The projectile, like that for the 3.2-inch rifle, has a copper band set in a groove cut near the base to give rotation, this band being forced into the grooves in firing. This gun is intended to replace the $4\frac{1}{2}$-inch muzzle-loading cast-iron siege rifle of the service. The new gun is mounted on a steel carriage designed by Capt. Chas. Shaler, Ordnance Dept., U. S. A. Shot received from Ordnance Proving Ground.

32. Eight-inch Breech Loading Steel Rifle.

This is represented by its cast-iron cored shot, weighing 285 pounds. The gun is built up after the manner of the 3.2-inch, and the 5-inch B. L. Steel Rifles before explained. (See 30-31 above). The gun is 30 calibres, 20 feet long, and weighs 13 tons. It fires a projectile weighing 285 pounds with a charge of 100 pounds of slow-burning powder. The rifling has an increasing twist, beginning with one turn in 70 calibres at the origin, and increasing to one turn in 25 calibres, 16 inches from the muzzle, and thence a uniform twist, with the same pitch, to the muzzle. The number of grooves and lands is 45; width of grooves, 0.39; lands, 0.17. The volume of the powder chamber is 3,107 cubic inches. The French breech-block is used, swinging to the right in opening. It has the DeBange gas check (see 30). The vent is axial, through the obturator spindle, as in the 5-inch rifle, diameter of vent, 0.2. The forward end is bushed with copper, and tapering to a diameter of 0.1 at the orifice. At first the ordinary primer was used, but it is now fitted to use the obturating primer, either friction or electric. The steel tube for this gun was made abroad.

In firing this gun the new brown prismatic powder, made by Messrs. Du Pont, has been used, and trials have also been made with increased charges of German brown powder. With a charge of 110 pounds, a muzzle velocity of 1,878 feet per second is obtained, with a pressure in the chamber of 36,000 pounds to the square inch. The carriage used with this gun is the 10-inch proof-carriage, recently constructed at the West Point Foundry; it is adapted to the 8-inch gun by the insertion of the steel trunnion rings, which rest in the trunnion beds. The projectile has a copper band set in a groove, cut near the base, to give rotation; this band being forced into the grooves in firing. The gun has been fired over 1,000 rounds with no trace of erosion of bore by the powder gases. The ballistic results from this gun, that is, the energy developed in the projectile, exceed the published results with any gun of like calibre extant. (See appendixes Nos. 17 and 20. Report Chief of Ordnance, 1886, and Report for 1887.)

33. The 12-inch Cast-Iron Breech-Loading Rifle.

This is represented by its cast-iron cored shot, weighing 800 pounds. The gun is made of cast-iron, with a breech bushing of steel, and it is provided with the interrupted screw fermeture. The exterior outline conforms closely to the Rodman model. The weight of the gun complete is 54 tons. The projectile has a copper band similar to those previously described. (See 30-1-2.) The powder charge is 265 pounds of brown prismatic powder. The total length of gun is 30 feet. The rifling is polygroove, with an equal number of lands and grooves [illegible]; the twist is first increasing and then uniform to the muzzle. The vent is axial and coincident with the axis of the spindle. A vent bushing is placed in the front end of the mushroom head of the spindle. Dummy cartridges are shown by the side of the shot. With powder pressures less than 35,000 pounds per square inch on an average of 100 rounds, erosions of the bore began at the fiftieth round, and became pronounced at the ninety-sixth round. After firing 137 rounds the chamber and rifle bore became so badly eroded that firing was suspended, and the results with a similar gun lined with steel are awaited. It is doubtless the case that in the future, for the higher power guns, cast iron will be abandoned, except for emergencies requiring more rapid preparation than the making of steel guns allows, but it has been of obvious utility to test the possibilities of cast iron for heavy guns. Twelve-inch rifled mortars—cast-iron hooped with steel, both muzzle-loaders and breech-loaders, have been made and tried with great success.

COMPARISON WITH LARGEST EUROPEAN GUNS.

The largest United States Rifle Shot (weighing 800 pounds) is placed in the exhibit in a group containing models of the projectiles for the 100-ton Italian guns, the 110-ton English gun, and the 150-ton gun now building by Krupp, the latter projectile, six feet high, weighing 3,300 pounds. The group brings out with striking distinctness the needs of the United States in the development of the manufacture of steel, which is now alone used in making the heaviest guns. Even the 8-inch and 12-inch guns, made for the U. S. Army, are merely experimental, and it is only just now that appropriations have been made to develop the manufacture in this country of guns of such comparatively light weight. The larger steel parts heretofore used in our guns have had to be brought from Europe. As an illustration of these guns, which carry from ten to twelve miles, an account is given of the English gun, the most powerful one yet completed.

34. English 110 ton Steel Gun, Breech-Loading; calibre, 16.25 inches.

This gun is represented by a wooden model of the steel projectile. Weight of projectile, 2,240 pounds; length, 4½ feet; muzzle velocity, 2,128 feet per second, with powder charge of 960 pounds; range, about 10 miles; mean pressure in tons, per square inch, 18.75; total energy at muzzle in foot tons, 56,520; penetration in wrought iron, 33.8 inches.

The 110-ton Elswick gun is intended for the armament of first-class ships of war. It is constructed entirely of steel, the inner tube being in one length. Over the inner tube is shrunk the breech piece, which is surrounded by three layers of comparatively thin hoops of steel. In this manner the whole of the metal assists in bearing the transverse strain. The inner tube extends only to the obturator, or breech-block, which engages in the breech piece.

the longitudinal strain being partly borne by this piece, assisted by the peculiar distribution of the hoops. A long hoop with stout shoulders forms the rear part of the first layer, and its front shoulder engages the rear shoulder of another long hoop, which forms the front part of the second layer. Again the "trunnion hoop," so called, is shrunk on in such a manner as to draw the long hoops of the first and second layers together. Hence, there is a direct pull from the trunnion hoop to the shoulder on the breech piece, all parts being solidly bound together against longitudinal strain. There are, in reality, no trunnions, the exterior of the trunnion hoop being formed with rings, over which a strong steel band passes and ties the gun to its carriage. To prevent the inner tube from moving forward from the breech piece, a ring of bronze alloy is run into a serrated recess at the front of the latter. A similar ring is used to assist friction in keeping the front of the trunnion hoop in place.

The principal dimensions of the gun are as follows: Total length, 524 inches; length of bore, 487 inches; length of rifling, 397 inches; diameter of bore, 16.25 inches; diameter of chamber, 21.125 inches; cubical capacity of chamber, 28,610 cubic inches; weight of gun, 247,795 pounds.

Obturator.—In the "obturator" or means of stopping the escape of gas, a modification of the De Bange pad, made by Mr. Vavasseur of the Elswick firm, is under trial. The asbestos pad is retained, but it is covered with a thin sheath of copper, which is forced by compression on discharge of the gun into close contact with the inner tube.

Carriage.—The gun is mounted on a heavy frame of steel, which forms a carriage. The carriage moves backward and forward on two stout steel girders, forming the slide, the ram of the recoil press passing through the lower part of the carriage, and being fixed thereto. The slide-girders are pivoted at the front, so that the motion of recoil is always parallel to their upper surface. All the operations of working the gun are performed by hydraulic power. The elevation or depression of the gun and slide is performed by means of hydraulic rams under each slide-girder. Pressure is also admitted to one side or other of the recoil cylinder, according as it is desired to run the gun in or out. To turn the gun in a horizontal direction it is necessary to rotate the platform or turret by means of hydraulic engines, acting on pinions in circular racks surrounding its base. By means of hydraulic breech mechanism the breech-block is unscrewed and moved aside, while the shot and charge are forced into the bore or breech chamber by the hydraulic rammer; the breech-block is then similarly returned to its normal position. The shot and cartridge are raised from the magazine by an hydraulic lift, so as to deliver the ammunition at the level of the loading tray, and between the breech and rammer. The 900-pound charge for the 110-ton gun is composed of two cartridges of prismatic form, 38 inches long by 18 inches. The first cartridge or portion of the charge is closely filled with powder, but the second portion is arranged with a cylindrical space* for receiving some quick firing powder for properly igniting the whole of the charges. The total length of the charge or combined cartridge is six feet four inches. Slow-burning, brown prismatic powder is used for the charge, composed of hexagonal pebbles or cubes of about 1½ inches in diameter. These cartridges are transported from place to place, *e. g.*, from the magazine to ammunition lift, in a water and fire proof metallic case.

Model of shot furnished through courtesy of Major Clifton Comly, Ordnance Department. Model of Italian shot from West Point. Model of Krupp shot constructed for illustration.

DEPRESSING CARRIAGES AND ARMORED TURRETS FOR PROTECTION OF GUNS.

35. DeRussy's Counterpoise Depressing Gun-Carriage.

Model. This carriage was devised about the year 1835, by the late Brig. Gen R. E. De Russy, Corps of Engineers. The top carriage rests in front on the eccentric axle of a pair of large wheels, the rear end resting on small wheels running on curved wooden braces. In the firing position the axle is in its highest position, and the small wheels on the highest point of the braces, the gun pointing over the parapet. As the gun recoils the wheels roll backward on cogged rails, carrying the axle to its lowest position, and the truck wheels move to the bottom of the braces, the recoil being partly taken up by a counterpoise of metallic spokes on the main wheels, opposite the axle, and partly by frictional appliances. The depression of the gun in recoil brings it under the shelter of the parapet from direct fire of the enemy, and protects the gunners in loading. The gun is run into battery by a windlass and chain, the counterpoise assisting. It will be seen this carriage embodies the principle which Captain Moncrieff has lately employed in the construction of his depressing carriages.

Property of Major W. R. King, Corps of Engineers. From West Point.

36. King's Counterpoise Depressing Gun-Carriage.

Model. Devised by Major W. R. King, Corps of Engineers, U. S. A. In this carriage the chassis rails on which the top carriage rests slope downward to the rear, at an angle of about eighteen degrees, so that the top carriage slides down during the recoil, carrying the gun below the level of the parapet. The chassis swings on a front pintle, which is made hollow. A wire rope attached to the lower part of the top carriage passes over a pulley and down through the hollow pintle to a counterpoise weight in a well below the pintle. The movement of the gun to the rear lifts this counterpoise. When the gun is "in battery" the rope draws nearly at right angles to the chassis, gradually changing its angles as the piece runs back, until finally, before the gun stops, it draws parallel. By this means, combined with the elasticity of the counterpoise system, the shock, or very sudden motion communicated to the gun and top carriage by firing, is much more gradually transmitted to the counterpoise, the strain upon the rope being, in fact, almost constant. The necessary elasticity of the counterpoise system is obtained by the rope of steel wire, and by making the counterpoise in sections, with disks of rubber between them. Cranks and endless chains at the sides of the chassis furnish a means of maneuvering the gun when not firing, or when the recoil or counterpoise do not complete their work. The recoil of the gun when fired carries it down the inclined rails to the loading position, where it is held by friction due to its own weight. When thrown "in gear," by turning the hand-wheels at the side of the top carriage, the weight of the gun coming upon the truck-wheels, the counterpoise overcomes the rolling friction and runs the gun up to the firing position. The gun is traversed in the ordinary manner, and the elevation is given by the hand-wheels above mentioned. One advantage of this system is that it can be constructed from the ordinary carriage by lowering the rear of the chassis, raising the front, and slightly modifying the shape of the top carriage. It is suited to guns of the largest calibre.

Furnished with other models from Willet's Point, through the courtesy of Major King.

37. Early forms of Iron Armor for Protection of Guns.

Two very interesting models are shown illustrating devices of General J. G. Totten and General John Newton, Corps of Engineers, U. S. Army, and showing that armor for forts engaged the attention of the Engineer officers of our army long before anything was adopted abroad. These are shields for heavy guns, made up of horizontal layers of wrought-iron bars, each of the upper layers set a little further back than the layer beneath. General Newton's device is a revolving turret, gun carriage and turret made to revolve about the same center. General Totten's device is a stationary shield with a revolving piece containing the embrasure, and intended for guns mounted on carriages made to swing on a pivot at the muzzle end. This may be regarded as a forerunner of the Krupp muzzle pivoted gun, fastened to the shield by a perforated spherical block which allows the gun to be pointed as desired. This system of armor was devised before practical methods of making thick plates of iron or steel had been found.

Willet's Point.

38. Gruson Revolving Turret.

Model of fort for land defense. This shows one form of the modern turrets for protection of guns. The part of turret projecting above the ground is of dome shape, presenting an inclined surface to the enemy's shot, instead of having vertical sides like the Ericsson Monitor turret. It rotates on a live roller running on a roller path fixed to the foundation. This dome is composed of thick plates of chilled cast iron, grooved and fastened together. The very complete working model shown was sent from the office of the Board of Engineers, U. S. Army, through the courtesy of its President, General Casey (now Chief of Engineers). It was presented to the Board by Julius Von Schutz, Engineer of the Gruson works in Germany. The model shows two heavy breech-loading guns in position, and machinery is provided, concealed below the armor, for revolving the turret, raising and lowering the guns, etc. The especial peculiarity of the gun carriage here used lies in the arrangement for changing the elevation, leaving the muzzle nearly stationary, and allowing the use of a very small embrasure. This is accomplished by raising or lowering the guns at the trunnions, instead of simply turning them about the trunnions.

STATIONARY AND MOVABLE TORPEDOES.

As important additions to the protection afforded by heavy guns, torpedoes are arranged in this class.

39. Stationary Torpedoes for Defense of Harbors.

Models of buoyant torpedoes shown in a large tank to illustrate method of placing them in the water according to the system devised by General H. L. Abbott, Corps of Engineers, U. S. A., in which the torpedoes are fired from the shore by means of an electric cable. They can be exploded in groups of three, each group having a separate connection with the battery on shore; the wire from each torpedo of any one group passes to a small box, where they unite and pass to a larger box, and in the latter the wires from the different groups, though insulated from each other, are formed into a single cable connecting with the shore. When a vessel touches a torpedo the shock causes electric connection to be made, sending a signal to the operator and warning him when to explode any group by passing a strong current through the wire. They can be made automatic, to explode at once. Loaded with dynamite, they play an important part in our defenses where they can be placed under range of the guns. Torpedoes serve as aids to other armament, and delay hostile ships where the high power gun can reach them, but when unprotected by guns from the shore the enemy have time to remove them and pass in safety. Note the developments made in the torpedo since the war of the Rebellion, as shown by several rebel torpedoes described further on. Models made by Sergeant Nulty, Engineer Battalion.

Furnished by Major King, Willet's Point.

40. An 8-inch Dynamite Projectile for the Pneumatic Dynamite Torpedo Gun is shown as the most striking example of movable torpedoes, others of this class moving through the water, while this moves through the air.

The special feature of this torpedo is the electric fuze invented by Capt. Zalinski, Fifth U. S. Artillery, to whose efforts is due the success of the gun, originally invented by Mr. Mefford, of Ohio. The fuze is concealed in the torpedo, and it becomes active only when wet by the submergence of the torpedo in the water. Though called a "gun," it is not claimed that the great "air gun" from which the torpedo is thrown has the power or range of powder guns, which will send projectiles weighing from eight hundred to thirty-three hundred pounds distances of eight to twelve miles, nor that it can replace them, but that it will be a powerful adjunct in defense by affording means of throwing a torpedo with considerable accuracy for a mile or two.

A gun of fifteen inches calibre to throw six hundred pounds of explosive gelatine, has recently been made.

Received through the courtesy of Capt. Zalinski.

VOLLEY GUNS AND MACHINE GUNS.

Though even in the days of matchlocks, examples are found in which several guns of small calibre were attached to the same stock and fired successively by the same man; the first employment of guns of this class in war was that of the French Mitrailleuse, now obsolete. It is illustrated in the exhibit by description and drawings. The machine gun possesses the advantage over volley guns of giving a constant succession of shots by automatic re-loading, and some guns combine the advantages of both systems.

These guns are usually of comparatively small calibre, firing small arm cartridges, and they are either mounted as wall pieces or placed on carriages like field guns. They are here classed, therefore, as intermediate between cannon and hand fire-arms.

1. French Mitrailleuse. Represented in the exhibit by description and drawings received from the Ordnance Office.

This gun had twenty-five barrels grouped in parallel rows of five, all terminating at the rear in one slot in the breech casing for the reception of a movable breech-block, having short cartridge chambers corresponding to the different barrels. Several of these blocks could be loaded up in advance, and after the shots were discharged from one it would be removed and another substituted. Each barrel had a separate firing pin, and these pins were released in succession by mechanism operated by a crank.

2. Vandenburgh Volley Gun; obsolete; weight, 663 pounds.

Said to be of English manufacture, and to have been captured from the Confederates. It consists of eighty-five barrels, calibre .46 inch, grouped in a cylindrical casing of bronze. A breech piece, with corresponding muzzle-loading cartridge chambers, copper-lined, fits in rear, this piece being attached to a hinge and slide, and having an independent screw block at the outer end to screw into the casing from the rear. After firing, the block had to be unscrewed, pulled out and swung down. The chambers were then separately re-loaded, the breech closed, and all the charges fired at once by a percussion cap in rear. The copper-lining of the chambers projects a little from the block to fit into the barrels and serve as gas check. From West Point.

3. Requa Battery Gun; calibre, .58; obsolete.

For simultaneous discharge of twenty-five barrels. The barrels are placed side by side in the same plane, and loaded successively at the breech with paper ammunition. The breech action gives a very firm support against the shock of discharge. All the barrels are closed by a single sliding plate, which is supported by another plate hinged to its rear edge, the free edge resting against a shoulder on the frame of the gun when the breech plate is pushed forward. The hinged plate is operated by a lever working in a vertical plane parallel to the line of fire. The lever is hinged to the frame and to the rear end of the hinged plate, so that pulling the lever backward raises the plate over the supporting shoulder, and pulls it to the rear. The breech plate and hinged plate constitute practically a broad breech-block and locking cam, like that used in the Springfield breech-loading rifle, except that the breech plate, instead of being hinged to the barrels at the front, like the breech block of the Springfield, is made to slide backward and forward. The gun failed with paper cartridges for want of a proper gas-check, but for metallic case cartridges the breech system would answer for guns of the type of the Nordenfeldt. The barrels can be brought together at the muzzle or spread apart as desired by a lever below. Used at the siege of Fort Wagner, South Carolina. From Springfield Armory.

4. Guthrie and Lee Machine Gun; calibre, .45; obsolete.

Two barrels are fixed to the frame. At right angles to their length travels a breech-block, to which by the action of the hand-lever a horizontal reciprocal motion is given. By this movement chambers in the block are brought first opposite the barrels and then opposite loading troughs by the side of the barrels and in front of the block. Cartridges are placed singly by hand in these troughs, and pistons force the cartridges automatically into the chamber. When the chambers come opposite the barrels, the charge is fired by a concealed lock. The loading troughs and pistons are interesting pieces of mechanism. No record of this gun is accessible. From West Point.

5. Union Repeating Rifle Gun, or Coffee Mill Gun; single barrel; calibre, .58; obsolete.

Short, muzzle-loading barrels, or chamber pieces, with an axial nipple at the rear, are used to hold the charges. A number of these are loaded and capped, and fed by means of a hopper upon a fluted cylinder, which revolves and brings the charges in succession in rear of the long barrel, pausing long enough to allow the charge to be fired. A wedge-shaped block, moving vertically in rear, forces each small chamber-piece in turn forward against the rear of the barrel to prevent escape of gas, and serves to support the recoil. But one lock is used, working through a slot in the block. After firing, the chamber pieces are carried round to an opening which allows them to fall out. They can be re-loaded and used again indefinitely. A crank at the side operates the breech mechanism. This gun was used at the siege of Petersburg. From National Armory.

6. Lowell Machine Gun; calibre, 0.45.

Cartridges are fed from above by means of a vertical feed guide, grooves in the guide catching the flange and leaving the rest of the cartridge free. They fall on a block revolving about an axis parallel to the barrel, and drop successively into grooves in the outer surface. Turning a crank revolves this block and brings one cartridge after another opposite the barrel, the block remaining stationary long enough for the sliding breech-bolt to push the cartridge into the chamber and draw out the shell after firing. One lock only is needed, and only one bolt. A firing pin worked by a spring is released when the gun is loaded. This is the first gun here described using metallic ammunition. The gun has not stood the tests of service. The action is jerky and irregular. Four parallel barrels are provided with this gun. They are arranged to be turned around an axle. When a barrel gets heated up by firing, a new barrel is moved up, and so on.

From National Armory.

7. Gardner Machine Gun; calibre, .45; manufactured by The Pratt & Whitney Co., Hartford, Conn.

This gun has two barrels side by side to be fired alternately. A bolt is placed in rear of each barrel, and these bolts are actuated by cams on a horizontal shaft perpendicular to them. This shaft is turned by a handle at the side, and the cams are so placed as to draw out one bolt while pushing in the other, releasing a firing-pin on each bolt when the corresponding barrel is loaded. The feed case, similar to that on the Lowell, is double, containing a row of cartridges for each barrel, a swinging plate closing openings below alternately. The barrels are enclosed in a hollow sheath of bronze, intended for holding water to prevent heating the barrels too much in firing. This is an excellent gun, simple and effective. From National Armory.

8. Improved Gatling Gun; 10 barrels; calibre, .45.

The barrels are fixed on a revolving frame, parallel to its axle, and they are revolved by turning a crank which can be placed at the side or rear of the breech casing at pleasure. The frame projects to the rear of the barrels in the form of a drum, longitudinal slots in the outer surface holding opposite each barrel a sliding breech-bolt with a spring firing-pin. A curved lip on the interior of the stationary breech casing engages the bolts, and wedges them forward and back as the barrels revolve. When a bolt is well drawn back, its firing-pin catches in another lip, which holds it back as the bolt moves forward. This compresses the firing spring, and the revolution carries the pin to the end of the lip, where it is released when the bolt is pushed home, and so the cartridge is fired. Cartridges fall successively in rear of the barrels through a mouth in the casing over the position of a barrel when the corresponding bolt is drawn back. By the forward and back motion of the bolts, as the barrels revolve, first the cartridges are pushed into the barrels, and then the empty shells are drawn out, a spring hook, which projects beyond the front of each bolt, acting as extractor. The operations of loading, firing and extracting the shells are going on in different barrels at the same time while the barrels are revolving. The gun has a universal pivot mounting, which allows it to be turned in any direction by the pointing lever. Clamps secure it in any position. Cartridges are supplied to the gun by means of the Bruce feed frame, or by the Accles feed drum, the old straight feed cases being practically abandoned.

The Bruce feed. In this, a vertical frame fitting over the mouth holds a swinging plate, on the front face of which are two channels with undercut sides to catch the flanges of the cartridges. This plate can be shifted so as to bring these channels alternately over the mouth and allow the columns of cartridges to fall down by gravity. The ordinary paper boxes in which the cartridges come from the arsenals, holding twenty cartridges in two rows, can be used as in the Gardner gun for filling the feed channels. The cover off the box, the flanges of all the cartridges can be slid into the channels, and pulling the box forward leaves the cartridges behind.

The Accles feed drum. This holds the cartridges in spiral guides within, a series of radial arms revolving together and pushing the cartridges towards the orifice. Projections on the revolving frame of the gun engage the ends of these arms and turn them by a positive motion, without the use of an actuating spring in the drum. The drums hold about one hundred cartridges, and with this attachment shots can be fired at the rate of 1200 per minute. The positive action of the feed allows it to be used in firing at great angles of elevation or depression where a gravity feed would be useless.

From the National Armory.

9. Hotchkiss Machine Gun; 9 barrels; calibre, .62.

The barrels are fixed on a revolving frame, as in the Gatling gun, and they are worked by turning a crank at the side. The crank shaft carries a driving worm running half round the circumference, so that the barrels revolve only during half a turn of the crank. They therefore have an intermittent motion round the axle. Cartridges fed from a hopper fall successively in front of the loading bolt, which, while a barrel is stationary in front of it, pushes a cartridge in. The revolution of the barrels brings them successively opposite a solid part of the breech, which supports the base of the cartridge. During the pause of the barrel here, the cartridge is exploded by a firing pin working through the breech. The shell is carried on down opposite an extractor which draws it out and lets it fall to the ground. The operations of loading, firing and extracting are performed in different barrels at the same time, during the intermittent pauses, by a single set of parts answering for all the barrels in succession. The gun fires about 150 shots a minute. The system is better suited to the longer calibres, as it is hardly rapid enough for the small. The solid support of the cartridge at the moment of firing is a great advantage, and the pause of the barrel at the same time insures greater accuracy. The five-barrel gun, calibre 1½ inches, fires 60 to 80 times a minute, projectiles weighing 1½ pounds.

10. The Nordenfeldt Machine Volley Gun.

This is represented in the exhibit only by drawings and descriptions. From two to seven barrels are arranged side by side on a frame, as in the Requa battery above described. These barrels are all loaded at once by means of breech plugs attached to a sliding plate in rear. This plate is moved forward and back by a lever working horizontally on the right hand side. Each breech plug contains a firing pin, and behind the plug is a hammer operated by a spring. When the lever is drawn back and the breech plate is brought to the rear, the hammers engage in a sliding comb on the frame, and at the forward movement they are held back and cocked. When the breech is closed, the lever still moving forward secures the breech piece by operating a swinging plate, which by means of cam surfaces pushes locking bolts on the breech plate into mortises in the side frame. Further motion of the lever slides the comb which holds the hammers, and releases them one after another. For each barrel a feed case is required, placed in rear and a little to the left. A slide plate carries the cartridges to the right, in front of the breech plugs when drawn back, and a forward motion of the plug pushes the cartridges into the barrels. All the barrels are loaded at the same time, but fired separately though in rapid succession, the interval of fire from the different barrels depending on the rapidity of motion of the lever. The effect is, therefore, practically that of a volley, but the shock of recoil is not so great as if all the barrels were fired at once. Many of these guns are used in England, but none are used in this country.

11. The Maxim Automatic Machine Gun.

Represented only by drawings and descriptions. This gun, by the effect of its own recoil over a space of only three-quarters of an inch, compresses a spring, and this, when the pressure is released, operates mechanism which ejects the empty shell, draws a new cartridge to the front of the bolt, forces it into the barrel and fires it automatically, this operation continuing as long as cartridges are supplied. The cartridges are placed in pockets on a belt holding 333 cartridges, and several belts can be fastened end to end. The end of the belt is introduced into the breech casing from the side, and the belt is drawn in as the gun is fired, the breech bolt passing through the sockets and pushing the cartridges into the barrel. At the same time water is automatically injected into a casing around the barrel to keep the metal cool. Six hundred shots per minute can be fired. This is an American invention developed abroad.

12. Buffington Steel Carriage and Curved Shield for Machine Guns.

The carriage is formed of steel plates, so arranged that the body forms a hollow axle between the wheels. This gives room for storing a large supply of cartridges, instead of depending wholly on the supply in the limber chests. The curved shape of the shield, extending upwards from the front of the carriage, gives greater protection to the gunners, but the especial feature is the arrangement by which the gun can be aimed as desired, though the shield is fixed to the carriage, without exposing the gunners through a wide opening for the muzzle. A square opening in the shield is covered in front by a covered slide, free to move laterally, and in this slide an opening the width of the muzzle extends from top to bottom. This opening in the slide is covered by two overlapping disks, pivoted centrally on either side of the opening, these disks having notches cut out where they overlap, the notches allowing room for the muzzle to protrude. Just enough play is given to allow sighting through the opening. The slide allows lateral movement of the

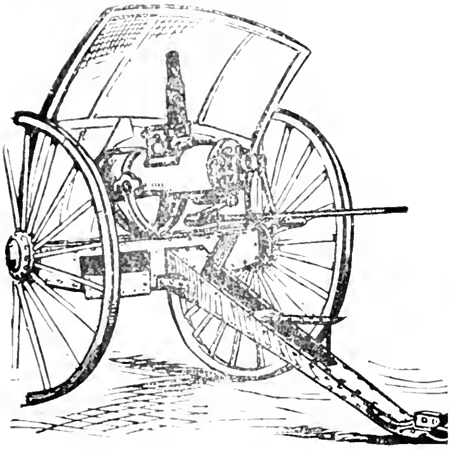


Fig. 1.

muzzle and the disks allow a vertical movement in any position of the slide. It is intended to have a steel flap hinged to the under part of the carriage

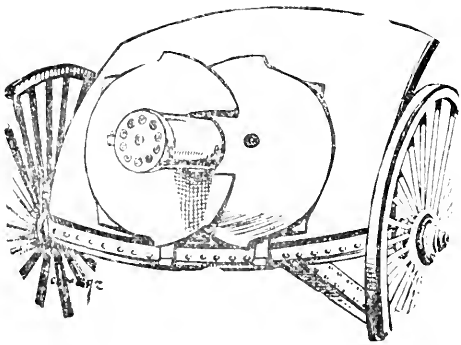


Fig. 2.

filling the opening below, and to sheathe the wheels if necessary. Though a Gatling gun is now mounted on this carriage, it is intended for any gun that needs to be pivoted on the carriage. From the National Armory.

13. New Limber for Machine Guns.

Constructed to use with the Buffington carriage and Williston harness. The wooden chest is fastened permanently to the frame and axle of steel.

The lid of the chest, hinged in front, is made of steel, and it is intended when raised to serve as a shield to protect men at the chest. In front of the chest is a shelf with a low iron railing. A double-tree is used with single-trees attached. The pole has no permanent yoke and no straps, but a projection a little in rear of the pole-pad prevents the ring of the neck yoke from slipping back. The interior of the chest is divided into three compartments, each 13 inches deep, 12¼ inches wide, and 21 inches long. The limber can be used as an ammunition wagon for distributing ammunition in the field. The shelf in front of the chest serves for holding sacks of cartridges. In the system of distributing cartridges it is intended to have the wooden boxes made to hold 600 instead of 1,000, making a box that one man can readily handle, and giving handier shape and size for packing on mule back when necessary. The paper boxes, each holding 20 cartridges, are strapped together in square packages of 10, and each wooden box holds three such packages. The box is made to open readily without the need of breaking it apart. The packages are of convenient form and weight to be carried by hand to supply troops on the firing line, and they can be readily stowed in the limber chest. The wooden boxes were devised by Col. D. W. Flagler and Col. Williston.

14. New Harness for Light Artillery and Machine Guns.

A full set of wheel and lead harness, devised by Brevet Lieut. Col. E. B. Williston, Major Third Artillery, is shown. It differs materially from artillery harness previously used.

The saddle and equipment of cavalry are adopted in place of the old, and the harness is made to conform more closely to the ordinary draught harness used for wagons. It is constructed with a view to celerity and ease in harnessing and unharnessing. The pole yoke is given up, and a neck yoke is adopted. In place of the rigid splinter-bar, a swinging double-tree is used, with single-trees attached, to equalize the draught of the two horses. The single-tree is placed above the pole for light draught, and below it for heavy loads.

To unhitch it is only necessary to unhook the single-trees from the double-trees, and slip the ring of the neck yoke off the end of the pole. The single-trees can be then attached to hooks on the cantle of the saddle. Instead of a single lead-line for the off horse the bridle has two reins, which unite in a single strap passing over a roller on the saddle and hanging on the side toward the driver, where he can readily grasp it. Wide and thin traces are used instead of the present thick, narrow trace. The collar is hinged at the top and fastened at the bottom by a spring fastening. Martingale and side straps are used to hold the neck yoke down and relieve strain in holding back. A woven hair pad is recommended.

The new harness is much lighter than the old system. It is claimed that this harness is much more convenient in harnessing and unharnessing, and that it can be manufactured more cheaply than that now in use; also, that its adjustment can be more readily learned by civilians called to act as teamsters. From National Armory.

15. Williston's Sectional Picket Rope for Light Artillery.

This consists of several lengths of rope, each length provided with steel shoes at the ends, one holding a link and the other a hook. The link is made thin enough at one side for the hook to slip on, the rest of the link being large enough to keep the hook from slipping off. The lengths can be readily joined by these fastenings, each wagon carrying one length, enough for the horses belonging to it when detached from the rest of the battery. The rope is laid along the ground and secured to it by iron picket pins having two hooks at the end to overlap the rope from opposite sides.

HAND FIRE-ARMS.

A very full collection of these arms is shown, indicating the development from the earliest times, and including many of the most recent magazine guns of to-day. Most of the guns are from the fine collection at the National Armory, but the more recent foreign guns were sent from West Point.

The descriptions of hand fire-arms are divided into the following classes:

Match Locks—Muzzle Loaders.
Wheel Locks—Muzzle Loaders.
Flint Locks—Muzzle Loaders.
Percussion Locks—Muzzle Loaders.
Single Breech Loaders.
Repeating Arms, including Revolvers.

Though the last two classes involve the use of the different kinds of locks described in the first three classes, the locks are not the distinctive feature. Repeating arms and revolvers also embrace breech loaders, though not confined to that class. No separate classification of smooth bores and rifles is made. The rifle with spiral grooves was probably invented in the latter part of the 16th century, but straight grooves were used as early as 1498 in Germany. This form steadied the bullet, but the advantages gained by twist seem to have been an accidental discovery. About 1600 the rifle began to be used as a military weapon, with spherical bullets, and in 1729 elongated bullets were used. In this country military rifles were made as early as 1814, at Harper's Ferry, but the mass of American infantry were armed with smooth bores until 1855. Rifles were in common use by the Americans during the Revolution.

MATCH LOCKS.

Hand guns first appeared in the 14th Century—the earliest ones requiring to be touched off, like cannon, by means of a slow match held in the hand. These were called hand-cannon, petronels, culverins, etc. (the recoil of the petronel being taken up on the breast-plate instead of on the shoulder). The match lock soon appeared. It had a swinging cock on the gun to hold the

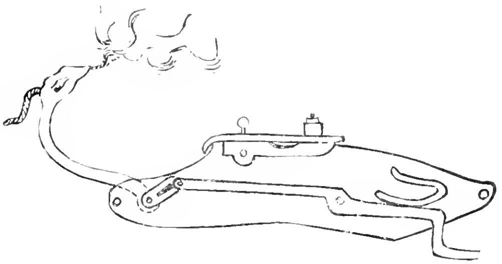


Fig. 3.

slow match. It was fired by forcing the cock down, and so bringing the slow match to the firing pan. In later models the cock had a lever attached to act as trigger for bringing the slow match down. The match locks are the earliest models shown in the exhibit. Many of these early guns were so heavy that a crutch had to be used to support them in firing.

1. Match Lock Musket—Formosan.

Captured from the Boutans and Kussikuts, of Aboriginal Formosa, at the battle of Seik Mon (Stone Doors) by the Japanese troops under General Saigo, May 22, 1874. This represents the earliest form of match lock referred to above. It has no trigger. It is of form and weight to be fired from the shoulder. From National Armory.

2. Match Lock Musket from India; date unknown.

British coins on butt. The bands and mountings are silver. This has a trigger for operating the cock. The butt is bent downward and then upward, forming a curious curve. The construction of the gun and its general finish are of the most primitive character.

3. Match Lock Musket; calibre, .717; of XIV. Century.

The trigger works an intermediate lever to bring the lighted end of the match into contact with the pan. One objection to match locks was that the blast from the vent or touch-hole would blow out the match. This gun is light enough to fire from the shoulder.

1. Match Lock Musket; calibre, .56; history unknown; probably Eastern.

Has a trigger for operating the cock, but the trigger is pushed up instead of backward as in other guns. The stock is nearly straight. The barrel was originally covered with gold leaf, and the stock was ornamented with same. No trigger guard is found on the match lock guns.

WHEEL LOCKS.

These guns first appeared early in the 16th Century. They originated in Germany. The lock is very ingenious and complicated. In these locks a piece of flint is pressed down by a spring against a revolving wheel of tempered

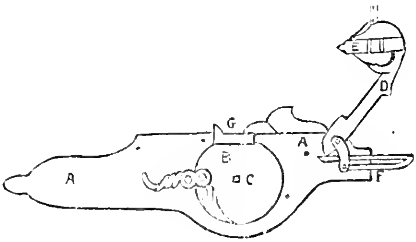


Fig. 1.

steel placed under the pan. The friction between the surfaces produces the sparks that ignite the powder. The flint is held in a clamp hinged in front. A ribbon spring round the arbor of the wheel is wound up by a key, and pressing a trigger releases the wheel and allows it to revolve. Two of these guns are shown.

All the early fire arms were so slow to load that in a battle as late as 1636 they could be fired only about once an hour.

1. Chinese Wheel Lock Pistol; calibre, .492.

This shows very fine work. The stock is inlaid with ivory.

2. Wheel Lock Gun; calibre, .707; date about 1520?

Used in the field with a crutch to support the barrel. Stock highly ornamented. The barrel is marked Gottfried Fleming. Engraving of battle scene on lock plate. This gun was probably used as a wall piece or with a portable crutch in field firing. A slide covers the pan to keep the priming from falling out. Winding up the spring slides the pan forward. The lock has a set trigger. It is remarkable for the fineness and force of its engraving, and for the general beauty of its form and finish.

A detached wheel lock is also shown in working order. By pressing a knob outside the lock-plate, the pan cover slides back and protects the priming from wet or loss. The key is permanently attached to the arbor winding up the spring.

FLINT LOCKS—MUZZLE LOADERS.

The flint lock was invented early in the 16th century. It was introduced into the French army in 1680, and it continued to be used in all armies until about 1842, when the percussion lock replaced it. The muzzle-loading guns of this type shown in the exhibit are as follows:

1. Rifle Used by Minute Men of the Revolution in 1776.

2. Five Samples of Blunderbuss.

Some with iron barrels and some with brass; cylindrical and bell-mouthed; two with swivel for use as wall pieces. These date from 1776 to 1820.

3. Eight Guns Made for U. S. Army at Springfield or Harper's Ferry.

These include models of 1799 (one of the first made), 1808, 1814, 1818, 1837, and 1843, the latter from the last lot of flint locks made. These guns show changes in attaching the barrel to the stock, and in securing the bayonet. In the earliest models the barrel had no bands. It was attached by keys to the stock. The Harper's Ferry model of 1814 is a rifle, calibre .53. The model of 1818 shows a magazine lock for repriming the pan. The calibre of the muskets varies from .69 to .70.

4. Arab Musket; calibre, .727.

Barrel 4 feet 10 inches long. Total length, 6 feet 1 inch long. Highly ornamented barrel and stock. The locking of the hammer draws the pan cover over the pan, and protects the priming from wet, etc. The fall of the hammer pushes this cover forward, and allows the sparks from the steel to fall into the priming and ignite the charge. Six bands of sheet brass hold the barrel to the stock. The butt plate is of bone, and is highly decorated on the sole. The length of guns of this class is probably due to the imperfect gunpowder manufacture of the period. This being used with a slow-burning mealed powder, the long barrel was necessary to allow complete combustion.

5. Albanian Musket; calibre, .72.

Silver mounted. Resembles very much in length, style of ornamentation, etc., the Arab musket, but it is banded and inlaid with silver. The hammer has a special dog outside the lock-plate for holding it off the steel. The hand of the firer is protected from abrasion by a leather flap. The piece has no trigger guard. The butt is of brass and uncomfortably narrow.

PERCUSSION LOCKS MUZZLE LOADERS.

1. Austrian Smooth Bore Musket; calibre, .705.

This is evidently a detonating gun, operated by exploding a percussion capsule in the pan. The pan is covered by a lid on the principle of the flint lock, and a pin works through this lid acting on the capsule below. The hammer strikes the pin and explodes the charge.

2. Springfield Smooth Bore Musket; calibre, .69.

Altered from the old model flint lock to percussion in 1843. The bayonet has a clasp. Many of the altered locks were used in the first years of the rebellion, as new arms could not be supplied in sufficient quantities.

3. Springfield Smooth Bore Musket; calibre, .69; model 1842.

The first model of the United States percussion musket, used in the service in the Mexican War. The supply being insufficient, however, flint locks were generally employed. Bayonet has clasp.

4. Harper's Ferry Sharpshooter's Rifle; calibre, .75; 1847.

Used on tripod. Peep sight on trigger, globe sight on barrel.

5. Short Rifle, Harper's Ferry; calibre, 53.5.

Manufactured 1848. Browned barrel. Brass mountings. Patch box in stock.

6. Double Barrel Rifle; calibre, .54; Munich.

Lock plate guard and butt plate engraved. No bands. Ramrod on left side of stock. Barrels superposed.

7. Springfield Smooth Bore Musketoon; calibre, .69; 1851.

Brass butt plate. Guard and bands. Ramrod in swivel to prevent its loss on horseback. Long swivel bar.

8. Short, Heavy Sporting Rifle.

Private manufacture made from stray parts.

9. Springfield Rifle Musket; calibre, .58.

Two leaf sights, 300 to 700 yards. Manufactured in 1859. Maynard primer.

10. Short Rifle, Harper's Ferry; calibre, .58.

Manufactured in 1859. Browned barrel. Maynard primer and sabre bayonet. Patch box in stock.

11. Springfield Rifle Musket; calibre, .58; model, 1861.

This is the arm made in greatest numbers during the War of the Re bellion. It differs mainly from the model 1855 in the change in the rear sight, and the omission of the Maynard primer. The necessity for the immediate production of guns did not allow time for changing the lock-plate tools, so as to reduce the thickness of the lock-plate from the thickness required by the Maynard primer. Some of the minor details of the mountings are also altered.

12. English Enfield Rifle Musket, with Sabre Bayonet; calibre, 58.7; model, 1861.

Has nipple protector held by chain on trigger guard. Many of these guns were used during the Rebellion.

BREECH LOADERS.

Breech loaders date back to the time of King Henry VIII. The earliest forms of French and German make, in latter part of 16th century, had a chambered breech piece, similar in action to that described for the early Chinese cannon. These were match lock guns. Some flint lock breech loaders in latter part of 17th century used a similar block, but had a barrel turning on a hinge below, as in the modern Smith & Wesson revolver, or made to swing sideways to allow inserting the chamber piece. These removable chamber pieces were really the first metallic case cartridges. During the Revolution a breech loader was in use closed by a screw turned in from below across the rear of the barrel. This was the Furguson rifle. The first American breech loading gun was the Hall, and specimens of this gun are the first shown in the exhibit.

1. Breech Loading, Flint Lock Rifle Musket (Hall's); calibre, 51.2.

Ten thousand of these guns were issued to U. S. troops in 1818. A muzzle loading chamber piece hinged at rear in line of barrel could be tilted up to allow the insertion of the paper cartridge. A catch underneath holds the breech piece down when closed. No provision for a gas check was made in these guns. A joint loose for one thickness of writing paper, but binding on two, being considered tight enough to prevent the escape of gas, and yet loose enough for free manipulation.

2. Same System, Flint Lock, Model of 1832; calibre, 53.5.

3. Hall's Carbine, Same System, Percussion Lock; caliber, 64.2, with Ramrod Bayonet; 1832.

4. Hall's Rifle, Percussion; calibre, .51; 1832.

5. Breech Loading Navy Carbine, Jenks; calibre, .52; 1843.

Paper cartridge, hammer on side of the barrel. Opened by drawing back top [illegible]. By means of [illegible] this draws back a sliding breech plug, and exposes [illegible] of the bore, a little larger than the ball. The ball [illegible] and allowed to run forward to its seat. The powder is then poured in and pressed forward by reversing the movement of the lever.

6. Sharp's Carbine: calibre, .52; paper cartridge.

Closed by a block sliding vertically across rear of barrel, operated by a lever below. Percussion cap and nipple. Edge of block sharp to cut off rear of paper cartridge. Gas check formed by undercut hollow in face of block. Sharp's guns were used in the U. S. Army as early as 1846, in the Mexican war, and during the Rebellion.

7. Sharp's Rifle: caliber, .58; paper cartridge; Maynard primer.

In this model the breech block is inclined to axis of barrel.

8. Prussian Needle Gun: calibre, .60; invented by Dreyse in 1838.

Presented by the Prussian Government to the United States in 1868. This gun was adopted by the Prussian Government in 1847. It fires a paper cartridge, front ignition, the needle striking a pellet of fulminate in the base of the paper sabot which surrounds the ball. There is no gas check except that resulting from the mechanical fit of the bolt. This is the earliest self-primed cartridge adopted for military service, and the gun is the first example of the bolt system now so common in Europe. The bolt is pushed in and turned, like a common door bolt, to secure it.

9. Carbine of Same System; calibre, .577.

The front sight is protected by guards on either side projecting above the barrel. These guards stand away from the sight far enough not to interfere with aim. This device would be useful where no sight cover is used.

10. Allen and Wheelock Carbine; calibre, .40; paper cartridge; made at Worcester, 1855.

11. Green's Bolt Gun; calibre, .535; Paper Cartridge; 1857.

Hammer underneath barrel. By depressing the spring in the rear of the bolt the handle of the bolt can be lifted and withdrawn. A piston, traversing the length of the bolt and attached to the handle, serves to pass the charge forward into place. The piston being then withdrawn, the bolt is turned and locked in place by two lugs at its forward end engaging with corresponding recesses in the receiver.

12. Lindner Carbine; calibre, 58.2; paper cartridge.

13. Early French Breech Loading Rifle; calibre, .58.

System somewhat resembles "Sharp's" (no marks); probably used with Lefaucheux cartridge.

14. Merrill Musketoon, Latrobe and Thomas "Rebel"; calibre, .54; paper cartridge.

Altered from Harper's Ferry rifle. Manufactured 1849. See Lock plate. Leaf rear sight. From National Armory.

The Merrill rifle resembled the Jenks, described above, except as to manner of loading. It has a spring catch engaging with rear sight base. Also, an ordinary side lock meant for prepared paper or skin ammunition. No extractor used, as cartridge is all consumed. Breech plug faced with copper, probably to serve as gas check. 14,495 Merrill carbines were purchased for use of the army during the Civil war.

15. Starr's Carbine; calibre, .54; paper cartridge; Skeletonized to show Breech Action.

By depressing the lever the brace in rear of the breech-block is drawn downward by means of a link connecting it with breech-block. The breech-block is simultaneously caused to revolve downward and backward. The piece is fired by an ordinary side-lock. The face of the breech-block is countersunk annularly so as to give a conical bearing against the butt of the barrel, probably to serve as gas check. 25,603 of these arms were purchased for use in the army during the Civil war.

16. Smith Carbine; calibre, .52; Paper Cartridge.

Barrel connected with butt by a hinge below, and held above by a spring on the barrel, stretching across the joint and fitting over a square lug on top of buttstock. Spring lifted by a lever underneath. 3,062 of these rifles purchased for use during the civil war. From Alleghany Arsenal.

17. Gallagher Rifle Carbine; calibre, .51.

Barrel opened at breech by lever underneath, pushing it forward. Used in Civil war.

18. Cosmopolitan Rifle Carbine; calibre, .50.

By depressing the lever the front section of the breech-block slides back until a cylindrical tenon on its face is clear of the chamber. It then revolves about an axis in front and below it until the chamber is exposed. The strain of the discharge is transferred by the head of the lever to the abutment on the frame. The arm uses a paper or linen cartridge, ignited by a percussion cap. An apron above the block protects the parts from dust, etc., and helps to guide the cartridge in loading. Used in Civil war.

19. Joslyn Carbine Rifle; calibre, .54.

The breech is closed by a plug at the forward end of the strap running backward on to the small of the stock. The shape of the plug is conical; it is loose upon the strap, and contains a split ring designed to be expanded by the force of the discharge against the sides of the seat of the mouth of the [illegible] loss. This expansion is effected by means of a con- [illegible] of the split ring by the discharge. This is similar to the [illegible] described under cannon. The locking catch [illegible] with the sear that the hammer can not fall while the breech [illegible]. The breech-block is locked when closed by the locking catch at its rear end. Used in Civil war.

20. French Chassepot Carbine; calibre, .45.

Ha[illegible] bent down to be out of the way. Paper cartridge. Bolt gun resembling the Prussian needle gun in principle. The gas check is a rubber washer on the end of the bolt. This is compressed axially by the powder pressure and forced against the sides of the chamber, being similar in principle to the De Bange gas check now used in heavy guns.

In the above guns paper cartridges were used, bullet and powder wrapped in paper which had to be removed, or in the latter models, cartridges in which the powder only was covered with paper, cloth or other combustible substance so that powder and ball could be inserted together. The following use

METALLIC SHELL CARTRIDGES.

The first of these shells were unprimed like the Maynard and Burnside, and in the transition stage some were made with tin or brass foil wrappers.

21. Spencer Single Firing Rifle; Removable Steel Loading Chamber.

This has a thin removable steel loading chamber, like the system described above as of the earliest model known. The chamber can be taken out and reloaded. It was probably intended to have a number of these chambers loaded for use, and therefore the gun is placed in this class.

22. Burnside Rifle Carbine; calibre, .54; 1856.

Movable chamber pivoted in front under barrel held close by cover on transverse shaft operated by side lever. Used an unprimed metallic cartridge, the front part of the shell covering the joint between the breech block and the barrel to prevent leakage of gas. Central fire; perforation in center of base admitting flame from cap placed on an outside nipple. In closing, the breech block has a forward movement, so that the bullet projecting from forward end of chamber is pushed into the rear of the barrel. A number of these arms were used at one time by the United States for cavalry.

23. Burnside Carbine; calibre, .54.

This differs from the above in the locking device, consisting of a barbed catch on the receiver, connected with a pivoted thumb-piece on the inner side of the guard. 55,567 of these guns were purchased for use in the army during the Civil war. Alleghany Arsenal.

24. Morse's System, 1858; Wilson and Flather's Alteration of Smooth Bore; calibre, .58.

Essentially the same principle as the Morse. The cartridge is rim fire, fired by a side lock; the parts not so well proportioned as in the Morse, and the breech not so securely locked as in that arm. This arm is provided with an automatic ejector, rising from the bottom of the receiver to throw out the cartridge after it has been withdrawn by the extractor.

The Morse system is opened by raising a flap hinged at rear to butt of barrel. This, by means of a link from the middle point, operates a breech-block which travels back and forth in the cavity exposed by raising the flap. A center fire cartridge, with rubber base, was used, one of the earliest of the metallic shells. Springfield Armory.

25. Ballard Rifle; caliber, .54.

By depressing a lever the breech-block is caused first to recede from the barrel, and then to drop downward, revolving about a shifting horizontal axis at its lower and rearmost corner. Hammer and lock concealed in the breech-block. Rim fire cartridge. The cartridge shell is extracted by means of a sliding extractor beneath the barrel, moved independently by hand by means of a finger-piece projecting beneath the tip stock. Depressing the stock leaves the hammer at half-cock. Block can not be depressed when hammer is cocked. Fifteen hundred of these guns were purchased for use in the army during the Civil war.

26. Joslyn Carbine; calibre, .50.

Opens by turning block to the left. Extractor on block.

27. Palmer Carbine; calibre, .50; 1865.

Bolt gun with side lock. Instead of being secured, like an ordinary door bolt, as in the needle gun and Chassepot, the bolt has a sectional screw at the rear end, engaging, when turned, with corresponding screw sections in the receiver. Essentially the same as the "French breech screw," described under 3.2 inch rifle. Rim fire cartridge. Spring extractor lying on bolt and fastened to it. The bolt revolves independent of extractor. Ejection accomplished by a side lever thrown outward by a spring as the shell passes it. Fired by ordinary side lock, the hammer striking cartridge directly on rim. 1,000 of these arms were purchased for use of army during the Civil war.

28. Ward Burton Rifle; calibre, .50; model, 1870; alteration of Muzzle Loading Springfield.

Same method as above of securing bolt. Lock concealed in bolt. Self-cocking by operation of loading. Ejector, a pin driven out of front face of bolt when well back. Issued for experimental trial in the field with the Springfield, Remington, and Sharp's arms. 1,000 of each.

29. German Mauser Rifle; calibre, .45; 1870; for sabre bayonet.

The breech action is similar to that of the later forms of needle gun, but the needle is abolished and a firing pin substituted, as the piece is used with central fire metallic cartridges. An extractor, working in a slot in left side of the shoe, is fastened to the bolt, projecting forward. The needle gun had been much improved before the change was made. The earlier ones required to be cocked by hand before the bolt could be turned and drawn out. In later patterns the operation of turning the bolt cocks the piece. The nose of the bolt is held from turning, and this steadies the striking mechanism.

30. Austrian Werndl Rifle; calibre, .45; 1872; sabre bayonet.

Fired by side lock. The breech-block swings on an axis below the line of the barrel but parallel thereto. This is turned by means of a thumb-piece. A spiral groove in the shaft serves to work the extractor.

31. French Gras Rifle; calibre, .433; model, 1874.

This is the development of the Chassepot as adapted to the metallic cartridge. The rubber washer, formerly used as gas check, is therefore omitted as unnecessary, and a heavy extractor placed on the bolt.

32. Beaumont Musket, Holland; calibre, .45.

Presented to the United States by the Government of the Netherlands in 1872. A bolt gun. Cocked automatically by turning up the handle to open the breech. It operates otherwise very much as the Chassepot. This has a spiral spring. A safety catch on the right side of the receiver locks the bolt in place after loading, and permits the arm to be carried without danger either of accidental opening or of discharge.

33. Comblain Rifle, with sabre bayonet; calibre, .45.

Partially adopted by the Belgian Government. By depressing the lever the breech-block slides downward to expose the chamber; the motion of the lever cocks the hammer meanwhile.

34. Pierie or Glisenti Rifle.

This is a bolt gun, and the special peculiarity is that the trigger extends to the rear of the bolt, so as to be operated by the thumb instead of the forefinger.

35. Norny's Alteration of Muzzle Loader; calibre, .58; 1866.

Opened by drawing back a lever pivoted underneath the stock in front of the trigger guard. The lever has a link connecting it with the butt of the barrel, so that by the above operation the entire barrel is slid forward in its bed between the stock and the band. Loaded with a cartridge inserted by hand into the chamber. Closed by reversing the movement of the lever, which is secured when closed by means of a turn screw at its forward end. Fired by the ordinary side lock, the face of the hammer being prolonged, and sharpened to strike the rim of the cartridge. Cartridges extracted by the beveled stud on the face of the breech screw.

36. Collin's Alteration of Muzzle Loader; caliber, .58.

The breech-block is opened by liberating a spring catch on its right side and swinging it over to the left. The extractor slides under the well of the receiver, and is moved by a separate trigger beneath the barrel. This trigger has a cogged section on its upper surface, which meshes into an intermediate pinion between itself and the cogged lower surface of the extractor. This causes a pull on the trigger to slide the extractor backward.

37. Breech Loading Rifle, Freeman; calibre, .50; 1870; metallic cartridge.

Opened by swinging back breech-block by the thumb-piece in front. Locked by the position of the breech-block and by help of hammer. Extraction and ejection by sliding extractor underneath seat of block, which operates in connection with it.

38. Five Guns, showing modifications of the Remington System.

In this, the breech is closed by a block revolving backward on an axis below, perpendicular to barrel. A cylindrical shoulder at the base of the hammer in rear is made to support this block. The specimens show different modifications—Benton, Laidley, etc.—of the locking device, to give security from premature explosion or to render the opening easier.

From National Armory.

39. Breech Loading Rifle Musket (unknown); 1863; calibre, .50.

Breech-block opened by hammer, closed by hand. By cocking the hammer a parallel projection on the shaft of the tumbler strikes against a hinged stud within the breech block, first lifts it out of its seat in the receiver, and then draws it back until the breech is fully exposed. The hammer is stopped at the half-cock by a projection on the side of the breech-block, against which it strikes. The block is closed by hand. It is locked when in place by setting into its mortise or seat in the receiver. One remarkable feature, especially, considering its date, consists in the absence of screws; the entire breech mechanism, including the lock, having but *one screw*, and that one free from many objections of its kind.

40. Lee Gun; calibre, .45; 1875.

Opened by pressing forward the hammer. The insertion of the cartridge releases the breech-block, which is raised when the hammer is next cocked. The cartridge is extracted and ejected by pressing forward the hammer. One hundred of these made at the National Armory.

41. Braendlin Albini Rifle; calibre, .45; 1868.

Presented by Belgian Minister. The breech-block is hinged in front at top of barrel, as in Springfield breech loader. It is locked in place, when closed, by a bolt connected with a hammer, which entered an axial cavity in the block. The firing pin lies forward of this cavity, and is struck by the bolt when the hammer falls. Opening the breech-block operates a double extractor which is without an accelerating device. This arm is used by the line of the Belgian army. The first Berdan rifle adopted by the Russian Government is a combination of the Braendlin Albini and the Chassepot. The lock is in line of barrel, and it is worked by a spiral spring. Berdan's later model is a bolt gun. He also invented a double-jointed block, which is claimed to be the basis of the present Springfield model.

42. Austrian Wonzel Rifle; calibre, .54; 1870.

Action similar to that of Braendlin Albini. By cocking the hammer, a bolt attached to the tumbler is drawn back from its cavity in the body of the breech-block. The breech-block is then raised by the handle on its right. The bolt above referred to locks down the breech-block against the strain of the discharge. The extractor slides along the side of the receiver, being connected with a projection on one of the hinge pieces of the breech-block forward of the joint. The projection is cam-shaped, and bears against a flat spring on the side of the receiver. This spring tends to keep the breech-block open until forcibly shut. The hammer strikes a special firing-pin, traversing the block diagonally to the lowest point on the face of the breech-block. The cleaning implements accompany this piece.

43. Swiss Millbank Amsler; calibre, .45; 1870.

Essentially like the Springfield rifle, the cam-latch in the gun stretching across the full width of the receiver. Browned barrel and mountings. It has no spring. There is no ejecting device. The hammer has no half-cock.

44. Springfield Rifle Musket; calibre, .50; model, 1862.

Altered on Allen's plan. Leaf spring ejector stud. Five thousand of these guns were made in 1865, as soon as the return of peace permitted the attention of the Ordnance Department to be directed from the question of the immediate supply of the most easily manufactured arms. The arm is the first of the series of alterations of the muzzle loading rifle musket which have developed into the Springfield rifle, caliber, .45, of the present day. It is opened by raising the cam-latch by means of the thumb-piece as at present, fired by a side lock in the same way. It differs from the present gun mainly in the detail of its parts and in the extractor. This slides back and forth in a groove cut in the side of the barrel. Upon its upper edge it bears a rack into which meshes a series of similar teeth in a curved arm running up from the front of the breech-block. A spring serves to draw it back. The objection to this arrangement was its delicacy and the liability of the stock to being blown away through the cut made for the extractor in case the cartridge-head should burst.

45. Millbank's Alteration of Springfield Muzzle Loader; calibre, .58; 1866.

Block on side hinged in front, swings to the right and forward. Block is locked by point of hammer.

46. Miller's Alteration of Springfield Muzzle Loader; calibre, .58; 1866.

The breech-block, which is hinged above the barrel, is made with an L-shaped arm covering the mouth of the chamber, and provided with a tenon entering a mortise in the bottom of the receiver. This mortise is a little longer than the tenon, and receives the lower end of a vertical bolt sliding in the back surface of the breech-block. When this bolt is down, the mortise is filled and the breech can not be opened. When it is lifted sufficient space is given for the tenon to clear the end of the mortise in opening. A spring tends to keep the bolt always down. A projecting arm at its forward end moves a sliding extractor in the side of the barrel.

47. Springfield Rifle Musket; calibre, .50; model, 1866.

Differs from Allin's alteration in the greater strength of its parts, and in the extractor, which consists of a U-shaped spring against the side of the receiver. One point of this spring projects into the receiver, and catches against the rim of the cartridge as the cartridge is passed into the chamber. Closing the breech-block compresses this spring, which is released on opening with sufficient force to throw out the empty shell. The calibre of this barrel is reduced from .58 to .50 by the insertion and brazing of a lining tube.

48. Springfield Rifle Musket; calibre, .50; model, 1868.

The main point of the improvement over the last arm consists in the use of a separate receiver for the barrel and parts of the mechanism, and in the improvement of the extractor, which is the same as that now employed, a lever turning on hinge pin and started positively by the block, the motion being completed by an ejector spring acting on the extractor.

49. Springfield Rifle Musket; calibre, .50; 1870; E. S. Allin's Improved Centre Lock.

The essential feature of this consists in its dispensing with the number of parts forming the ordinary side lock. The main-spring in this case lies under the receiver. The other parts lie beneath the tang of the breech-screw.

50. Springfield Rifle "Officers;" model, 1873.

Detachable pistol grip, checked stock, peep and globe sight.

51. Springfield "Marksman's" Rifle; 1873.

Pistol grip, peep and globe sight, covered front sight with level attached.

52. Twenty Springfield Carbine service; model, 1884; Buffington sight.

A description of this sight is given later on.

53. Twenty Springfield Rifles; service model, 1884; with Buffington sight.

54. Two Springfield Rifles, with ramrod bayonets, one bayonet round, latest model, 1886; the other triangular, 1873.

See Ha[illegible] for note of very early form of ramrod bayonet. The rod fits in the [illegible] groove, and when slipped forward to serve as bayonet, it is held by spring catches.

55. Springfield Long Barrel Carbine: New model; calibre, .45; experimental, 1887.

Barrel 24 inches long. Stock runs nearly whole length of barrel. Has no lower band. Buffington sight.

56. Springfield Breech Loading Shot Gun: model 1881.

This is a single barrel gun. Two are issued to each company in service, for hunting purposes.

57. Kelton's Hammerless Springfield Rifle; 1887.

In this model the lock is concealed in the breech-block. Opening the block compresses the firing spring by means of a side lever and arm, as

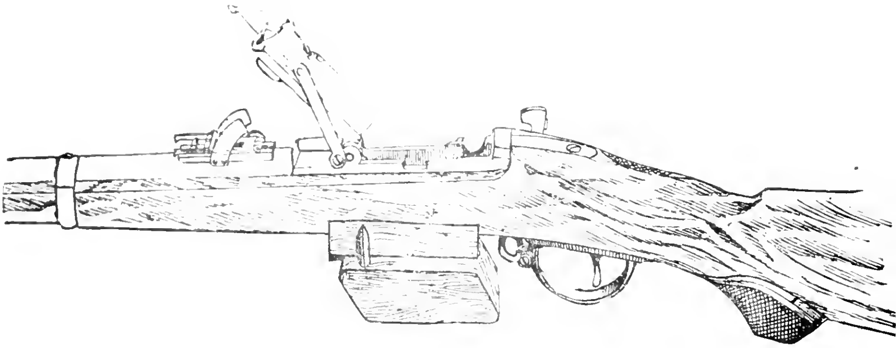


Fig. 5.

shown in figure 5. The sear projects below the block and catches in the trigger. For note of another hammerless device, see Clemens' Magazine Springfield Gun, under head of "Repeating Arms."

The Kelton cartridge carrier block, shown below the gun in the figure, is the latest device proposed for supplying cartridges readily to the soldier's hand when armed with single loading guns. These devices, of which there are several shown, form an intermediate stage in the progress towards the magazine gun of the present day. They are usually called

QUICK LOADERS.

Some of these are fixed to the stock, and others are detachable.

58. Col. J. G. Benton's Quick Loader, Fixed; 1870.

The cartridges are placed point down in holes in the stock, which is enlarged at the left of the receiver, the side of the breech-block having a projecting ledge to cover them when it is closed.

59. General Hagner's Quick Loader, Fixed; 1874.

Fixed under butt stock. A perforated projecting block holds several cartridges, points to the rear.

60. Jas. B. Stillman's Quick Loader, Fixed; 1874.

There are two forms, each consisting of a row of holes in the top of the butt stock. In one form the cartridges are protected by a cover swinging laterally. In the other by a cover turning up on a horizontal hinge.

61. Ira Merrill's Quick Loader, Fixed; 1884.

In top of butt stock like Stillman's, but instead of a row of holes, a mortise is cut in top of the stock, and this is covered, except at the front end. A spring within presses a follower forward to hold any cartridges that may be put in, and to keep them near the opening ready to hand.

62. Col. Benton's Detachable Quick Loader; 1873.

This is a perforated block which can be attached to catches on the right side of the stock near the receiver by means of a lever fastened to the block.

This resembles the Krnka quick loader, which recently was highly commended in England. It is intended to be preserved and refilled.

63. Capt. Metcalfe's Detachable Quick Loader, and Cartridge Packing Block.

This differs mainly from Col. Benton's in the method of attachment to the gun, having the block itself free from mechanism, and in making the block to serve for packing cartridges at the Armory for transportation. It holds eight cartridges. It is intended to be thrown away when emptied.

64. General Kelton's Detachable Quick Loader; 1887.

This is a block having two rows of holes, and made to attach below the stock at the receiver, instead of at the side. The flange ends of the cartridges are towards the right, near the right hand, for ease of withdrawal. Figure 5.

PISTOLS.

Thirty-six pistols are shown.

These are on boards from the Ordnance Office and National Armory. They are of various kinds and sizes, muzzle and breech loaders, rifle and smooth bore. Some pistols, and revolvers also, are used with a detachable carbine-stock for firing from the shoulder.

REPEATING ARMS.

Repeating arms here include revolving arms and magazine guns proper, the latter arranged in three classes, according to form and position of the magazine:—*tubular magazines in the butt-stock; tubular magazines under the barrel;* and what are here called *box magazines*, placed under, or beside the receiver, with cartridges touching lengthwise instead of endwise.

Still earlier forms of repeating arms are first shown.

65. Ellis' Repeating Flint Lock Muzzle Loading Rifle; calibre, .54.

This illustrates one of the earliest forms of repeating arms. The barrel has three vents along the side of the breech, with a single lock made to slide back and forth to bring the pan opposite one vent after another. It was intended to put three loads in, one above another, with the wads between, the powder of each load coming opposite one of the vents. On firing the front charge the lock would be slipped back to the next vent, and so on, firing the rear charges in succession, if they had not gone off at the first shot.

66. Single Barrel Pistol, Percussion, firing two charges.

Similar to Ellis gun in method of loading, but provided with two hammers, one longer than the other, to reach two nipples, one in advance of the other. It was probably intended to force the bullets in tightly enough to prevent flame from front charge igniting the rear one. Loaned by Capt. Wachs, Covington, Ky., who also loaned a blunderbuss, fitted with a hinged bayonet.

REVOLVING ARMS.

Some sixty specimens are shown. The earliest revolvers were matchlocks, but there are no specimens of these in the exhibit. The earlier forms had the cylinder extending the full length, and they required to be turned by hand. Though Colt's revolvers were the first ones generally used which turned the cylinder automatically, earlier forms show this improvement crudely. The chief point claimed in the original Colt patent was the central fire, the nipples being placed in the axes of the barrels in the cylinder. An old revolver, shown by the Bandle Gun Co., of Cincinnati, has four barrels, each provided with a pan and cover for the single flint lock.

One great objection to the revolver system for anything but pistols is the escape of gas at the joint between the cylinder and barrel, as this lessens the range. The last specimen shown, the Swingle, combines a bolt with the cylinder and pushes the cartridge into a chamber in the barrel. It is filled as readily as some of the tubular magazine guns. Savage's revolver has a contrivance for pushing the cylinder against the barrel before firing, to shut off escape of gas.

67. Flint Lock Revolving Carbine; Pepper Box Pattern; 8 Shots.

68. Revolving Percussion Pistol (Pepper Box); 6 Shots.

69. Whittier Revolving Rifle; date about 1835.

Cylinder has to be turned by hand. Has a single long barrel in front of the revolving cylinder.

70. Cochran's Revolving Pistol.

Revolving chambers; revolves by hand; hammer below; chambers extend radially from the centre. Cylinder is a flat disk, with chambers in the curved surface, running radially from near the centre. Revolved by hand. Hammer underneath. Paper cartridge, percussion.

Contributed by Colt's Pat. Fire Arms Co.

71. Cochran Revolving Rifle.

Similar construction to pistol first described. Has a disk holding nine charges; revolved by hand. Hammer underneath. Disk taken out to charge by throwing up strap which runs along top of stock.

From Colt's Arms Co.

72. Two Colt's Revolvers, of earliest pattern.

Used for paper ammunition. From Colt's Arms Co.

73. Colt's Revolving Rifle; early pattern.

From Colt's Arms Co.

74. Colt's Revolving Shot Gun; No. 12 bore.

From Colt's Arms Co.

75. Colt's Revolving Rifle, five shots, with sword bayonet; calibre, .56; 1857.

From National Armory.

76. Colt's Revolving Carbine, five shots; calibre, .56; 1857.

77. Eight Specimens of Colt's Revolver.

Showing the progression from the earlier forms used with paper cartridges to the most recent used with metallic ammunition. Some show marks of alteration from old form to new.

78. Wesson & Leavitt Revolver; calibre, .35.

First revolver patented after Colt's. Made by Massachusetts Arms Co., Chicopee Falls, Massachusetts.

79. French Navy Revolver, Lemat pattern; nine shots; central barrel for buckshot.

The extremity of the hammer is made with a joint, so that it can be

turned forward to fire the chambers, or turned down to fire the central barrel.
Loaned by C. Breckenridge, Covington, Ky.

80. Three Joslyn Revolvers; calibre, .44; one skeletonized.

81. Eight Specimens of Remington Revolver.

Illustrating the development from the time of paper cartridges to to-day. Some forms have the Hay safety device, a slide passing up in front of the hammer to keep the latter up until the slide is withdrawn by pressing the trigger.

82. Beall Revolver; calibre, .44.

Bears close resemblance to the Remington

83. Two Allen & Wheelock Revolvers; calibre, .44.

Its main difference from the ordinary form of the Colt revolver, or of the Remington which it resembles in having the cylinder inclosed by the frame, consists in the position of the rammer lever, which is turned backward and bent so as to form the trigger guard

84. Adams Revolver (English); calibre, .44; patented 1856.

A self-cocking revolver, the hammer being raised by pulling the trigger.

85. Four Self Cocking Starr Revolvers.

The trigger is double. By continuing to pull on the forward trigger, which raises the hammer and revolves the cylinder, the back of the trigger strikes against the front of a rear trigger and causes the hammer to fall.

86. Two Dreyse Needle Revolvers; calibre, .35; self cocking.

87. Four Savage Revolvers; calibre, .3625; self cocking.

By pulling back the lever in the rear of the trigger, the cylinder is first slightly retired from the barrel and then caused to revolve. The hammer is cocked at the same time. When the lever is released, the cylinder moves forward slightly, so that the mouth of the nearest chamber may embrace the butt of the barrel, made somewhat conical for this purpose. The cylinder is withdrawn by means of a toggle-joint, connected in its rear end, which is lifted by a projection on the upper part of the lever. An arm, attached to this end of the toggle, reaches forward and operates the ratchet. The stop-ratchet is formed on the body of the cylinder, back of the cones. The operation of the moving parts, which is very interesting, may be readily seen by removing the plate on the left of the lock.

88. Pettengill's Revolver; calibre, .44; Double Action, Hammerless.

89. Two Lefancheux Revolvers (French); calibre, .35; Pin Fire.

By opening the gate on the right side, the rear chambers are exposed and an opportunity given to insert the cartridges. The empty cartridge shells are pushed out to the rear by sliding a rod on the frame. The cylinder stop consists of a pin plying back and forth in the face of the breech. It arrests the movement of the cylinder by striking against projections on the face of the cylinder between the chambers. In consequence of M. Lefaucheux's early invention of this pin-fire cartridge, this is one of the earliest breech-loading revolvers using metallic ammunition. The trigger folds up when not in use.

90. Christiensen Revolver (Danish); calibre, .45; pin fire.

The hinged gate in rear of the right side of the cylinder allows the chamber to be loaded with a pin fire (Lefaucheux) cartridge. The stop operates against a series of inclined ratchet teeth formed on the body of the cylinder. The trigger folds up when not in use. The butt contains an oil cavity closed by a screw stopper which has an internal stem to take up the oil one drop at a time. An eye is formed in the frame immediately in the rear of the hammer, by which the pistol is fastened to the person by a langard.

91. Three Perrin Revolvers (French); caliber, .44.

The cartridges are inserted through the gate in the rear of the cylinder on the right. The tumbler is without any notch, the hammer falling at the moment that the "lift" of the trigger is accomplished. It may be kept off the cartridge by means of a wedge pressed in by a spring so as to block its fall. The wedge is out of the way when the hammer falls in firing. The pistol uses a central fire cartridge, instead of the pin fire Lefaucheux cartridge for which it was originally made.

92. Sharp's Revolver; calibre, .44.

Opened by swinging barrel sideways. Same as Wesson's, except in mode of opening.

93. Smith and Wesson Revolver.

By raising the barrel latch in the rear of and above the cylinder, the barrel may be turned down about a horizontal axis in front of the lower part of the cylinder. The barrel in turning down carries with it the cylinder, and at the same time a shaft running through the axle of the cylinder is driven to the rear, pushing out the empty shells by a projecting plate on the rear end. When pushed out far enough to remove the shells, this extractor springs forward into place, and gives room for inserting more cartridges.

94. Smith and Wesson Revolver; calibre, 43; Russian model.

95. Schofield, Smith and Wesson Revolver; calibre, .45; U. S. Service pattern.

This arm differs principally from Smith and Wesson, in the form of the extractor and of the barrel latch, the latter being hinged to the frame, instead of the barrel, of the cylinder catch. The height of the front sight is also reduced by placing it in a groove along the top of the barrel.

96. Smith and Wesson's Army Revolver, with Kelton's Safety Stop attachment.

As shown in figure 6, the handle of the revolver has a thumb-piece on the right. This serves two purposes. First, it steadies the revolver by giving a firm grasp with the aid of the thumb. Second, it prevents firing the piece until the trigger is pulled. For this purpose the thumb-piece is hinged at the

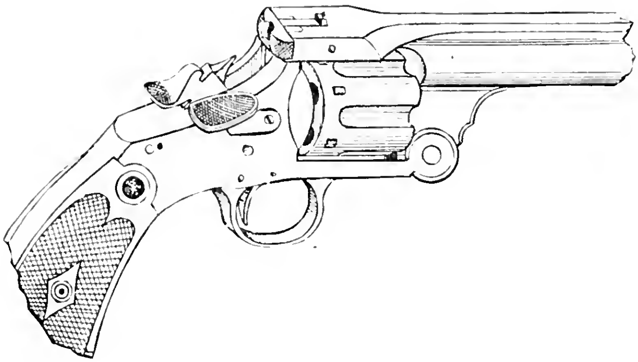


Fig. 6.

forward end on a shaft, which extends into the frame of the handle and keeps the hammer from falling until the thumb-piece is pressed down. This is the invention of Bvt. Brig.-Gen'l J. C. Kelton, U. S. A.

97. Kelton's Cartridge Pack for Smith & Wesson Revolvers.

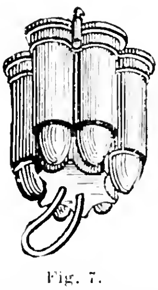


Fig. 7.

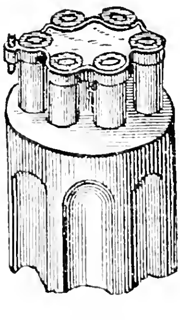


Fig. 8.

This is shown in figures 7 and 8. Figure 7 shows the package, and figure 8 shows it partially inserted in the barrels of the cylinder. The cartridges are arranged around a central stem, and held by a paper band, or by a brass strap with a simple catch. The packages are carried in cylindrical boxes attached to the waist or shoulder belt, and when the revolver is opened they can be readily taken from the belt and pushed into the cylinder. The band or strap is readily loosened, and the central stem falls out. This gives a ready means of reloading the cylinder.

98. Swingle Revolving Repeating Rifle; 1880.

This is a bolt gun with a revolving cylinder beneath the bolt. This cylinder, instead of holes parallel to the axis, has grooves in its outer surface, as in the Lowell and other machine guns, and the bolt works through one after the other in succession. The cylinder is supplied with cartridges through an opening on the right hand side as in the Colt breech loading revolver.

TUBULAR MAGAZINES IN THE BUTT-STOCK.

The earliest example of this kind known is a match lock gun of the 18th century. It had two tubular magazines running lengthwise of the butt stock as in later models, one holding powder for the charge and the other powder for priming, the bullets being inserted singly. A revolving disk, turning like the Cochran, round an axis perpendicular to the barrel, but horizontal instead of vertical, served to close the breech and the tubes. A chamber in the circumference allowed the insertion of a ball from underneath the gun. The disk was then turned to carry the hole past the magazine openings, muzzle of gun held down to let the powder drop in, and was then set to bring the chamber opposite the barrel.

99. Spencer Carbine; old model; calibre, .52; skeletonized.

This gun was introduced in 1860. It was the earliest magazine gun used in actual war. Ninety-four thousand one hundred and fifty-six were purchased for use in the army during the Civil War. Used a rim-fire metallic cartridge. A lever underneath, swinging down and forward, draws down the breech-block and swings it backward far enough for a cartridge to slip over the block from the magazine in rear, a spring finger above the mouth of the magazine keeping the cartridge from slipping out. Swinging the lever forward, pushes the cartridge in and closes the breech. Fired by an independent hammer striking a slide in the block and driving it against the rim of cartridge. By a button underneath the swing of the lever can be limited so that a cartridge will not be admitted from the magazine, and the gun can then be used as a single loader. A narrow plate hinged to the block serves as extractor, and the shell is forced out by sliding up the inclined finger which covers the magazine. A tube containing a spiral spring can be drawn out from the rear, allowing cartridges to be dropped into the magazine. Returning the tube to place brings the pressure of the spring upon the cartridges to force them forward. The spring has a head, or "follower" at the end to bear upon the cartridge, and this is common to all spring magazines.

100. Spencer Repeating Rifle; calibre, .50; altered from Carbine.

Same system as above.

101. Scott or Triplett Magazine Rifle; calibre, .50; about 1870; Meridian Manufacturing Co., Meridian.

The magazine in butt stock; barrel revolves on parallel axis beneath it until opposite mouth of magazine, when it receives its charge.

102. Clemens Magazine Rifle "Springfield System;" 1878.

The magazine in this gun is placed in a groove in the left side of the butt stock, and it runs up to the side wall of the receiver, which has an opening to allow cartridges to slip obliquely from the magazine towards the firing chamber. A coiled spring at the side of the magazine works a flexible plunger to force the cartridges forward. Rather complicated mechanism, somewhat on the order of the first Allin model for the Springfield (No. 19 above), is needed to throw the empty shell clear of the magazine and draw a cartridge from the magazine to the chamber. This gun shows a hammerless breech-block. It is converted from the regular block with little exterior change. A side lever, as in the Kelton hammerless gun above described (No. 57), pushes back the firing-pin and compresses a spring in the block, but instead of having a sear below, the firing-pin projects from the rear of the block as in the service model, and a shoulder there catches on a spring plate which is pressed out by movement of the trigger, releasing the firing-pin. The description of this gun in Report of Chief of Ordnance for 1878 does not refer to the "hammerless" device. Other attempts to make a magazine gun of the Springfield are there noted.

103. Hotchkiss Magazine Rifle; calibre, .45.

See Report of Chief of Ordnance for 1882. This gun was introduced about 1879. It is a bolt gun similar to the Mauser. The slot in the receiver is curved at its junction with the front and rear shoulders. The bolt is hence gently checked just before it is pushed home, preventing shock on the head of the cartridge, and making the operation more continuous than with square shoulders. The front curve also cams the bolt backward in beginning to open, and so starts the shell, which can then be readily drawn out. This action, now used in other bolt guns, was claimed by Hotchkiss as his invention. The magazine, in the butt stock like the Spencer, runs under instead of over the breech piece, and brings the cartridge into the receiver through an inclined opening in the bottom. A spiral spring is used with follower. Centre fire cartridges are used. To insert them the bolt has to be opened, and they are pushed in through the chamber, endwise, singly, butt end first. By a lever at one side the bolt can be locked shut for security, and the hammer held from striking. A lever at the other side shuts off the magazine when necessary for use as a single loader. It is a remarkably simple gun, and it avoids having an extra piece to serve as carrier for transfer of cartridges from the magazine. A peculiar feature is a trigger with a hollow or curved stem where it passes round the magazine. Stops connected with the trigger check and release cartridges in the magazine at the proper time.

104. Chaffee Reece Magazine Rifle; calibre, .45; 1881.

See Report of Chief of Ordnance 1882. The position of the magazine is nearly the same as in the Hotchkiss, but in place of having a spring in the magazine, the cartridges are forced forward by studs on a bar at the side of the magazine tube. This bar is moved back and forth by a projection on the bolt. Another bar, which does not move lengthwise, has corresponding studs, and it is kept pressed in by a spring, the studs on this bar keeping cartridges from slipping back when the first bar moves back. The reciprocating bar thus draws the cartridges forward, by regular successive steps, distances equal to their own length. The front cartridge, before the breech is opened, lies in a hollow under the bolt, far enough forward to be pushed up and into the chamber as the bolt is pushed in after opening. A hinged gate in the butt plate can be thrown open to admit cartridges in filling the magazine tube. This gate in opening acts upon the studded rods to force them out from the tube, and allow cartridges to be dropped clear in without striking the studs.

TUBULAR MAGAZINES UNDER THE BARREL.

105. Henry Magazine Rifle—Sliding Carrier Block; calibre, .42; old model.

This system was invented about 1850, but it was slow in coming into use, until developed about 1866 into the form of the Winchester gun next described. The gun is operated by a lever swinging forward below. This acts on an elbow joint which works the bolt back and forth. An arm connected with the lever causes a carrier-block to slide up and down, transferring the cartridges from the level of the magazine to that of the barrel when the bolt is back, and dropping the block when the bolt is forward, and a cartridge pushed into the chamber. The magazine is charged from the front. The tube is in two sections, the muzzle part made to swing round to the side to clear the mouth of the magazine tube; the spring being first pushed up into this part by means of a thumb-piece attached to the follower, and projecting through a slot cut lengthwise in the magazine tube. Cartridges can then be dropped into the tube. A magazine under the barrel gives room for more cartridges than one in the butt-stock.

106. Winchester Magazine Rifle; calibre, .45; military model, 1876.

This differs from the Henry gun, from which it was developed, mainly in the method of filling the magazine. Instead of having a movable muzzle section, the tube is continuous, and an opening at the rear covered by a spring plate allows the insertion of cartridges one at a time even when the gun is loaded. No other means of loading is provided than this method through the magazine. This gun attracted much attention abroad when first made, about 1866, and it was adopted in Switzerland, where it was afterward displaced by the Vetterlin, next described, constructed on the same magazine principle. The Winchester is very popular for sporting purposes, where small cartridges can be used. Its operation depends on good workmanship, and it is a fine piece of mechanism. The length of the breech system prevents its being used to best effect for long cartridges.

107. Swiss Vetterlin Magazine Rifle; calibre, .40; about 1868; adopted by Switzerland for its Corps d'Elite.

This is a simple bolt gun, the bolt operating a sliding carrier block like that of the Winchester, from which magazine system it is derived. The same remarks as to filling the magazine and loading apply to this as to the Winchester. The bolt differs from the Mauser bolt in having the handle near the rear and bent down by the side of the stock, two lugs on the turning post of the bolt, near the rear, catching the shoulders in the breech frame. This rear position of the bolt is an advantage in magazine guns. The firing spring is spiral, as in the Mauser, but made large and heavy, though short, and placed in the rear instead of the front part of the bolt. This makes an enlargement in rear and gives a clumsy look.

108. Ward Burton Magazine Rifle; calibre, .45; 1873; rocking carrier.

The bolt mechanism of this gun is the same as that of the single loader above described (No. 28). Like that gun the handle is placed at the rear of the bolt, and a stop is provided to hold the handle half turned, thereby giving a half-cock. The magazine is a tube under the barrel with spring and follower as above described, but instead of a *sliding* carrier block, a *rocking* carrier of spoon-shape is used. This spoon is made to rock on horizontal bearings at the rear. Its front end is forced down by the bolt in moving forward, and up by the bolt in moving backward, striking projections at the rear end. The spoon when down receives a cartridge from the magazine, and when up it holds the cartridge inclined upwards towards the chamber, about at the position and slope of the front cartridge in the Hotchkiss, with the flange end raised sufficiently for the bolt to strike the upper edge in going forward, and so push the cartridge into the chamber. A side lever operates to hold the spoon up, and cut off the magazine when desired for use of gun as single loader. Instead of loading the magazine from an outside opening in rear, which allows the magazine to be filled even when the gun is loaded, as in the Winchester and Vetterlin, cartridges have to be inserted through the receiver, and for this purpose the bolt must be drawn back, unloading the gun. Cartridges are put in endwise, singly, point first. The magazine mechanism is indicated in the cuts illustrating the new German and French magazine guns, next described, to which the remarks about loading, etc., also apply.

109. Mauser Magazine Gun; new German model; calibre, .43.

This is practically the Mauser single loading mechanism with a magazine of the Ward Burton type, having a rocking carrier or spoon. This is commonly known as the Kropatcheck system, which, however, was not known until about 1878, while the Ward Burton was tried in this country in 1873.

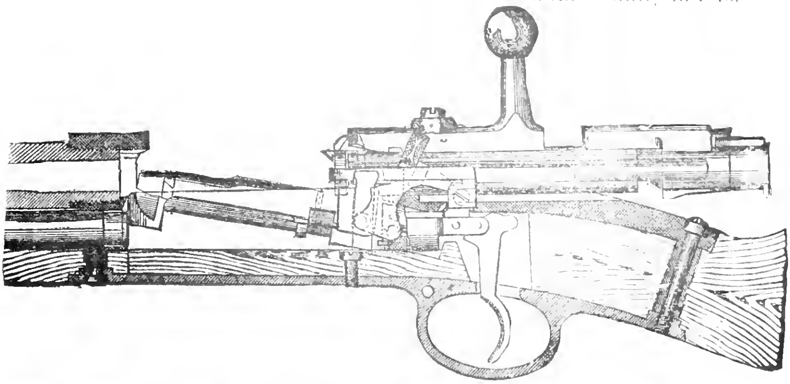


Fig. 9.

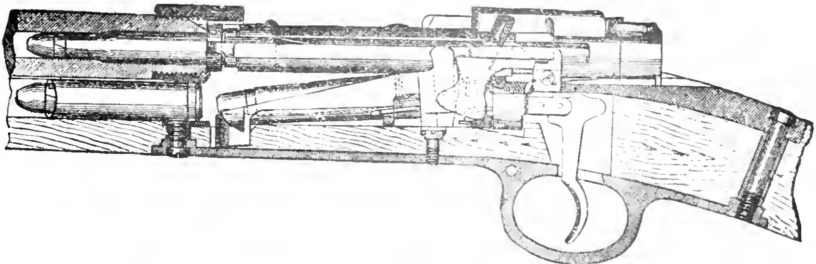


Fig. 10.

Figure 9 shows the Mauser magazine gun in longitudinal section, with bolt drawn back and spoon up. Figure 10 shows the same with bolt closed and spoon down. A projection below the nose of the spoon serves to prevent cartridges from slipping under the spoon from the magazine, and a detent operates when the spoon is down to prevent a second cartridge from following the first into the spoon. A cut-off operates in a similar manner as in the Ward Burton gun. The rifle is 4 feet 3 inches long, and with the bayonet 5 feet 11 inches long. With the magazine empty the gun weighs about 10 pounds; with it filled, about 11 pounds. The bayonet weighs 1.76 pounds. The trigger mechanism is so arranged that a gradual pull on the trigger finally disengages the tumbler and permits the firing pin to fly forward. The magazine holds 8 cartridges end to end. The service cartridge weighs 663 grains. It is 3.07 inches long. Later cartridges contain 89½ grains of powder. Reduction of calibre is now going on, and its advantages will be discussed under **Ammunition.** The French gun next described is of reduced calibre.

110. The Lebel Magazine Gun; new French model; calibre, .304; represented only by drawings and description.

This is practically the French Gras rifle fitted with the Kropatcheck (or Ward Burton) magazine, and the same general remarks apply here as to the Mauser gun, just described. The new bolt has double lugs, as in the Lee bolt, to take up the recoil on both sides the receiver.

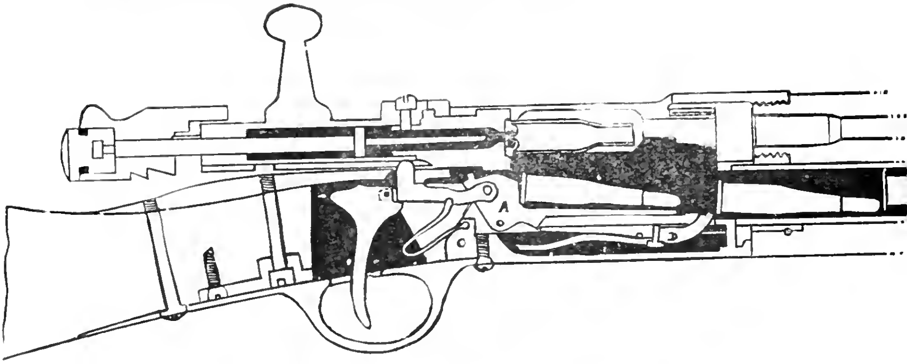


Fig. 11.

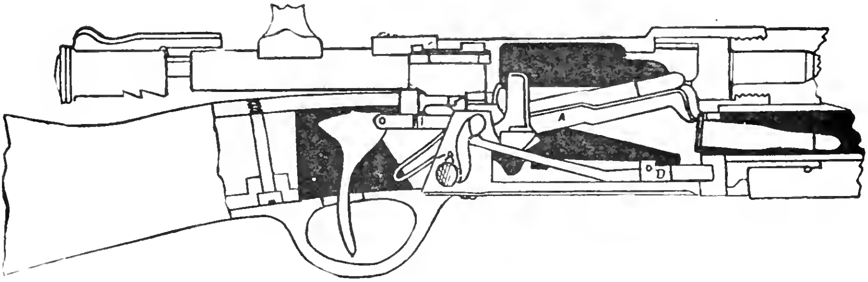


Fig. 12.

Figure 11 shows the spoon down, with a cartridge lying in it received from the magazine. The bolt is partly pulled back, drawing out an empty shell, in the position just before tilting up the spoon with the new cartridge to the position shown in figure 12. For description of cartridge and results with it, see under Ammunition.

111. Spencer Repeating Shot Gun; 12 bore; 1881.

The breech-block in this gun resembles the Peabody, it being hinged in rear, and made to move up and down in front. Its special peculiarity lies in the arrangement for operating the block by means of a sliding handle on the magazine tube under the barrel. This handle is connected with flat bars, which extend to the rear, into the receiver and along the breech-block. A stud on the inner side of one rod fits in an inclined groove in the side of the breech-block, so that sliding the handle back wedges down the block to open the breech. Immediately after this, an extractor is operated by the bar on the other side to remove the empty shell. When the handle is well back the block is thrown up by a spring, tossing the shell out above. While the block is up, a cartridge underneath, received from the magazine below the barrel, is pushed in by moving forward the slide, and the breech is closed. The magazine is filled from underneath the breech-block.

112. Colt's Magazine Rifle; calibre, .22; 1887.

This gun is also operated by a handle sliding on the magazine tube under the barrel, but the breech action is a bolt system, instead of the falling block. A bar, attached to the slide, works a lever connected with a cam latch, which is hinged at its forward end to the under side of the bolt towards the rear. When the bolt is closed, the rear end of this cam latch drops into a depression under the bolt in the bottom of the frame, and abuts against a shoulder in the frame, securing the bolt. Drawing back the handle raises the cam latch over the shoulder and then pushes back the bolt so freed. Forcing the handle to the front draws the bolt forward and finally swings the cam latch down again, locking the bolt. A spring extractor on the bolt withdraws the empty shell. A sliding carrier block, moving like that in the Winchester and Vetterlin, transfers cartridges from the magazine. The rear end of the magazine tube can be swung slightly to the right to insert cartridges, a spring plate securing them from springing out. This gun was used during the Exposition, in the shooting gallery of the War Department, in determining practically the velocity of projectiles. Loaned by B. Kittredge Arms Company, Cincinnati.

BOX MAGAZINES NEAR THE RECEIVER.

CARTRIDGES TOUCHING LENGTHWISE INSTEAD OF END TO END.

These magazines are either detachable, so as to be readily replaced; or fixed in place and arranged to be rapidly refilled by means of compact packing cases. The Lee is the best known of the box magazine guns. It has a detachable magazine, the only one shown of this type. The other type is now coming into prominence from its recent adoption in some form by several nations. One great advantage of the box magazine is that the bullet of one cartridge does not rest against the primer of another, and so the possibility is removed of exploding a cartridge in the magazine, or injuring the bullet, by shock from another cartridge. If necessary a spring plate can be placed front or rear to lessen all shock. In some, an opening at the side allows inspection of the interior. They work without carrier-block or spoon, though some, like the Rubin, have a catch operated by the bolt to check and release cartridges. The chief advantage, however, is that it enables the supply of cartridges to be rapidly renewed. This becomes more and more apparent with the reduction of calibre and lengthening of the cartridge. While box magazines avoid the slow process of inserting cartridges one at a time endwise, some even of these fail in a point covered in several tubular magazines —the power to refill when the gun is loaded—and require the refilling to be done through the receiver with the bolt drawn back.

113. Lee Magazine Rifle: calibre, .45; 1879.

This is a bolt gun, with an opening the length of a cartridge in the bottom of the receiver, just back of the barrel, and it has a detachable magazine which is inserted from below.

Figure 13 is a longitudinal section showing the magazine in position. Figure 14 is a cross section of the gun with the magazine removed, showing the opening through the stock under the receiver for the insertion of the magazine. Several of these magazines are carried on a belt. They are each

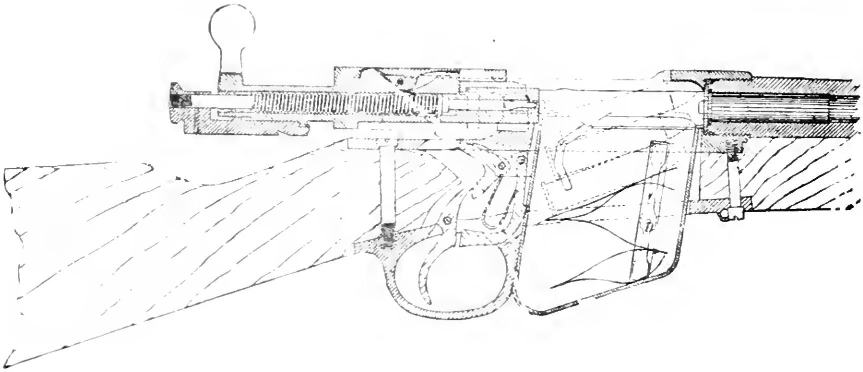


Fig. 13.

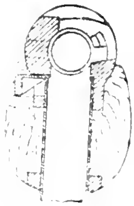


Fig. 14.

provided with a spring and follower within to force the cartridges up, and they are filled up in advance by the soldier, as it is intended that they should be saved. They have to be strong, and they must be made carefully, as they form, when attached, a working part of the mechanism, and a slight deformation would interfere with their operation. When a magazine on the gun is emptied, it is dropped out by pressing a spring, and a new one already filled is inserted. A magazine holds five cartridges of our service model, calibre .45, but more of smaller calibre could be carried. The gun can be used as a single loader when the magazine is off, as a spring plate then covers the bottom of the receiver. A recent addition made for the proposed arm of the English service, allows this bolt to come in play even when the magazine is on the gun but not forced up into position for feeding. This magazine can be filled when on the gun, if the bolt is drawn out and the gun unloaded. See Report of Chief of Ordnance for 1882.

114. The Rubin Magazine Gun; Swiss; 1888.

This has a magazine set like the Lee under the receiver, but fixed in place. To fill it the bolt has to be drawn out, and cartridges are inserted through the receiver. They can be put in singly, or, by means of the prepared package shown in side and bottom views in Figure 15, can all be inserted together. A spring gate, similar to that in the next gun described, admits cartridges at the top of the magazine, but this gate has to be worked by the bolt to release cartridges for loading. The gun could not be obtained for exhibit, but cartridges and packing cases were sent from the National Armory, where the gun is now on trial.

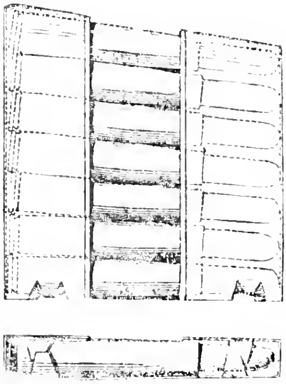


Fig. 15.

This package or case, holding 7 cartridges, is made of light tin, and the cartridges are held in by flexible lips at the open bottom. When the case is placed over the magazine, the cartridges are pushed down by the thumb or finger, passing through the slot in the case, and the lips yield, allowing the cartridges to pass at once to the magazine. These cases are light and cheap, and they require no spring. They can be carried like detachable magazines on the belt; and cartridges can be packed in them at the arsenals for issue to the soldiers. The idea involved in the fixed magazine so filled is, that it is preferable to have a magazine that can be rapidly filled, and that will form a part of the gun, receiving the same care as the gun itself, than to run the risk of losing a detachable magazine, or damaging it, so reducing the gun to a single loader.

115. Livermore-Russell Magazine Gun; 1879.

The magazine is placed at the side, extending downward, as shown in Figure 16, an opening at the side of the receiver, admitting cartridges from the magazine to the front of the bolt when drawn back; but the special feature is the spring-gate at the top, closing an outer mouth. This allows cartridges to be inserted singly, or, by means of a packing case, all together, even when the gun is loaded; but prevents their exit there and guides them towards the other opening leading to the receiver. The feed of the magazine can be cut off by a stop, which simply keeps the bolt from drawing back far enough to catch the flange of a cartridge, and the gun can then be used as a single loader. The magazine feeds cartridges without the use of special mechanism operated by the bolt.

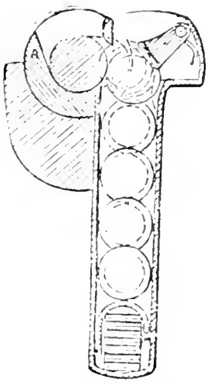


Fig. 16.

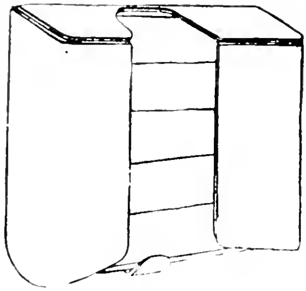


Fig. 17.

The position of the magazine allows an opening to be made in the side through which the soldier can see how many cartridges remain in reserve.

The packing case described above for filling such magazines was originally made for this gun. Fig. 17 represents the original design practically identical with that shown in Fig. 15. Norton's "American Inventions in Fire Arms," published by Ticknor & Co. in 1882, says of this gun as originally designed: "The object of the invention is two-fold: First, to provide a magazine which can be rapidly filled, whether the gun is loaded or not, without necessarily detaching it from the gun. Second, to provide a breech-closing bolt system which can be operated by a simple forward and back motion of the hand." The latter arrangement was intended to secure quick action of the bolt and greater rapidity of firing from the magazine. The bolt system referred to by Norton is quite similar to that of the new Mannlicher gun recently adopted in Austria and next described, but the gun in the exhibit has practically the Mauser or Hotchkiss bolt.

116. Mannlicher (Austrian) Magazine Gun; 1888.

In the Mannlicher gun the bolt is operated by a simple forward and back motion of the hand, all other military bolt guns in use requiring the bolt to be turned to secure it after closing, or to unlock it for opening. Figure 18 shows a longitudinal section of this gun. The handle is indicated by the round knob at the rear, connected with a piece which slides in and out at the end of the bolt, and which has a wedge-shaped projection below. Hinged at the front to the under side of the bolt, in rear of the magazine, is a brace, or cam latch, shown in the drawing, and the wedge above referred to works in a slot in the rear of this brace, forcing the latter down when the bolt is pushed well forward, and securing it against a shoulder in the frame of the gun, as here shown. Drawing back the handle raises the brace by inclined projecting lips on the wedge, and allows the bolt to slip back. This method of locking the bolt by a brace or cam has been adopted in the Colt magazine gun above

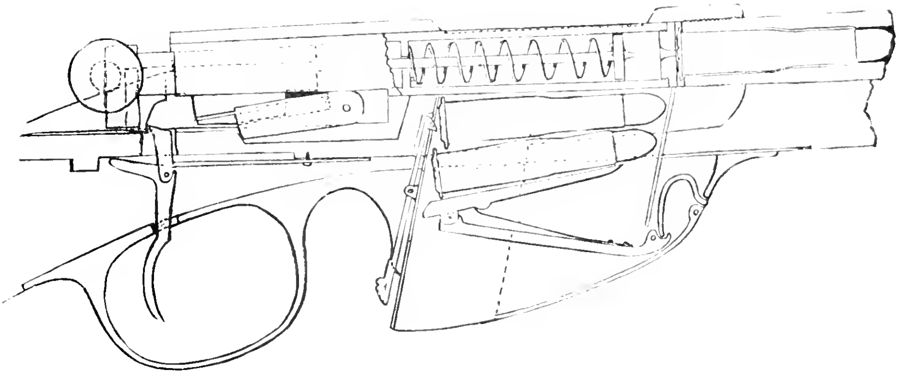


Fig. 18.

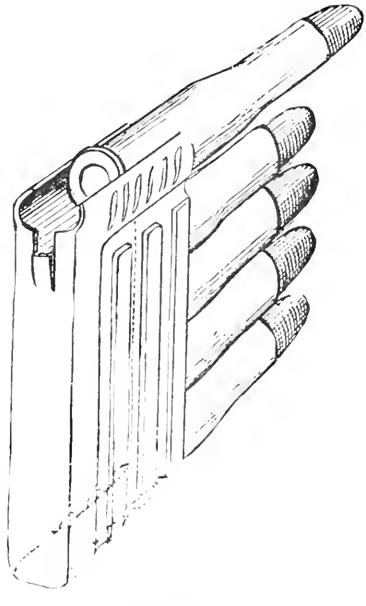


Fig. 19.

described. The Mannlicher magazine is under the receiver, and to fill it the bolt has to be drawn back. A special cartridge feed case is used with this gun, as shown in Figure 19.

This case holds the flange ends only of the cartridges, and the top one alone can move forward. The whole package, case and all, is inserted from above into the magazine, the spring in the magazine acting through the case on the cartridges. The emptied case either falls out at the bottom of the magazine or it is forced out by inserting another full case. Cartridges can not be inserted one at a time into the magazine, as the case forms part of the mechanism to control the cartridges, making a sort of cross between a detachable and fixed magazine. There seems to be no provision for using the gun as a single loader.

117. Schulhoff Magazine Gun (Austrian Invention): 1888.

The Schulhoff magazine gun, also an Austrian invention, is shown in Figure 20. Its construction is novel and interesting. The magazine is a fixed hollow drum under the receiver. An axial shaft nearly parallel to the barrel

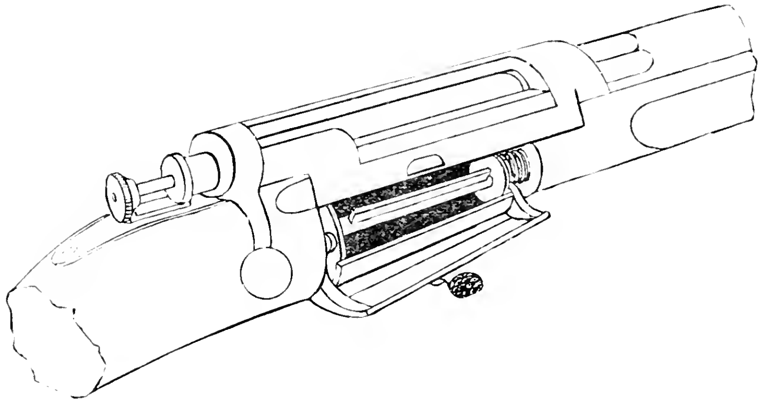


Fig. 20.

runs through the drum, and this carries a radial plate which revolves with the shaft and acts as a "follower," pushing before it cartridges placed in the magazine, and delivering them at an opening in the bottom of the receiver, where they can be caught by the bolt in loading. An opening on the right hand side of the magazine allows cartridges to be inserted, and a hinged lid closes the opening. The shaft is turned by a spiral spring round the front end.

The figure is a perspective view of the gun, showing the lid of magazine open, and exposing the interior with its shaft, follower and spring.

Figure 21 is a cross section, actual size, through the magazine full of cartridges, as seen looking from the front. The lid is shown closed.

Figure 22 is a cross section, reduced size, just in rear of the magazine, looking towards the front, showing that the lid in opening is made to revolve the shaft to a position where the follower clears the entrance. Closing the lid releases the shaft and brings the pressure from the spring against the cartridges.

The cartridge cases described above are also used to rapidly fill the Schulhoff magazine, but loose cartridges can be thrown in readily. This magazine holds nine of the new small calibre cartridges. Like No. 115 above, it is unnecessary to unload the piece to fill the magazine; but in the Schulhoff it is

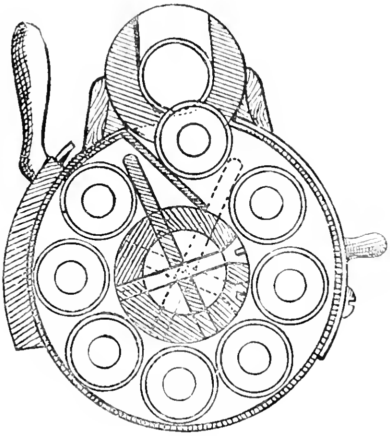


Fig. 21.

necessary to make a separate motion to open the magazine for insertion of cartridges. This magazine might have an opening round the drum to show the number of cartridges in reserve. The gun is a natural development from the Swingle revolving gun, No. 98. The "cut-off" for the magazine is a slide, the handle of which is indicated in Fig. 24, on the side opposite the lid. It

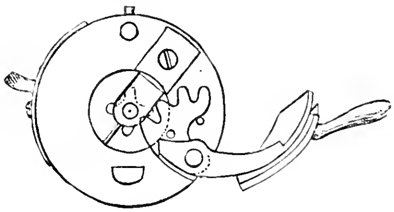


Fig. 22.

is bent to the outer surface of the drum, and pushing the handle, slips it round so that the end comes over the opening into the receiver. In the model here shown it seems to interfere with the extraction of the empty shell. Limiting the retraction of the bolt, as described above, would answer for this or any other system of box magazine.

Schulhoff Magazine Pistol. A pistol is constructed by Schulhoff with a magazine working on the same principle. It has a bolt mechanism, which is operated by the trigger. The trigger is double, and pressure on the forward part draws out the bolt, ejecting the old shell, and then closes the bolt, pushing in a new cartridge. Further motion of this trigger causes it to strike the second trigger and fire the pistol. The same kind of cartridge case is used to fill the pistol magazine as is used for the rifle.

The Schulhoff and Mannlicher guns, together with the Gras and Vetterlin, were obtained through the special efforts of Capt. Henry Metcalfe, Ordnance Dept. at the U. S. Military Academy.

A form of box magazine, which has recently attracted much attention, is the Burton. It has a side hopper, extending above the barrel, feeding cartridges down by gravity. No model of this system could be obtained.

REVIEW OF MAGAZINE GUNS.

A progression is here shown from magazines requiring special carriers, or movable guides, to transfer the cartridges from the magazine to the barrel,—first, the spring guide of the Spencer, which often gave trouble; next the sliding carrier of the Henry and Winchester, followed in the Vetterlin; then the rocking carrier of the Ward Burton, Kropatcheck, and the new French and German Guns,—to systems requiring no special carrier, the Hotchkiss butt-stock magazine, and, lastly, the box magazines, which now operate universally without a carrier. A device has been patented, by which the carrier is dispensed with, even for a tubular magazine under the barrel, but of its success nothing is reported. Some tubular magazines run along the top or side of the barrel. One of the earliest box magazines—the Lowe—was placed at the side or wrapped round the stock at the receiver, with a rocking piece at the mouth to transfer cartridges. To fill the magazine the follower spring had to be compressed by hand, and the mouth-piece thrown back to admit cartridges. There was no automatic device to keep cartridges from slipping out. Both the butt stock and box magazines, on account of having cartridges nearer the shoulder, the point of motion, have advantage over the other in changing the balance less as the shots are fired away. The box magazine gives the best opportunities for inspecting the interior to see how many cartridges remain.

Different theories are held about the proper use of magazines, and even as to the propriety of their use at all. The Russian authorities have decided against a magazine rifle. Some hold that a simple breech loader is sufficient, with means for quickly finding and inserting a cartridge, taking the ground that with the possibility of firing more rapidly too much ammunition will be wasted, without the means of supplying it in sufficient quantities. The reduction of calibre makes it possible for the soldier to carry more cartridges, and they can be supplied in greater quantities with the same means of transportation as before. It is certainly true that the box magazine is the only one that can compete with the best single loaders in continuous firing, on account of the time required to replenish the others. It is rarely the case, however, that it is necessary to keep up a rapid fire for more than a short interval; and some advocates of the magazine, holding that it should only be used as a reserve in case of such emergency, think it unnecessary to provide for rapidly refilling it; but others recognize the possibility of a succession of emergencies demanding power of rapidly replenishing the magazine, but not requiring it to be used for ordinary fire.

The great problem seems to be to provide a means of controlling the use of the magazine. Detachable magazines and packing cases for rapid refilling seem to promise well for this purpose, and the advantage of being able to inspect the magazine through open sides is recognized. The Mannlicher system would perhaps allow greatest control over the number of cartridges so used, as no means are provided for putting cartridges in singly, and the use of packages can be readily observed; but it may often be desirable to refill a partly emptied magazine, and the need to load singly is often imperative, for no system allows replenishing as quickly as a single shot can be put in, and the soldier would be at a disadvantage when his magazine was emptied if he must needs wait till the magazine was filled again. He should be able to fill his magazine by putting in cartridges one at a time or all together, and do either with his gun loaded or not.

Great opposition was at first made to the simple breech loader, from the same fear that cartridges would be shot away too fast, but that result has not followed. Improved methods, too, have been devised for supplying a fighting line of troops with cartridges, and small calibre cartridges now used abroad offer great advantages over the old in the number a man can carry. 102 Hebler cartridges, calibre, .31, weigh only as much as 80 Mauser cartridges of calibre .43. It does not follow that trained troops are to shoot too fast because they can do so, but the power to reload rapidly gives the soldier confidence and enables him to aim more deliberately. For raw troops the danger is greater, and it is doubtful whether they should be supplied with magazine guns.

AUTOMATIC RECOIL GUNS.

What will result from the use of magazine guns operating by their own recoil remains to be seen. Maxim, the inventor of the automatic recoil machine gun, has also invented a musket acting on a similar principle, in the latest form practically adopting the system of feeding used in the Swingle revolver gun above described; and in an earlier form using a modification of the Winchester system operated by a spring butt plate. In the Freddi rifle the recoil pulls out the breech bolt for the insertion of a cartridge by hand, and compresses a spring so that on pressing a button the breech closes again. In both systems the firing is controlled by a trigger, but in the Maxim, by keeping the trigger pressed back, all the shots in the magazine will be fired in rapid succession. The operation of refilling the magazine is, however, very slow.

AMMUNITION.

Projectiles of larger calibre have been described under Cannon. This division includes fuzes, primers, powder and small arm ammunition.

FUZES FOR SHELL AND SHRAPNEL.

Those on exhibition are for the most part arranged on four boards from Frankford Arsenal. The collection embraces most of those that were used during the war.

1. *Simple time fuzes* in wood, metal, and paper cases. These require the passage of flame over the outer end of the fuze to produce ignition. They are of wood, metal, or paper.

In the *wooden fuze* the burning composition is driven into a cylindrical hole bored in a conical plug which can be cut off to allow the desired length of burning. The specimens shown are for the 6 and 12-pounder guns, 8-in., 12-in., and 13-in. mortar.

In the *metal fuze* the composition is packed in an annular slot in a thick metal disk screw plug. The specimens shown are the Austrian, Babbitt, Bormann, Laidley-Bormann, and the Wright.

The *paper fuze* consists of a conical paper case, formed by rolling a triangular strip of stout paper around a cylindrical former, which when withdrawn leaves a cylindrical bore into which the fuze composition is driven. Some of the above fuzes have a priming of powder and quick-match to facilitate ignition.

The specimens of U. S. paper fuzes shown are for 4, 5, 8, 10, 12, 15, 20, 25, 30, 35, and 40 seconds, with two of Rebel make of 5 and 15 seconds.

The paper fuzes have to be inserted in *fuze plugs* hollow plugs of wood or metal driven or screwed into the fuze hole of the shell.

The wooden fuze plugs shown are for 6 and 12-pounder guns, 4½ in. Siege rifle, 13 in. mortar, 3-inch rifle, 10-inch sea-coast gun, and 8-inch sea-coast mortar. The metal plugs are of Dyer, Hotchkiss, and Parrott patterns.

2. *Special Time Fuzes* and Fuze Plugs.

These are fitted with special features, such as hoods to direct flame to the fuze, water caps to protect open fuzes from contact with water in burning, holes in fuze plugs to allow boring into paper fuze without removal, and igniters by which the shock of discharge sets fire to the time fuze without passage of flame over the projectile.

The igniters are the most important.

The following are the characteristic igniters, others differing rather in mechanical arrangement than in principle:

Laidley's igniter, still used in 3-inch rifle, consists of a small brass tube, closed at one end, filled with friction powder in which is embedded a roughened wire projecting at the open end and there weighted with lead. Two igniters are placed open end first in small holes bored in the front of the plug by the side of the time fuze hole, then, on the sudden forward motion of the shell at time of discharge, the lead weights hang back, drawing out the wires and igniting the friction powder. The fire is communicated to the time fuze through small holes near the closed end of igniter tube.

Stevens' igniter has a plunger, suspended by a loop in the front end. On firing, the plunger hangs back, breaks the loop and strikes a percussion composition in rear, igniting the time fuze. To the Stevens' class belongs the Russian fuze, described p. 836 War Department Report on the Centennial Exposition of 1876, the plunger being held in front by an axial wire, which is twisted and pulled apart by the discharge.

Armstrong's igniter contains a sphere of percussion composition which is crushed by the discharge, so igniting the time fuze.

The following fuzes of this class are shown: Parrot, with water cap; Hubbell, with water cap; Stevens, with igniter; Rebel, with igniter, wooden plug; Laidley, with igniter and water cap; Laidley, with igniter; Hotchkiss, with water cap; Hotchkiss, with igniter and water cap; 3-inch gun, with water cap; Foreign, with igniter and water cap; Arick, with igniter; Taylor, with hood; Sea-Coast, with water cap; Navy, with water cap; Navy, with water cap and bushing; Hotchkiss, with water cap and igniter; Navy, with water cap; Navy, with water cap; Adams' Hand Grenade, with igniter.

The following forms, though more strictly time fuzes, only, with special igniters, are placed on board I with combination fuzes: Sawyer's, Armstrong's, Shenkle's.

3. *Impact fuzes—concussion and percussion.*

Concussion fuzes are those that are ignited by the impact of the projectile at any point of its surface, and they are applicable to spherical projectiles. Percussion fuzes are especially suited to elongated projectiles, and they are fired by the impact when the projectile strikes head on.

In general, percussion fuzes act by means of a plunger, which moves forward in the projectile on impact, and either strikes a percussion composition or draws a roughened wire through a mass of friction powder.

Varieties of impact fuzes shown are the Absterdam, Butler, Curran, old pattern Hotchkiss, James, Janezeck and Simpson, Laidley, Parrott, Patterson, Shenkle, Petman, and several of Rebel pattern.

The latest and most approved form of percussion fuze, shown on a separate board prepared at Frankford Arsenal, is the new Hotchkiss, which combines the following principles, illustrated by the different fuzes mentioned above. Before discharge of piece, the plunger can not be moved by any ordinary shock, and can not come in contact with the primer. The shock of discharge forces the plunger back, leaving it free to move forward and strike the cap on impact.

HOTCHKISS BASE PERCUSSION FUZE.

This fuze consists of a brass screw plug, enclosing a plunger of lead surrounded by a brass band. A pin, slightly longer than the plunger, is embedded in the lead, with its point so far in, that it can not strike the cap in the front of the fuze. The shock of discharge drives the plunger back on the pin, leaving the point projecting to the front, the lead still holding it tight. On impact, the plunger is thrown forward and the projecting pin explodes the cap. This fuze is intended to be placed in the base of a shell, and it is made with a flange to act as a gas check and keep the powder gas from getting into the shell past the fuze. A front fuze, having the same kind of plunger, is also used by Hotchkiss.

4. *Combination Fuzes.*

This name is given to fuzes which, besides to the time fuze to explode the shell within a certain time, have a concussion or percussion device which will explode the shell on impact if the time fuze fails, or if the projectile strikes before the time fuze is burned through.

The following varieties are shown on board 4: McIntire, Woodbridge, Drake, Treadwell-Splingard, Clapp, Tice, Belgian, etc.

The Belgian illustrates the use of an annular time fuze in the combination.

TWO NEW FORMS ARE SHOWN ON SEPARATE BOARDS.

1st. New Armstrong Combination Fuze. (Received from New York Arsenal.)

This consists of a brass fuze plug containing, at the front end, a cylindrical metal plunger held in place by a soft copper wire connecting it radially on one side with the wall of the plug. A primer is placed in the base of the plunger. The shock of discharge shears off the wire, throwing the plunger back and striking the primer against a projecting pin. (See Figure 23.) This

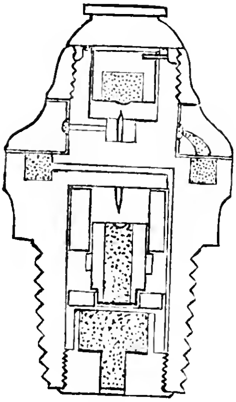


Fig. 23.

ignites a quick burning composition on the inner side of a movable ring, and flame communicates through a small hole with the *time fuze* composition which is packed in an annular slot in the body of the plug. The ring can be turned to bring the hole over any desired part of the time fuze, and give proper length of burning to 6 seconds. In the rear part of the plug is another plunger having a cap at the front end and a perforation through to the rear filled with quick powder. This plunger is double, consisting of a plunger of lead within a ring of brass. Before firing, the inner plunger which holds the primer is kept well to the rear of the cavity by a spring which surrounds it and keeps the outer ring forward. The shock of discharge drives the ring back, and on impact the whole plunger moves forward, the primer striking a pin projecting from the front of the cavity.

2nd Col. D. W. Flagler's Fuze. (Received from Frankford Arsenal.)

This fuze is like the Armstrong, in having two plungers, the time plunger in the front, and the impact plunger in rear (as shown in figure 24), but the means of holding them differ, and the fuze composition is arranged differently. The front plunger is held in place by an axial wire at the forward end, similar to that described in the Russian time fuze above. The rear plunger is made on the principle described in the new

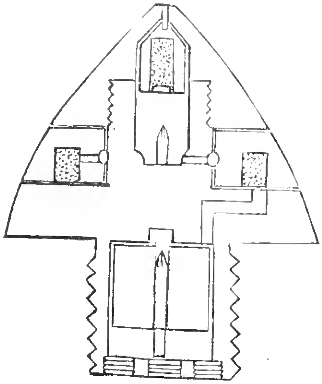


Fig. 24.

Hotchkiss percussion fuze. The fuze composition is contained in the movable ring itself, instead of in the body of the plug, and the latter has only a passage filled with quick powder leading to the interior of the shell. The parts are arranged to increase the sensitiveness of both the time and percussion parts, and especially to make them uniformly sensitive. A restraining disk protects the percussion igniter from the plunger when in the gun, and from pressures caused by the atmospheric retardation of the projectile during flight. This arrangement gives a very efficient and compact fuze, less than ¾ths the length of the Armstrong, enabling the point to be made more solid. It is graduated to burn up to 20 seconds.

PRIMERS FOR CANNON.

The *Service Friction Primer* consists of a small tube drawn from a flat disk of copper, filled with rifle powder and fitted with a branch tube at the closed end. This branch contains friction powder, and a serrated brass wire passes through it, ending in a loop outside. To fire the gun the long tube is inserted in the vent, and a lanyard is hooked to the loop of the wire. Pulling on the lanyard draws out the wire, igniting the composition by friction, discharging the powder and communicating fire to the charge in the gun. An improved lanyard having a sliding handle is shown. The lanyard is held taut, and the slide is brought sharply up against a knot on the top.

Electric Primers are also shown in various styles of manufacture. In these the tube is enlarged at the top for the insertion of an electric fuze, with wire connections for exploding the primer by electric battery or magneto-electric exploder.

Obturating Primers are shown on the same board. These primers are so constructed that they prevent the escape of gas through the vent in firing. The tube is made of brass, larger in diameter than the old primer, and a screw thread near the closed end allows them to be screwed in to the vent, enlarged and tapped at the outer end for this purpose. The gas pressure forces the mouth of the tube against the walls of the vent and prevents escape of gas, the action being similar to that of the metallic cartridge. They are of two kinds, friction and electric primers. A hole in the solid end admits the wire for the friction primer, or the insulated wires for the electric primer. In the friction primers the wire has a swelling within the tube to prevent its being drawn completely out, and this fills the hole after ignition, preventing escape of gas. The electric wires of the electric primer pass through a disk of insulating material—vulcanized fibre—which covers the aperture from the inside, and prevents escape of gas past the wires.

POWDER AND SMALL ARM AMMUNITION.

POWDER.

Specimens of powder of various grain are shown, from that used for small arms to the large blocks used for heavy guns. Samples of large grain powder—hexagonal, sphero-hexagonal, mammoth and cubical—with some of the prismatic perforated grains, both of black and brown ("coco") powder, were supplied through the courtesy of E. I. Dupont de Nemours & Co., Wilmington, Delaware; and cartridges such as are used for the U. S. 12-inch rifle were exhibited, made up of wooden blocks representing the prismatic grains. The two cartridges shown form one charge together, weighing 265 pounds.

ELONGATED BULLETS.

Most of these are arranged on boards received from the Military Academy, showing about 100 varieties, and embracing the French bullet for the carabine a tige, one of the earliest forms, made to rest on a pin projecting from the bottom of the bore, and forced into the rifling by blows of the ramrod; the Minnie bullet, 1855, made with a hollow base to allow expansion by pressure of powder in firing; Jennings, containing powder charge in base; the Austrian explosive bullet for blowing up ammunition chests; also many others, showing steps of improvement to the present day.

In addition to these bullets there is shown a steel bullet with a copper ring, like that on the Butler shot for heavy guns, to take the rifling. This was devised by Major Geo. W. Meker, Ordnance Department, to be fired from the .45 calibre service Springfield rifle in experiments on iron and steel plates of moderate thickness, for calculation of effect of large steel shot on heavy armor.

A bullet coated with copper, made at Colt's Armory as early as 1881, is also shown, with specimens of the new small calibre lead bullets sheathed with copper and steel, and one of very recent pattern wound with steel wire.

An interesting revolver bullet of recent invention is shown in Figure 25. This is made up of two parts, one solid forming the base, and one split at the rear into three sections, but united at the point. The figure shows the separ-

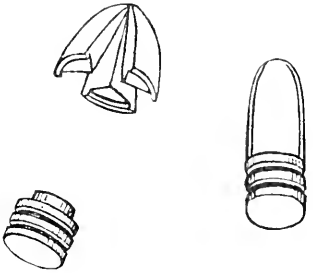


Fig. 25.

ate parts, and on their right the appearance of the whole bullet prepared for loading. In firing, the parts separate, and though the penetration is not very great, it is claimed that at short ranges it is very effective, particularly for mounted practice. This bullet is the invention of Capt. Henry T. Nowlan, 7th Cavalry, who claims that pistol practice should not be attempted by mounted men except at very short ranges.

SMALL ARM CARTRIDGES.

Fifty-six specimens of foreign and American cartridges are arranged on a board received from the Military Academy. These include, with many others, some of the earlier forms of self-primed cartridges; the needle gun cartridge; Morse's American cartridge, with metallic shell and rubber base, 1858; Boxer cartridge, thin brass, wrapped, with iron head, for Martini-Henry rifle. Besides these there is a large collection giving an historical series, to show the progressive stages of manufacture from early cartridges for muzzle loaders to the latest cartridges for modern breech loaders. All but the new small calibre cartridges in this collection are from Frankford Arsenal.

1. Paper ammunition, not fixed.

Round and elongated bullet and buckshot cartridges; powder and bullet wrapped in a paper cover. Twenty-five specimens.

2. Paper and linen ammunition, fixed.

Wrapper round the powder inflammable. Could be inserted whole. Used both for muzzle-loaders and for the earlier breech-loaders. Cartridges for Merrit's, Hall's, Sharp's, Colt's, and Starr's arms are noted. Twenty-nine specimens.

3. Transition from inflammable wrapper to metallic cartridges.

This includes the Gallagher foil cartridge; the Maynard brass shell cartridge, with a flange at rear, as in modern cartridges, but having no priming a central perforation in the base admitting flame from a primer fired on a nipple outside the barrel; the Burnside copper shell cartridge, with flange at forward end, and central perforation at base; also some foreign gun cartridges. Thirty-seven specimens.

4. Early self-primed cartridges, rim-primed and center-primed cartridges.

Poulney brass-foil, with iron base; Crispin zinc-foil; Hotchkiss solid head, pressed up from solid base; Remington-Martin base; Winchester (Milbank primer). The primer is a flanged percussion cap inserted in a pocket without anvil; United States Cartridge Company solid head, both inside and outside primed cartridges; Berdan, early forms with outside pocket, and impressed shallow cup; Mead's explosive bullet cartridge; Spencer; Ballard; Morse; Henry; various experimental cartridges, including Col. Laidley's; and several pistol cartridges by various makers, including inside and outside cap, teat and rim-primed cartridges.

5. Foreign and sporting cartridges, metallic, etc.

English Boxer, Snyder; English Boxer, Henry; French chassepot and mitrailleuse, pasteboard, with metal base; Prussian needle gun, paper cylinder, choked in front of bullet; Austrian "Werndl," with annular copper anvil; Dutch Beaumont, with solid brass head and pocket, cap with anvil primer; Swiss Vetterlin, rim-primed; and various sporting cartridges for shot, nearly all pasteboard with metal base, pocket and anvil primed.

6 Modifications made in the charge. (Cal. .50 cartridges.)

Charges of Oriental, Hazard, and Du Pont musket powders, 70 grains. These show the various effects of compressing the charge, either from front, rear, or from both ends, and either perforating it from end to end, or leaving a conical rear cavity; Sleeper's chlorate powder is also shown in charges of from 15 to 30 grains, as is also Gomez's iron gun-powder.

7. Modifications in bullet and lubricant.

These show the various effects of deepening the cannelures to hold more lubricant; use of two broad cannelures instead of three; use of lubricant with wad under the bullet, either alone or in addition to lubricant in the cannelures; use of a front lubricant; patching bullet with bank-note paper; and use of bullet hardened by the addition of tin.

Various forms of bullets are also shown, the usual one being the frustum of a cone on a cylinder; various reductions in weight are also made, usually by conical cavity in base.

8. Center primed cartridges, disk and bar anvils.

These show the center swell base, copper disk anvil, two vents, short case; Martin straight bar reinforce, tinned iron, with reinforce copper cup held in by indents in wall of shell; various disk and bar anvils of copper or iron, held in by indents or re-entrant fold; and the Martin pocket with re-entrant fold.

Cap-primed cases are included. These show the solid nipple-head in brass pocket in base of case; various star and cup cap-receivers; front ignition cases; the Laidley arch anvil; Treadwell cube anvil; Berdan anvil; and cup anvils. One of the earliest was the Benét, 1866. One of Berdan's early models was made on the same principle.

They also comprise the tinned cup anvil, held in by crimps or indents; side vent cup anvil; corrugated base, copper cup anvil; copper cup anvils of various shapes; Treadwell's open base, with double cup; Berdan solid head teat anvil, and various cup anvil ammunition for pistols.

9. Modifications in calibre. Reductions.

Nearly all the first bullets of .45 calibre are in bottle-shaped cases, either for 70 or 80 grains charge, weighing from 400 to 425 grains; they are nearly all cannelured, with cases about 2.5 inches long. The bullets for the .42 cal. are used with from 70 to 80 grains of powder, and weigh from 350 to 385 grains. The early forms all appear in bottle-shaped cases, and are nearly all cannelured. The .40 cal., nearly all in straight cases, are used with from 65 to 80 grains of powder, and weigh from 290 to 350 grains. They nearly all have four or five cannelures.

10. Folded head, centre-primed cartridges; calibre, .75; non-reloading, showing stages of manufacture.

The shell is slightly tapering from flange to bullet, where it becomes cylindrical and extends to cover the cannelures. It is made from a thin plate of copper. First a disk is punched out and slightly cupped in a single machine. The cup is then drawn out more and more, becoming of smaller and smaller diameter by successive operations. It is then trimmed to length, and the head is formed by a press which buckles out the metal at the sides of the closed end, forming a folded flange. A perforated cup anvil with a shallow pocket in the bottom is inserted and pushed down, being fixed in place by crimps made just in front of it at two opposite points in the wall of the shell. The bullet weighs 404 grains; charge of powder for carbine, 55 grains; for rifle, 70 grains, the same shell being used for both, with wads behind bullet in the former to fill the space and give the cartridge the same size. The bullet is made from round cast bars of lead and tin; 16 parts lead to 1 of tin. These are rolled down to size, and then a single machine cuts to lengths and forms a bullet from each length between three dies, one die for the base and two for the sides. There are three shallow cannelures for lubricant.

Samples are given of carbine, rifle and revolver shells and bullets, showing stages of manufacture.

11. U. S. service cartridge; calibre, .45.

This differs from those just described, in being made with a solid flange at the head, and arranged for the insertion of a primer from the outside, so that the shell can be reprimed and reloaded. It has usually been made of copper, but it is now made of brass. It is made from thicker metal than the folded head cartridge. The sheet from which the disks are punched is shown, with the various stages in development of the tube, primer and bullet. (See Figure 26.) Weight of bullet, 500 grains; weight of powder, 70 grains.

12. *The Morse Shell* of service size.

This has a movable base, with rubber packing. It is a folded head brass shell, with the centre of the base cut out for the insertion of a solid cup containing an outside primer. (See Figure 27.) A rubber ring inside covers the joint. With the solid head cartridge, expansion of the front part caused it to clamp against the wall of the chamber, the pressure on the base tending to pull it away from the front part so held. This caused breaking, particularly with copper shells. The Morse shell was designed to obviate this trouble, and it is now undergoing trial to see whether the complication of parts and form

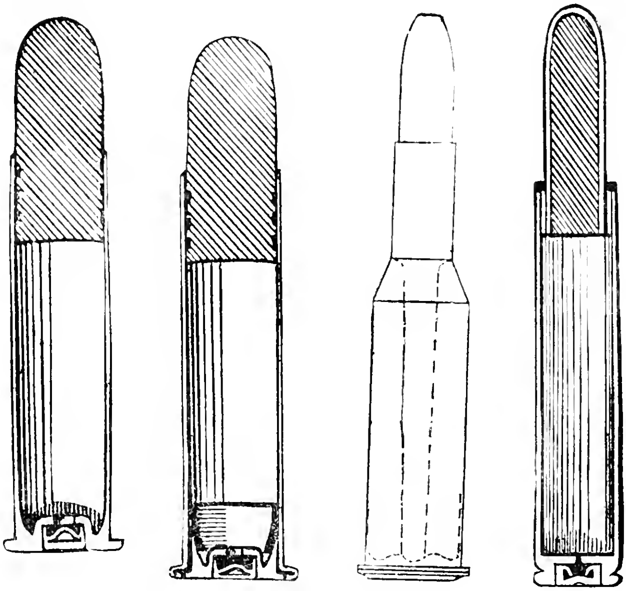


Fig. 26. Fig. 27. Fig. 28. Fig. 29.

of shell introduce other objections greater than the above, in reloading shells. Shells are reloaded by the soldier, and it is very important to have them last for many reloadings.

NEW SMALL CALIBRE CARTRIDGES.

The tendency to reduction of calibre has been constant from the old musket calibre, 70-100ths of an inch, to the prevailing calibres of recent years, .45 (the U. S. calibre) to .40.

To Professor Hebler, of Germany, and Major Rubin, of Switzerland, is due the credit of experiments within the last ten years which have led to recent reduction of calibres in Europe. The limit of advantage in reduction seems to be about .295 inches, and a calibre of about .31 is regarded as the best. The object of reduction, besides the saving in weight of cartridges and of space occupied by them in packing, and the diminution of recoil, lies in the flatter trajectory obtained with a bullet of diameter so slight as compared with its length. Such a bullet in moving point on suffers less resistance from the air in proportion to the weight, since the weight of projectile compared with resisting surface is greater. The retardation of the bullet is therefore less. Moreover, the area of the longitudinal section is greater in relation to the weight, and this increases the effect of the air in retarding the drop of the bullet. The result is that the velocity given it in the gun is maintained longer and the drop is less over a given range, as well as in a given time, making the path of the bullet straighter and increasing the "dangerous space," or the distance over which, for aim at any particular range, the bullet would keep within a man's height from the ground. This effect is augmented by greatly increasing the charge in comparison with the weight of the bullet, or by using a higher explosive, and so getting greater initial velocity: 1800 to 2000 feet per second, instead of 1300 to 1400 feet. To keep a long, thin bullet point on in its flight requires an increased rate of rotation, and the twist of the rifling is increased to 1 turn in 9 or 10 inches, while the twist in our service rifle is 1 turn in 30 inches. Lead bullets, unprotected, will not stand this under high charges without stripping, so the lead bullet is sheathed with copper or steel, and this covering assists too in penetration. A copper covered bullet recovered from wood into which it had been fired is shown. It bears the marks of the rifling, but shows no deformation. The Hebler and Rubin cartridges differ in details as follows:

13. The Hebler cartridge.

In one form of this cartridge the case is of steel, nickel-plated, with a copper head which contains the center-fire capsule and expands to serve as a gas check. The charge of powder, 83 grains, is compressed in the case, and has a central canal for the rapid ignition of the whole charge. It is arranged in layers of different densities, to give greater uniformity of pressure by increasing the rate of burning toward the end. The form shown in the exhibit, from the National Armory, represented actual size in figure 28, has a brass, solid-head, bottle-shape shell, with the usual flange.

The Lorenz bullet, used with these cartridges, is covered with a thin steel jacket, nickel-plated. This jacket is drawn and pressed into shape, tinned inside, and filled with compressed pieces of soft lead slightly hardened by tin and antimony. The whole is then heated to melt the lead and cause it to unite with the wall of the cover, and the lead is afterwards compressed and solidified. The steel jacket is tempered at the point, but it is softer at the sides. Six thousand rounds have been fired from a rifle without perceptible wear or injury to the grooves, the bullet taking the grooves perfectly. The bullet has no cannelures.

The following figures regarding the Hebler bullet, calibre, .295, are taken from various sources: Initial velocity, 1850 feet; weight of bullet, 224 grains; weight of charge, 83 grains; weight of cartridge complete, 521 grains; length of bullet, 4.46 calibres.

Penetration of Hebler at muzzle, 39.4 inches in pine; at distance of 2,500 metres, 2¾ inches. Of Mauser, at muzzle, 9.5 inches; at 1,600 metres, 2.16 inches.

The *Lebel rifle cartridge*, of the Hebler pattern, is said to be as follows: Length of bullet, 1.32 inches; total length of case, 3.07 inches; calibre, .304; weight, 211.12 grains. Front lubricant is supposed to be used.

This cartridge has a smokeless powder, but its composition it not definitely known, and there is some doubt about its standing storage and answering the requirements of service.

It is said that experiments on animals demonstrate that the wound caused by a Hebler bullet is much less serious than that from others, as the Hebler bullet makes a clean hole, while the others make ragged and splintered holes, producing wounds that remain serious for years even if vital parts are not struck. In one case, a man shot by a Hebler bullet in the upper left arm entirely recovered in three months, though he was *hors de combat* for two months. It is held to be better to wound than to kill. A dead man requires burial only; a wounded man needs the assistance of two others, is an additional expense to the State, and can render no service for a long time.

14. The Rubin cartridge; lead bullet, copper covered.

Two specimens are shown, of form indicated in Figure 29; one from the National Armory, and one presented by Herr Schulhoff and Major Glentworth, of the Austrian service. This is used in the Schulhoff magazine gun, shown in the exhibit, as well as in the Rubin rifle, of which a trial is now being made at the National Armory. This shell is of a novel pattern. It is made without a projecting flange, a groove for the extractor to engage in being cut round the base, which is made thicker to give room for it. The walls of the shell are thick, and at the mouth this is increased by an inner ring, forming a shoulder round the bullet, and this, with the taper of the shell, prevents forcing the cartridge too far into the firing chamber. One advantage of this form of shell in box magazines is obvious, as no care has to be taken to keep the flanges of the cartridges from catching on each other to prevent pushing the top one forward in loading the piece. The Schulhoff gun is also made to fire the Hebler flanged cartridge.

The following information regarding the Rubin cartridge, of form shown in Figure 29, is derived from experiments in this country with the Rubin rifle: Calibre, .29.5 inches. The charge is ordinary grain powder, compressed, with an axial perforation. Weight of powder, 69.48 grains; weight of projectile, 216.16 grains; velocity, 50 feet from muzzle, 1800 feet per second; maximum penetration in soft pine, 17 inches at 500 yards; 9.78 inches at 1000 yards; ordinates in firing at 500 yard target, 100 yards, 2.97 feet; 200 yards, 4.8; 300 yards, 5.49; 400 yards, 3.73; maximum ordinate firing at 1000 yard target, 31.226.

15. The Hurst accelerating cartridge; calibre, .32.

A cartridge invented by H. P. Hurst, of Mississippi, has recently attracted considerable attention. (It is shown only by drawings and description.) Remarkable results are to be expected from such a cartridge, with the weight of charge nearly double that of the projectile.

The base of the cartridge shell has attached to it a strong central tube, which contains the initial charge of powder, and extends beyond it over nearly all of the cylindrical portion of the bullet. Outside of this case is disposed a second charge, composed of rings of compressed powder considerably less in diameter than the chamber of the gun. The bullets are made of steel, and are of various lengths. The firing of the central charge is effected in the usual manner, and the bullet is driven from the tube, but the very instant it is clear, the flame is communicated to the second charge, and the projectile leaves the bore with a greatly accelerated velocity.

A collection of *cartridge primers* and parts of primer is shown, embracing different varieties—Berdan, Orcutt, Sharp, Wesson, etc.

SIGHTS, APPENDAGES, ETC.

1. Lorain telescope sight for heavy guns.

This is practically a surveyor's field transit instrument, with vertical and horizontal limbs; the vertical for adjusting the angle of elevation, and the horizontal limb to give allowance for wind and drift. This sight is intended to be placed on the left trunnion, with the horizontal limb parallel to the plane passing through the axis of the trunnion and the axis of the piece, no allowance being made for inclination of the platform. When the horizontal limb is set at the zero mark, the vertical limb is parallel to the vertical plane of fire, and this adjustment being made, setting the vertical limb at the zero of its scale should bring the line of collimation of the telescope parallel to the axis of the piece. It is only when firing at a target on a level with the gun that the elevation reading for any range will be the same as that required with the quadrant, as the reading gives the angle made with the axis of the piece and not with the horizontal. The vertical reading for the telescope sight will be greater than with the quadrant when the firing point is above the target, and less when the firing point is below.

From Fort Monroe. Designed by the late Maj. Lorain, U. S. Army.

2. Zalinski telescope sight for sea coast guns.

This sight has an adjustment for want of level of the platform. The frame carrying the telescope and its vertical and horizontal limbs has on the right side a round trunnion-bar, which rests in bearings on the face of the left trunnion, the axis of this bar being parallel to the axis of the piece. A thumb-screw lower down on the frame bears against the face of the trunnion to level the sight horizontally. Fixed to the frame by a horizontal axis, opposite the front end of the axis of the trunnion-bar, is a plate which holds the vertical limb, and attached to this at the front by a vertical pivot is a plate which revolves horizontally, and carries the telescope on Y's, the optical center of the object glass being over the vertical pivot. Verniers allow setting the limbs to minutes of arc. Levels for adjustment are placed, one longitudinally under the telescope, and one laterally on the frame which directly supports the telescope. The bar is hollow to serve as an ordinary peep sight. Fixed and movable cross-hairs, the latter moved by a micrometer screw, serve to give a range finder by measuring the angular depression of the mark below the gun, or its elevation above, the distance being a function of this angle and the known height of the gun above the water level.

From Fort Monroe. Designed by Capt. E. L. Zalinski, 5th Artillery.

3. Two double-reflecting sights for heavy guns.

The reflectors are fastened to the top of a graduated stem, which passes up and down through a socket attached to the breech. A lateral movement of the rear sight in front of the reflector gives allowance for wind, etc. The gunner stands behind the piece, sheltered by the parapet.

4. Phipps-Quinan sight for field guns.

This is a tangent sight with its stem made to slide laterally on a hollow block, which turns round an axis parallel to the axis of the piece. The block rests in the curved top of a standard, which is set in a socket fastened to the rear of the piece. A level on the block serves to set the stem in a vertical plane passing through the top of the front sight, this point being so placed that the line joining it with the axis of rotation of the block is parallel to the axis of the piece. This makes it practicable to sight correctly whether the wheels are on the same level or not, and in this particular it serves the same purpose as the old pendulum *hausse*, kept vertical by gravity. It is more stable in position than the latter, however, and it admits adjustment for wind and drift by the lateral movement. The sight-slide is moved up and down by a screw running the length of the stem.

From West Point.

5. Kelton's rear sight for rifles.

This has a rear skeleton leaf, the inclination of which is regulated by a shaft turned by a milled head at the right. A slide on the leaf carries a wind gauge. The object of the arrangement is to give the means of getting the sight quickly for any elevation.

6. Sight of Lebel rifle.

This sight has an inclined hinged leaf, with slide, and it seems to be similar to the old pattern sight of the U. S. service. The base is provided with five steps, against which leans the leaf, supported by the slide, for distances of from 100 to 800 metres. The leaf carries graduations of from 900 to 1,900 metres, and has on its top the notch for 2,000 metres, the highest contemplated range. When the leaf is lowered, a short sight projecting from its face near the hinge is available for ranges up to 350 metres.

7 Sight for Mauser rifle.

The rear sight consists of two sight leaves hinged to the sight mass by a movable pin. The small leaf is just in rear of the long one. The latter is kept steady when vertical by a flat spring below. It is a skeleton leaf having side bars which are graduated up to 1,600 meters. A plate enveloping the long leaf slides up and down, its lower edge being brought to the required graduation on the leaf, and held there by a spring. The plate has a notch at the top for long range sighting, and two sighting holes lower down. Besides the two leaves, there is a short standing sight, which is used for distances less than 270 metres when the two leaves are turned down. The small leaf serves for 350 metres; the long one for distances from 400 up to 1,600 metres. The sights are kept dark dull to avoid any errors in the aim by deceptive light. There is no adjustment for wind and drift.

8 Buffington sight for service Springfield rifle and carbine

This sight is shown in figure 30. It resembles the Mauser, in having a long hinged skeleton leaf, held in an upright position by a spring below, and in having a slide plate perforated with sighting holes, but the slide moves

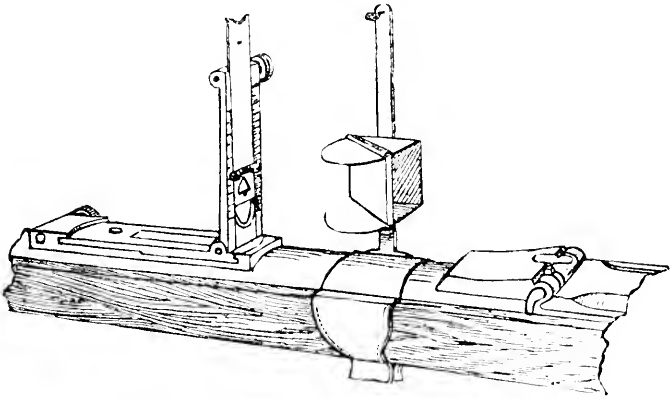


Fig. 30.

within the leaf instead of enveloping it, and a clamp screw at the top of the leaf holds the slide from jumping up in firing. Besides provision for upper and lower open sights, upper and lower peep-sight holes are made in the plate. When the leaf is down, a small sight projecting from its face serves for short range. The following important additions are made:

Compensation for drift. The guides in which the slide moves are inclined to the left, so that the sight holes move to the left slightly in going up, giving an automatic allowance for drift, and leaving only the wind to be considered by the soldier. This is the first application of this principle to sights for small arms, though it is used on some of the Navy sights for heavy guns.

Wind gauge. The leaf is hinged to a swinging plate pivoted to the sight mass or base, as indicated in the figure, and a worm turned by a milled head on the right side of the base at the front engages in the front curved edge of the plate to turn it, thereby moving the sight to the right or left to allow for wind.

9. Belgian aiming device for teaching recruits.

This is shown in rear of the Buffington sight in figure 30. It consists of an upright bar, which is fastened to the side of the gun by a curved spring clamp covered with leather, and it can be easily slipped on and off the gun. The bar has a sliding frame, which moves up and down, carrying a piece of smoky glass, held in a vertical position, but inclined to the axis of the gun so that a person standing at the side can see in it the reflection of the front and rear sights. This glass, however, allows the soldier to look through from the rear in aiming, so that both the recruit and his instructor can sight at the same time, and the latter can correct the errors made by the former. It is a great improvement over the old method of using a sand bag to steady the piece and having first the recruit and then the instructor look along the sights, as it is very difficult to keep the gun steady in place on the sand bag. Lt. Col. Andrew Burt, of the 7th Infantry, suggests the use of a cross level in connection with this device, to insure keeping the sight leaf vertical. The inclination of the sides of the sight slide renders this somewhat difficult in sighting at long ranges with the slide well up. The Mauser enveloping slide, with leaf instead of slide inclined, would remain vertical and allow putting the clamp screw at the bottom of the slide to serve as a handle, instead of at the top of the leaf where it requires both hands to set the sight.

From Ordnance Office.

10. Buffington headless shell extractor and gun cleaner.

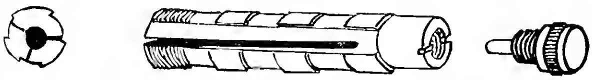


Fig. 31.

This device, lately adopted in the U. S. service for removing from the bore and chamber empty shells with heads pulled off, is shown in figure 31. It consists of two parts, the extractor proper shown in the middle of the figure, and a small drift shown at the right. The extractor proper is a hollow cylinder of tempered steel, rifled on the exterior to correspond with the rifling of the barrel. Four transverse grooves are cut in the projecting ridges. One end is divided by three longitudinal slits which can be expanded slightly by forcing in the drift. At the end of the prongs a screw thread is cut. The other end is tapped to hold the drift when its use is not required. A section of the prong end is shown at the left of the figure. To drive out a shell stuck in the rifled part of the bore the extractor is pushed into the muzzle, drift end first, and through the bore. If the shell is in the chamber, the drift has to be used. It is unscrewed and the extractor is inserted at the breech, prong end first. The breech is then closed and the drift is pushed down, small end first, from the muzzle, and driven in between the prongs. This sets the prongs out, and the screw threads at the end bite into the shell. Opening the breech, the extractor and shell can be driven out to the rear together. The extractor passed through the bore serves to clean it.

11. Russell inspecting glass for Springfield rifles and carbines.

Figure 32 is a perspective view, from the front and above. Figure 33 a longitudinal section through the receiver and through the instrument when in position, with a side view of breech-block.

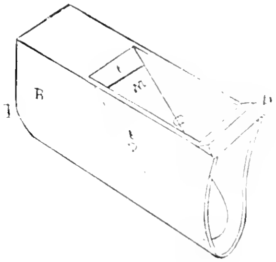


Fig. 32.

A brass frame, shaped to fit in the receiver, holds an inclined mirror, M, by which the inspector, looking in above, obtains the reflected image of the bore and chamber from the rear. For inspection from the muzzle, it serves to throw light in at the breech to illumine the bore. A bar in front, across the top of the frame, holds the breech-block open.

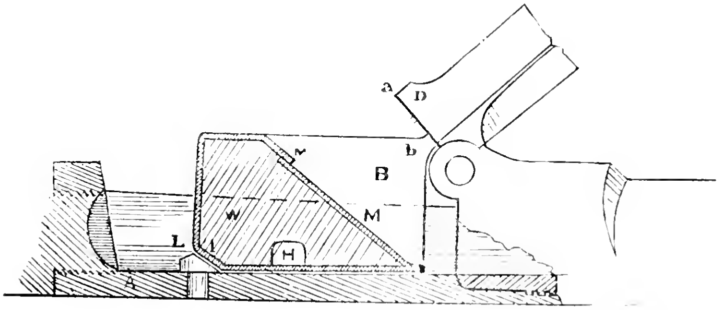


Fig. 33.

12. Devices for sighting through thick walls.

These give a wide field of view with very small apertures in the front and rear faces of the wall.

RANGE FINDERS.

These are instruments for quickly determining the distance of a target in order to set the sights of the guns for the proper range. With the exception of the Gordon, all that are shown in the exhibit are pocket instruments. They all depend on the principles of double reflection. If two plane mirrors are inclined to each other, as in figure 34, at any angle, a ray of light reflected from one surface after the other will change direction by an angle equal to twice the angle made by the mirrors, and turning both mirrors together does not change this angle. If a triangular prism is used, as represented in figure 35; suppose the ray enters one of the short faces where it is bent by refraction,

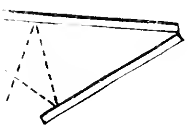


Fig. 34.

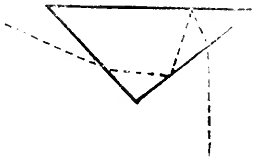


Fig. 35.

and that it passes to the silvered back, where it is reflected to the first surface again with greater inclination than before, and reflected again from that surface, passing out at the third surface. If the front angle of the prism is equal to twice the angle made by the reflecting surfaces, the deflection will also be equal to twice the latter angle as with plane mirrors, the bending of the ray at the surfaces of entrance and emergence being the same and in opposite directions. The reflecting angle used for both mirrors and prisms is generally about 45 deg., to give a deflection of about 90 deg. For such angles it is unnecessary to silver the first face to produce reflection, as the ray coming from the back surface strikes it at an angle which gives total reflection without silvering.

The prism will give only one angle, but when once constructed it is invariable. The angles between the mirrors can be varied at will, and both fixed and variable angle instruments are made with mirrors, but they require frequent adjustment. The dotted lines in figures 34 and 35 indicate the course of a ray, and an observer at one end can see by reflection a side object apparently in the direction of the line he is sighting on. This enables him to lay off the given angle, by glancing over the top edge of the instrument at the same time that he is looking through; and so to establish a marker at such a position with reference to any object, that the difference of direction of the two points from the observer will be equal to the given angle. He can also, by moving about, place himself in such a position as to make the bearings of two objects from his position differ by this angle.

FIXED ANGLE INSTRUMENTS.

1. The Weldon range finder.

This is a prism instrument giving an angle of 88° 34′ 3″. It is adopted in the English service under the above name, but it is really a German device, described, if not invented, by Bauernfeind. Figure 36 shows the Weldon

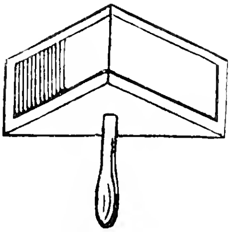


Fig. 36.

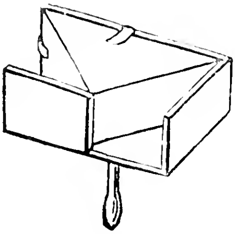


Fig. 37.

mounting, a brass frame covering the back and the upper and lower surfaces. A handle is placed below. Figure 37 shows the form of mounting devised in the U. S. Army. The top of the glass is left uncovered, so that the object seen over the instrument may come in close contact vertically with the image seen in the prism. Wings are placed on the frame to cut off unnecessary and confusing reflections from the outer surfaces, and to indicate the direction in which the observer should look into the prism.

Weldon also used two plane mirrors, fixed at an inclination which would give the same deflection.

Following a suggestion made in official publications of the U. S. Ordnance

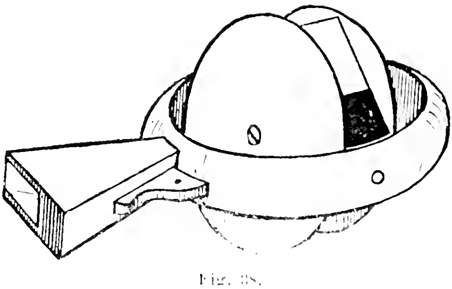


Fig. 38.

Department, Weldon combined three prisms, one giving an angle of 90° one of 88° 51′ 5″; and the other of 88° 5′ 12″. This is shown in figure 38

A ring carries a circular frame swung to turn within it, and two of the prisms are fixed back to back in the frame. A handle to the ring holds the third prism. This is the form now used in the English service. It was furnished for exhibition by Queen & Co., Philadelphia. The mounting resembles that of Bauernfeind for a single prism. See Ordnance notes 134, 162 and 170.

2. The Russell range finder.

This consists of a single prism with six sides. By looking into this in different directions, any one of three different angles can be obtained, 90°; 88° 34′ 3″; or 91° 25′ 57″, the supplement of the second. The prism is mounted in a frame, as shown in figure 39, leaving apertures at certain places for observation, the top being uncovered. This frame is placed in a circular box, open at the top and on one side. The frame revolves in the box round

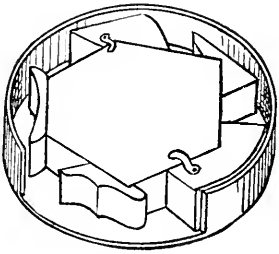


Fig. 39.

a pin in the center of the bottom, to uncover through the side opening two apertures in the frame at the same time and allow observation of either required angle, but prevent direct sight through. A spring stop underneath holds the frame in each of the three positions, and the outline given to the frame between the different faces of the prism indicates to the touch what angle can be observed at the opening. This one prism performs the office of the three Weldon prisms combined.

3. The Pratt range finder.

The Pratt range finder consists of a frame holding two small mirrors above and two below; the upper mirrors making an angle of 45° with each other, and the lower an angle of 43° 34′ 7.5″, for laying off an angle of 87° 8′ 15″. This range finder comes in a neat case, and has a small handle below for convenience of use. Figure 40 represents this instrument. Sections of the upper and lower mirrors are shown above and below, and in the middle is a perspective view. This was invented by Lt. Sedgwick Pratt, 3d Artillery, who has devised new and valuable methods of observation.

Furnished from Fort Monroe.

With instruments giving but one angle, it is desirable to have two observers, each one with an instrument. One observer lays off the angle from the mark, and ranges the other observer on his line of sight. The second observer, facing him, moves back and forth on this line till he sees the mark reflected from the direction of the first observer. The distance between observers, multiplied by 20, gives the range of the mark from either.

With instruments giving three angles, one observer is able to do the work alone. If he lays off from the mark, with the instrument, the largest angle, and then moves back on his line of sight until he sees the reflection of the

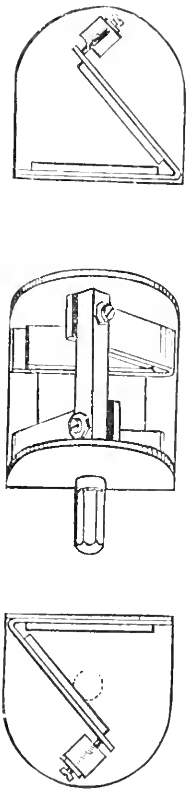
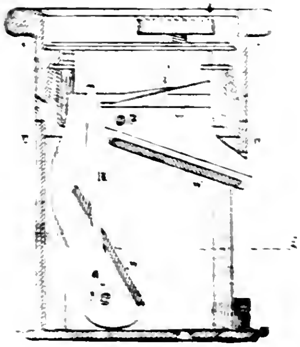
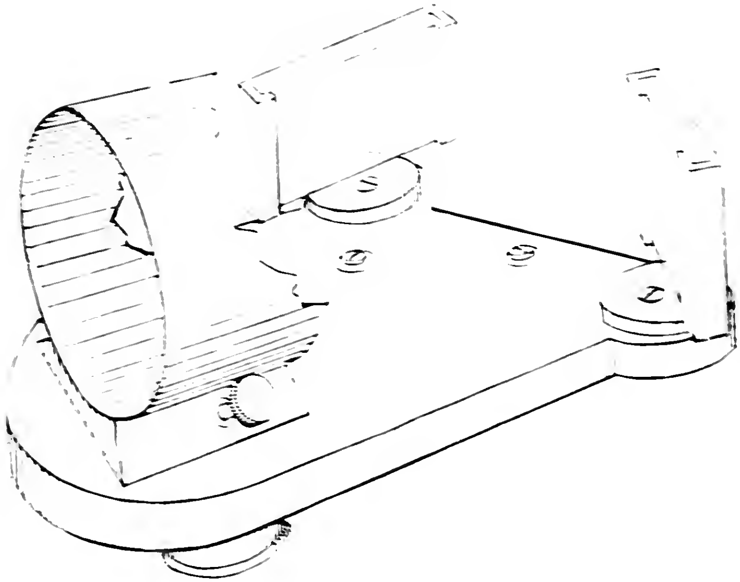


Fig. 40.

mark from the same point as before, using either of the other angles, the range can be found by multiplying the distance by 20 or by 40, according to the smaller angle used. With the Pratt range finder, giving two angles and used in like manner, the multiplier is 20. Weldon seems to use 50 and 30 as multipliers.





that the angle may be varied [illegible]
The object is first observed with the [illegible] angle of 45 degrees and the observer then moves 30 metres back along the line of sight and rotates the ring until the mark is reflected from the same point again. A graduated scale on the ring gives the desired distance [illegible]. A cord 30 metres long is used to fix the base. A second instrument [illegible] which has a telescope attached. Both Labbez instruments were furnished by Queen & Co., Philadelphia.

5. The Gordon range finder.

This consists of a horizontal plate holding two vertical mirrors and provided with a short tube which can be adjusted to the eye [illegible] a field glass. The reflectors cover one-half the object [illegible] and one eye [illegible] is used in sighting. One of the mirrors can be moved about a vertical axis by means of a nut under the plate. This turns a cam operating on a lever and a graduated disk attached to the nut gives the reading. The rotation of the plate being much greater than that of the mirror, the reading can easily be taken. Fig-

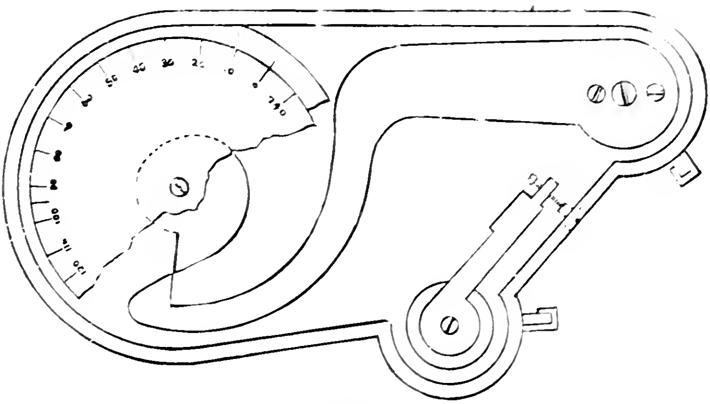


Fig. 43.

ure 42 gives a perspective view and figure 43 shows the arrangement of the cam, disk, and levers from below. The second mirror is adjustable by means of the screw and lever shown in the latter figure. This instrument is the invention of Lieutenant W. B. Gordon, Ordnance Department.

From Fort Monroe.

6. New reflecting instrument.

A reflecting instrument [illegible] the angular movement of the [illegible] one-half that angle as in the [illegible] sextant and other reflecting instruments.

SHOOTING GALLERY.

This is in a shed outside the building, near the office of the Navy Department. In it is shown a collection of ballistic apparatus for determining the pressure of powder in the bore of cannon, and the velocity and motion of projectiles. Also, the methods used in the army for reloading small arm cartridge shells, with the different targets in service. The early methods of obtaining the velocity of projectiles and determining pressures, were very laborious and far from accurate. Velocity was determined by firing a shot against a pendulum suspended in front of the gun, noting the swing of the pendulum and then calculating what velocity the shot must have had to produce this swing. For obtaining pressures the same instrument was used with such an arrangement as the Bomford and Warde gun in the exhibit, constructed as described below; or the gun itself was suspended from a frame forming a pendulum. Its swing on firing the gun was noted, and then the pressure that must have been exerted to produce this swing was calculated. So many allowances had to be made for uncertain influences that poor results followed.

PRESSURE OF POWDER IN GUNS.

1. Bomford and Wade's experimental gun, 3 in. cast iron, illustrating early methods of obtaining powder pressures.

Used by these officers of ordnance in 1841 to determine the proper exterior form of cannon. It has screw holes through the sides at regular intervals between the chamber and the muzzle, with steel screw plugs to fill them. One of these plugs is perforated, and it can be set in any hole, the other holes being filled with solid plugs. Steel balls of standard weight were shot from this perforated plug at successive points along the line of the bore, being projected by the force produced in the gun by firing it loaded in the usual manner. The balls were fired into a small ballistic pendulum. The thickness of new cannon was proportioned to the observed velocity at any point. These experiments served to determine the form of the Columbiads, model 1842, which, with slight changes of form and the introduction of the Rodman method of casting, afterward became our standard patterns of heavy, smooth-bore ordnance. These experiments were repeated in Europe by Cavalli in 1843. From West Point.

2. Rodman "cutting" pressure gauge; American.

This was the first device for measuring direct pressure. It consists of a hollow, cylindrical block, having a round pin or piston extending nearly through a hole in one head, in which it fits closely, and carrying on the inner end a curved or wedge-shaped knife, which rests against a disk of copper within; the other head being closed by a screw-cap supporting the copper, and having a copper ring in the joint to keep gas from entering the cavity. A cup of copper fits in the hole on the outer end of the piston to act as gas check there. This instrument is placed in the bottom of the bore in rear of the cartridge, and in firing the gun the gas pressure forces in the piston and presses the knife into the copper. The knife is so shaped as to make the cut larger the deeper in it goes, so that measuring the length of cut gives the relative pressures in different cases, by comparison with lengths of cut made by static pressure. From New York Arsenal.

3. Noble's "crusher" pressure gauge.

This instrument is of the same general construction as the Rodman, so far as piston and screw-cap are concerned, but a flat head is substituted for a knife on the inner end of the piston, and small cylinders of copper for the disk. These cylinders are compressed different amounts for different pressures, giving a means of comparison. A series of coppers for pressures from 15,000 to 50,000 pounds per square inch is shown.

From New York Arsenal.

MEASUREMENT OF VELOCITY.

Instead of the ballistic pendulum referred to above, electricity is now used, and the methods are illustrated practically in the shooting gallery.

4. Targets for velocity instruments.

The target connections are the same for the two instruments used in the gallery. The bullet on leaving the gun cuts a small copper wire stretched across the muzzle, this wire being in an electric circuit connecting with the instrument. This is called the 1st target. At a distance of 21 feet in front of

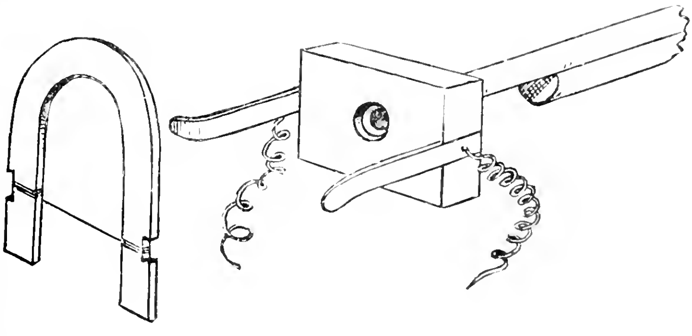


Fig. 11.

the muzzle is placed an iron plate, here referred to as the 2d target, and on the back of this plate, insulated from it, is a brass disk, fastened to which, but insulated from it at the fixed end, is a spring which presses at the free end against the disk. Disk and spring are attached to the opposite poles of another battery, so that electric connection is made at the point of contact of the spring, for a second circuit passing also to the instrument. When the bullet strikes the plate the spring is jarred away from the disk, breaking the circuit. The arrangement of the 1st target is illustrated in figure 44. In carrying out this design, similar to but more compact than one put in use at Frankford Arsenal, much assistance was derived from Mr. Luke Lilley, electrician of the Exposition. A block of vulcanite was perforated to fit over the end of the barrel, as shown in the figure, and at each side, projecting forward, is a brass spring, these springs being connected with opposite poles of the 1st circuit. A thin piece of vulcanite in shape of a horse-shoe, as indicated in front of the springs, has a fine copper wire passing from arm to arm, and wound round each arm in sockets which fit the springs, so that when this movable piece is pushed up close to the block, and held by the springs, the wire lies across the muzzle, and coming in contact with the springs completes the electrical circuit. Several of these connecting pieces are prepared beforehand, and when the wire of one is broken, another piece is quickly substituted. The spring at the 2d target re-makes the circuit automatically after breaking.

The .22 calibre Colt Magazine gun, described above, is used for these experiments, as only small charges and bullets would be safe. The space passed over by the bullet is enclosed with a wire netting, which leaves a passage down to the second target for inspection of the electric connection on the back. A fixed rest supports the gun. This is such as is used for testing at Frankford Arsenal, to secure steadiness of the piece. It consists of a heavy frame which can be turned about both vertical and horizontal axes at the front, and it has running lengthwise a slide, to which the gun is attached in such a manner that in recoil the plate moves back parallel to the axis of the piece, and does not disturb the aim. This rest is also used in testing the accuracy of the arm, and reduced targets are given, showing, from views observed in a camera obscura, the grouping of shots at 500 yards when the aim is kept on one point. In a group of ten shots the average distance of the shots from the center of the group is less than 8 inches for the Springfield rifle.

The Benton double pendulum chronograph, and the Le Boulengé drop chronograph are used in the gallery for measuring the time of flight between the two targets, which can be connected at will with either instrument.

5. Benton's Double Pendulum Chronograph.

This was invented by the late Colonel J. G. Benton, Ordnance Dept., U. S. A. Two pendulums turning on bearings in line with each other are hung in front of the vertical face of a frame having a scale below curved to correspond to the motion of the lower ends of the pendulum. An electro-magnet on one side of the axis is connected with one of the target circuits, and a corresponding electro-magnet on the opposite side is connected with the other circuit. These are placed so that when active each will hold one of the pendulums horizontal. The instrument is adjusted so that if both currents are broken at the same instant, the pendulums will cross each other at the zero of the scale, when the instrument is leveled so that it is at the bottom point. Cross levels allow adjustment by means of screw feet running through three legs and resting on a solid foundation. The currents can be broken simultaneously by a special disjunctor placed near the instrument. When the circuits are broken by the passage of the shot, the pendulums fall successively, and the number of degrees on the scale included between their point of passage and the lowest point, gives, by reference to previously calculated tables, the time intervening between the rupture of the first and second targets. To obtain the velocity, divide the space in feet between the targets by the fraction of a second it took the bullet to pass over the distance.

The inner pendulum carries a bent lever, a point on the rear lever arm being stained with printer's ink, the arm on the other end projecting to the front so as to be struck by a pin projecting from the rear of the front pendulum. When the pendulums pass, the lever is moved, and the inked point is thrown against the silvered scale, indicating the place of meeting.

The instrument also has attachments, which allow the pendulums to be held up by *taut threads*, one extending to and across the muzzle, and the other to a swinging plate, where it is clamped. The first thread is broken by the bullet and the second loosened by movement of the plate when struck, so allowing the pendulums to drop. The arrangement for holding up a pendulum is a lever turning a horizontal axis, a shallow notch at the bottom catching the end of the pendulum when the thread fastened to the top arm is stretched. From Frankford Arsenal.

6. The Le Boulengé drop chronograph

This was invented by Major Le Boulengé, of the Belgian service. It was first introduced to the public here through descriptions translated by Capt. O. E. Michaelis, Ordnance Dept., U. S. A. Instead of two pendulums supported by electro-magnets, two rods are used, which can drop freely when released by demagnetization of the electro-magnets on breaking the currents. One rod is quite long and the other short. The magnet holding the long rod is connected with the first target, and the other with the second. The short rod in falling strikes one end of a rocking piece which on the other end has a hook holding back a spring, this spring moving horizontally when released by the jar, and a knife on its free end striking against the long rod as the latter is falling. The long rod is sheathed with a movable zinc tube, which receives the blow and becomes indented. A scale is used to measure the height of this indent above the indent which would be made by the knife if it struck while the long rod was still suspended, and this shows the distance the long rod falls before the knife strikes it. The time corresponding to this distance of fall from rest can be readily calculated. If both currents are broken simultaneously, by means of a disjunctor like that used with the Benton machine, this gives the time it takes the instrument to work, and adjustment is usually made to have this 15-100ths of a second for convenience of reference. If the rods fall through rupture of the currents by the bullet, the time obtained is that occupied in the working of the instrument *and* in the flight of the bullet. The difference between the two times so obtained is the time of flight. Tables are constructed for a disjunction mark of .15 second, corresponding to different distances between targets.

There is another pendulum chronograph in the exhibit, one of the earliest forms, the one pendulum Vignotti, not connected with the target. The others, particularly the drop chronograph, having superseded it.

7. Vignotti one pendulum chronograph.

This is a device invented about 1857, by Captain Vignotti, of the French army. The one pendulum is suspended by an electro magnet, as in the two pendulum machine. The pendulum, hung in front of a vertical frame of vulcanite, has at its lower end a pointer projecting backwards, and in the frame, opposite the path described by this pointer in the oscillation of the pendulum, is a curved slot covered by a movable metal plate, upon the face of which is stretched a curved strip of paper impregnated with potassium ferro-cyanide. The pendulum is connected with one end of the secondary wire of a Ruhmkorff coil, and the plate, insulated from the pendulum, is connected with the other end, so that when the primary circuit, which passes to the targets, is broken, a spark passes between the pointer and the plate, piercing the paper and discoloring it by action on the salt. By a curved scale, below the slot, the number of degrees distance of this mark above the zero can be read off. As originally designed, the pendulum was released by rupture of the first target, and the spark was used only for the second target, and for others in case more than two targets were used; but the late Col. Laidley, of the Ordnance Department, arranged it so that the pendulum would drop an instant before, and connected the Ruhmkorff coil with the first target as well, bringing the interval indicating the desired time lower down on the scale, where the motion of the pendulum would be more rapid.

This instrument is an improvement on the Navez machine, the earliest form that attracted general attention, in which a light arm on the pendulum was stopped by an electro-magnet rendered active by rupture of second target; the magnet being attached to the standard near the center of motion.

The credit of first using the spark for an electro-chronograph is due to an American, Professor Henry, whose invention has not been recognized by foreign authors. He used a revolving cylinder having a motion of translation, and a Ruhmkorff coil to make sparks on rupture of the targets; in an earlier form, described in 1843, using galvanometer needles to make a mark on the cylinder.

There are many other forms of chronograph not shown, but the most practical forms for ordinary use, and especially for field tests, are those in operation here.

In Europe, and especially in France, there are many new instruments of great interest, not yet imported, for obtaining velocities and pressures. One instrument, first described here in General Benét's "Electro Ballastic Machines," to be found in the library of the exhibit, was brought from France—the Schutz chronoscope using the induction spark with a revolving cylinder to indicate the instant of rupture and measuring the time interval between the marks of the spark by sinuous trace made by a vibrating tuning fork on the revolving cylinder. It is too bulky for exhibition here.

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8. Re-loading tools.

The re-loading of cartridge shells is practiced extensively by the U. S. troops at the different posts, and tools made at Frankford Arsenal for the purpose are supplied. A set of hand re-loading tools, such as are issued to each company, is shown; also a set of bench re-loading tools, as issued one to each post. The bench tools are shown in operation in the gallery, and the processes of de-capping, re-sizing, and re-capping the shell, charging with powder and lubricated bullet, and crimping in the latter, can be seen. An imitation of powder, made by mixing fine hominy with lamp-black, is used in place of powder to avoid danger of explosion.

9. Motion of bullets.

This is illustrated by a special device, which shows to the eye, without the need of diagrams, the following phenomena:

Accuracy preserved with sight vertical, even if the barrel is turned about its axis, as with a field gun on uneven ground.

The deflection caused by inclining the sight to one side.

The effect of varying charge.

The influence of weight on balls of the same size projected with equal velocity; the heavier ball being less retarded by the air.

The influence of size on balls of equal weight: the small ball being less retarded.

The influence of form on projectiles of equal weight and volume; an elongated projectile, moving point on, suffering less resistance from the air, and carrying further than a round ball of the same weight and volume, or the elongated projectile moving sidewise.

The influence of wings, front or rear, on equally balanced projectiles; the wings tending to keep the winged end to the rear.

The influence of the balance of a long projectile, or the position of its center of gravity; the projectile keeping point on if the front end is much heavier than the rear, but "tumbling" if the rear end is the heavier.

The amount of "drop" in a shot from the line of fire (the prolongation of the axis of the barrel): when the axis is horizontal, a ball dropped from the muzzle of the barrel as the projected ball leaves it, reaching the level ground at the same instant as the other; and whatever the inclination of the line of fire, a ball dropped from any point on it meeting the other ball in its flight,—consequently reaching the ground at the same time, if the point of suspension is over the point of ground struck by the projectile. The case of horizontal fire is a particular case of the other.

The influence of Rotation on an elongated projectile; the projectile keeping its point on when rotating around the longer axis even when the front end is lighter than the rear.

The gyroscopic effect from the resistance of the air in turning the axis of a rotating projectile not perfectly balanced lengthwise; shown by a flying gyroscope representing the projectile.

The influence of the air on rotating round balls: when the rotation is about a vertical axis, as in the "curved ball" of base ball pitchers, the ball moving to the right or left; when the rotation is about the line of fire giving a similar effect; and when it is about a horizontal axis perpendicular to the line of fire, giving an upward or downward tendency to the ball.

The lateral pressure of the air on rotating elongated projectiles, independent of the gyroscopic action; a very great drop from the line of fire, as in high angle firing, tending to make this influence more important, so that it may cause a deviation to the opposite side from that due to the change of direction of the axis from the gyroscopic effect, this change of direction causing the projectile to slide off, as it were, from the vertical plane of fire.

10. Targets used in U. S. service.

Target A, elliptical, used at 100 and 200 yds., *regular practice.*

Target B, elliptical, used at 400 to 600 yds., *regular practice.*

Target C, elliptical, used at 800 to 1000 yds., *regular practice.*

Target D, front silhouette of man standing ready to fire; cloth and paper fastened to a steel frame, *skirmish practice.*

Target E, front silhouette of man kneeling ready to fire; cloth and paper fastened to a steel frame, *skirmish practice.*

Target F, front silhouette of man lying down, *skirmish practice.*

11. Effect of bullets fired against glass.

A large pane of glass perforated by bullets from Winchester rifles in the Cincinnati riots of 1884.

From the windows of the Danbury Hat Store, Main street.

RELICS AND MISCELLANEOUS ARTICLES.

ANTIQUE AND CURIOUS WEAPONS.

Straight sword from India. History unknown.

Persian sword and scabbard, inlaid with silver. Blade covered with proverbs in Arabic, taken from the Koran.

Scimiter, with scabbard. India. History unknown.

Short sword, with scabbard, from India.

Short sword, with scabbard, from India. Inlaid with silver.

Japanese fan dagger.

Lady's "Punch" (dagger), with scabbard. East Indian.

Two Persian daggers, with scabbard. Inlaid with silver. Blade covered with inscriptions in Arabic, probably taken from the Koran.

African assegai.

East Indian chief's sword. Captured at siege of Delhi.

Sword of pattern carried in 1610. History unknown.

Antique sword, corresponding with latter half of 16th Century.

Japanese executioner's sword.

Sword formerly worn by Japanese official.

Japanese lances. A very full and interesting collection of different makes.

Spanish pike. Presented by Col. Juan J. Marin, Royal Spanish Engineers.

Three European Lances. Modern.

Halberd, a combination of pike and battle axe. Used principally in 15th and 16th Century.

Antique fauchard.

Bill. Used by foot soldiers of the time of Poitiers, 1356.

French helmet. From battle-field of Sedan. Shows mark of sabre-stroke.

French cuirass. From battle-field of Sedan. Pierced by a bullet from a Prussian needle gun.

The above collection is from the National Armory.

MEMENTOES OF THE REVOLUTION AND WAR OF 1812.

Badge of the Society of the Cincinnati, worn by Gen'l Wm. Burnet, Physician and Surgeon Gen'l in the Army of the United States, with certificate of membership signed by George Washington. Loaned by Mr. Wm. Burnet, Cincinnati, Ohio.

Certificate of membership of Col. Oliver Spencer, Society of the Cincinnati, signed by George Washington. Loaned by Mr. Wm. Williamson, Newport, Ky.

British officer's gorget, picked up after the battle of Saratoga.

Old sword, supposed to have been presented by Frederick II., Landgrave of Hesse, to the commanding officer of his troops, sent against the new Republic of the United States.

Three shot dug up at Fort Montgomery, West Point, N. Y.

Two bullets, American and British, found on the battle-ground at Lundy's Lane, Canada, after the battle fought between the American and British troops on the 25th day of July, 1814. Presented to Military Academy by Lucius D. Hill, late Col. N. Y. Inft., Oct., 1884.

MEMENTOES OF THE MEXICAN WAR.

Mexican flag-staffs.

Copy of a letter from General Scott accompanying the flag-staffs and describing them:

West Point, N. Y., Sept. 17, 1848.

Sir—I offer through you to the United States Military Academy sections of seven flag-staffs, taken by the gallant army of the United States in the campaign that commenced at Vera Cruz and terminated in the Capital of Mexico. Four other staffs captured with the strong works, viz., the intrenched camp of Contreras, the Convent of Churubusco, the bridge head of Churubusco, and the Citadel of Mexico, were divided into small individual trophies by our officers and men, before my wishes on the subject had become generally known. Of course all captured flags, colors, etc., were, as national trophies, sent to Washington. The following inscriptions have been placed on the respective objects:

1st. Part of the flag-staff of the Castle of San Juan de Ulua, Vera Cruz, taken by the American army, March 29th, 1847.

2d. Part of the flag-staff of Fort San Iago, Vera Cruz, taken by the American army, March 29th, 1847.

3d. Part of the flag-staff of Fort Coinception, Vera Cruz, taken by the American army, March 29th, 1847.

4th. Part of the flag-staff of Cerro Gordo, taken by the American army, April 18th, 1847.

5th. Part of the flag-staff of the Castle of Perote, taken by the American army, April 23, 1847.

6th. Part of the flag-staff of the Castle of Chapultepec, taken by the American army, September 13, 1847.

7th. Part of the flag-staff of the National Palace of Mexico, taken by the American army, September 14, 1847.

At the foot of each inscription this line is added: "The plates and caps (all brass) made of the mountings of captured muskets." It may be worth stating that the caps and plates were made in the Citadel of Mexico by the mechanics of our own army.

As under Providence it was mainly to the Military Academy that the United States became indebted for these brilliant achievements and other memorable victories in the same war, I have a lively pleasure in tendering the seven trophies (semi-national) to the mother of so many accomplished soldiers and patriots. If acceptable, please give them such place of deposit in the Academy as you may deem appropriate.

With high respect and esteem, I remain, yours faithfully,

(Signed) WINFIELD SCOTT.

Captain HENRY BREWERTON, Superintendent U. S. Military Academy.

The above articles, with numerous others from West Point, were furnished through the courtesy of Bvt. Major Gen. J. G. Parke, Supt. of the Military Academy.

Flag carried by Duncan's Battery through the Mexican War.

Wheel from Duncan's Battery.

The names of the following battles the battery was in are printed on the wheel: Battle of Churubusco, Aug. 20, 1847; battle of Vera Cruz, March, 1847; battle of Monterey, Sept. 21, 22, 23, 1846; battle of Resaca de la Palma, May 9, 1846; battle of Palo Alto, May 8, 1846; battle of City of Mexico, Sept. 12, 13, 14 1847; battle of Chapultepec, Sept. 12, 1847; battle of Molino Del Rey, Sept. 8, 1847. This wheel shows two of the spokes spread apart by the blow of a cannon ball. The battery flag is wrapped around the wheel.

Two Mexican cannon balls of copper.

MEMENTOES OF THE REBELLION.

Seven John Brown Pikes.

"By far the larger proportion of John Brown's Pikes were shipped off to the South by Floyd during Buchanan's administration, and during the latter days of the war, when the Confederates were out of arms, money, and credit, these pikes and a quantity of scythes were used to arm a Texas regiment, from which they were captured and stored at Mt. Vernon, Ala., Arsenal, which was burned above them. The Government then sent them to the Arsenal, Rock Island, Ill., to be rolled into new iron, but as the rolling mill was not in operation, they were sold." *Newspaper extract.*

From National Armory.

Flag-staff of Fort Sumter.

A piece fifteen feet long of the staff that stood on Fort Sumter when surrendered.

First shot fired at Fort Sumter. From West Point.

First shot fired from Fort Sumter; April 13, 1861. Found in the quarters of Gen. Beauregard. From West Point.

Model of Swamp Angel Battery.

The labor of constructing this battery was mostly performed at night, by Col. E. W. Serrell's regiment of N.Y. Volunteer Engineers. The 200-pounder Parrott, mounted in it, was transported by water to the creek landing, just in front of the battery. The battery was 7,000 yards distant from the nearest point of the city of Charleston. The gun was fired with a charge of 16 pounds of powder, at an elevation of 37 degrees, and some of the shells were charged with tubes of Greek fire.

From Governor's Island Museum, by permission of the owner, Gen. W. W. H. Davis, of Philadelphia.

Sketch of Swamp Angel Battery. Showing mortars which replaced the 200-pounder Parrott rifle.

The sketch was made and loaned by Col. J. W. Abert, late of corps of engineers, U. S. Army, now living at Newport, Ky.

Joined bullets.

Two bullets, one Federal and one Confederate, which met in the air at the battle of Petersburg, and were found on the field joined together. Presented to Ordnance Office by Brevet Lieut. Col. E. Rice.

Bullet. Entered the body of John M. Roberts, Co. F, 83d Indiana Vol., at Vicksburg, Miss., May 19, 1863. Loaned by Mr Roberts.

Field office wagon, used by the late Maj. Gen'l George H. Thomas during the Atlanta campaign.

Rifle musket from battle-field of the Civil War; barrel perforated by bullet.

Rifle musket from battle-field; bullet imbedded in barrel near front sight.

Rifle musket from battle-field. Barrel burst by meeting of two bullets.

Oak tree cut down by bullets at Spottsylvania.

Section of an oak tree which stood inside the Confederate intrenchments at the battle of Spottsylvania Court House, May 12, 1864. It was cut down by musket balls during the attempt to recapture the works previously carried by the 2d Corps, Army of the Potomac, May 12, 1864. Presented to the Ordnance Museum by Brevet Maj. Gen'l N. A. Miles, and transferred to National Museum in 1888. Returned from Smithsonian Institution for exhibit in the War Department section through the courtesy of Professor G. Brown Goode.

Model of Fort Wagner, Morris Island, South Carolina. Scale 1" to 25', 1-300. Made by Col. J. W. Abert. Loaned by W. B. Carpenter, Esq., President of Cincinnati Mercantile Library.

A portion of Fort Wagner flag-staff.

Rail twisted by the soldiers of Gen'l Sherman's army in the campaign of 1864. Western and Atlantic R. R. Presented by Lt. Col. W. R. King, Corps of Engineers, U. S. Army. To disable railroads the rails were placed over bonfires until red hot in the middle, and then the soldiers seized them by the ends and ran against a tree or telegraph pole to bend the rail.

Model of a block-house. Devised by Lt. Col. Wm. E. Merrill, Corps of Engineers, U. S. A., and used in the Department of the Cumberland for the defense of railroad bridges. Block-houses of this form were designed to be defended by musketry, and to withstand the effects of field artillery. They are square in form. They have two stories, the lower being formed of a double thickness of heavy logs, and loop-holed. The upper story is smaller, of lighter construction, and is intended to afford a look-out and more comfortable quarters when the garrison is not engaged, but to be abandoned in action, the occupants retreating to the lower story. The block-house is surrounded by a ditch, from the bottom of which an embankment is run to the under side of the loop-holes. Colonel Merrill designed several other block-houses, for various purposes, descriptions and drawings of which may be found in the appendix to Van Horn's History of the Army of the Cumberland.

Confederate torpedo—tin. Intended to sink the U. S. gunboats on the blockade at the mouth of St. John's river, Florida. Charge, 75 pounds powder. Presented to Military Academy by Lieut. Col. W. Burns.

Confederate torpedo—tin. Fretwell's Percussion. Presented to Military Academy by Guy V. Henry, 1st Lieut. 1st Artillery, and Col. 40th Mass. Volunteers—commanding U. S. forces at West Point, Va.,—since Major 9th Cavalry.

Confederate torpedo—copper. A line of these torpedoes was stretched across the Louisville road, in front of the rebel works at Savannah, Ga. Presented to Military Academy by A. Baird.

Confederate keg torpedo. From light-house inlet, Charleston, S. C. Presented to Military Academy by Lieut. Com. Geo. Bacon, U. S. N.

Death of Lt. Cushing at battle of Gettysburg. Picture in frame, loaned by Mr. Alfred Holmes, in charge of Philippoteaux's Cyclorama of the Battle of Gettysburg.

Fourteen swords, Confederate. From National Armory Museum.

Jefferson Davis' rifle. Taken at time of his capture.

SHOT AND SHELL.

These are from the collection made by Bvt. Brig. Gen'l H. L. Abbot, after the war, and presented to the Military Academy.

Shot with wire through center, Confederate; winged shot, Confederate, from battle-field in Pennsylvania; two wrought iron shot, Confederate, Fort Fisher; Confederate shot, pierced with small holes; two rifle shot for breech loader, Confederate; two case shot, Confederate; two shell (fired), Confederate; shot with copper band, Confederate; shot with copper cup and wooden sabot, Confederate; composition shot, hard rubber, Confederate; bag of grape, cut links, Confederate; turbine shot, hole through center; Abbot's shot; Cochran's diagonal shot, with two lead bands; Lawson's shot; two Ritner and Day's lead shot; diagonal shot; 32-pounder shot (fired), lead base; chain shot and case; chain shot, with two balls attached; chain shot in four parts; Huginin; Sawyer; 8-inch Armstrong, blind; McIntyre's repeating; Dimmick; Stafford; 7-inch Schenkl; 10-inch mortar with handles; Sawyer experimental and other shell; 24 pdr. canister; 12 pdr. stand of grape; 12 pdr. stand of grape, quilted; 24 pdr. stand of grape; Whitworth short shell; 8 inch carcass ribbed; light ball.

Capt. McCarthy, Commanding Battery B, 1st Regiment of Artillery O. N. G., at Cincinnati, also loaned a number of shot and shell, relics of the Rebellion.

RELICS OF GREELY EXPEDITION.

The Greely Arctic flag; Lady Franklin Bay Expedition, 1881-84. Loaned by Mrs. A. W. Greely.

This flag was made by Mrs. A. W. Greely, and was intrusted to Octave Pary, M. D., and was carried by him to Greenland in a private Arctic Expedition of 1880. Dr. Pary delivered it to Lieut. A. W. Greely, 5th Cavalry at Rittenbenk, Greenland, in July, 1881. The flag was carried in May, 1882, by Lieut. Lockwood, 23d Infantry, to latitude 83 degrees, 25 minutes, longitude 40 degrees, 46 minutes; and was there unfurled by him at the nearest point to the North Pole ever attained by man. In the summer of 1882, the flag was carried by Lieut. Greely in to the interior of Grinnell Land, and was unfurled by him July 4th, from the highest point in Grinnell Land, the summit of Mt. Chester A. Arthur, 4,500 feet above the sea.

In 1883, it was carried to the shores of the polar ocean north of Greenland by Lieut. Lockwood; taken again by Lieut. Lockwood southwest across Grinnell Land to the western polar ocean, where it was displayed on the shore of Greely Fiord, May 16th.

The flag was also displayed on the launch Lady Greely on a trip made during the summer of 1882, into Weyprecht Fiord, to the head of Lady Franklin Sound, and down Kennedy Channel to Cape Craigcroft; and during the retreat from Fort Conger to Cape Sabin in autumn of 1884. The flag has been four years in the Arctic Circle, and has been unfurled nearer the North Pole than any other flag in the world.

Loaned by permission of Mrs. Greely, from the Museum at Governor's Island.

Small block of wood from the sheeting next to the keel of the U. S. S. Bear, of the Greely Relief Expedition of 1884.

Small block of wood from the keel of the U. S. S. Bear, of the Greely Relief Expedition of 1884.

Piece of wood taken from the shoe over the propeller of the flagship Thetis, of the Greely Relief Expedition of 1884.

Small block of wood from the keel of the U. S. S. Bear, of the Greely Relief Expedition of 1884.

Wooden cane, made from the keel of the U. S. S. Bear, of the Greely Relief Expedition of 1884.

Bottle of rum taken from cache in Littleton Island by Greely Relief Expedition, 1881. Deposited by Beebe in 1882. Presented by Lieut. S. C. Lemly, U. S. Navy, to Capt. Geo. E. Pond, A. Q. M. U. S. Army, and loaned by Capt. Pond to Museum, at Governor's Island.

Piece of leather: the last rations of the Greely Arctic Exploring Expedition, taken from Camp Clay by Lieut. J. C. Colwell, U. S. Navy. They had lived on this and rock lichen for about three months.

MISCELLANEOUS MODERN ARMS, FLAGS, TENTS, ETC.

Fourteen sword and sabre blades, heavy and light, nearly all of "Toledo" manufacture.

Fourteen swords and sabres, old model, with brass or bone hilt, nearly all for light artillery.

Board of swords; showing cadet sword, staff and foot officers' swords, cavalry officer's sabre and their scabbards, in various stages of manufacture.

Board of twenty-four trowel bayonets; comprising wooden models of combination and trowel bayonet blades, by Col. J. G. Benton, Ordnance Dept., and Felix Chillingworth; Rice's trowel bayonets, and various bowie knives, hunting knives and intrenching tools, intended to be attached as a bayonet to the rifle; one intrenching tool formed on bayonet scabbard.

Breech Loading Rifle (Springfield): calibre, .50; model, 1868. Turned in from the field; stock broken, barrel broken and twisted; breech and lock mechanism perfect. Illustrates the serviceableness of Springfield breech action.

Cadet fencing musket and bayonet.

Common bayonets and sword bayonets. A large number fixed on boards and used for decoration.

Prepared by Lieut. C. H. Clark, Ordnance Dept., National Armory.

Flags of different nations, used for decoration, and supplied by the Navy Department.

United States flags. A large number hung from the walls for decoration.

Supplied by the Q. M. Dept.

Models of tents; hospital, wall, common and shelter tents, and Sibley conical tents, one made with vertical walls at the bottom.

Furnished by the Qr. M. Dept.

Locking rack for carbines and pistols. Will hold 20 guns and 20 revolvers securely locked in place; revolvers above carbines. Rock Island Arsenal.

Locking rack for rifles. Holds 18 Springfield rifles, with bayonets attached.

Loaned by Capt. J. L. Tiernon, 3d Art'y, Newport Barracks, Ky.

Settees and chairs were placed in the exhibit, loaned by the Bromwell Brush and Wire Co., Cincinnati.

UNIFORMS AND ACCOUTREMENTS.

These are exhibited on lay figures of men dressed in uniform, armed and equipped. All but the first figure came from the Quartermaster's Depot, Jeffersonville, Indiana. The figures are scattered about the exhibit.

1. Minute Man of the Revolution.

Dressed in brown coat with cape, scarlet waistcoat, knee-breeches, slouch hat, shoes with silver buckles; powder-horn slung over shoulder; squirrel rifle in hand. This figure stands resting against the gun and carriage captured at Saratoga. From National Armory.

2. Commissary sergeant; full dress.
3. Hospital steward; full dress.
4. Chief trumpeter of cavalry; full dress
5. Private of artillery, time of war; full dress.
6. Private of cavalry, time of war; full dress
7. Private of infantry, time of war; full dress.
8. Musician of infantry; full dress.
9. Chief trumpeter of artillery; full dress.
10. Private of artillery; full dress.
11. Corporal of ordnance, time of war; full dress.
12. Private of artillery; fatigue uniform.
13. Private of infantry, present time; full dress.
14. Private of cavalry, present time; full dress.
15. Private of infantry, present time; fatigue uniform.

This figure shows the soldier equipped for the field with blanket, overcoat, canteen, cup, and with haversack containing meat can, plate, knife, fork, spoon, etc. Armed with rifle, and wearing the Mills woven-loop cartridge belt with 45 cartridges.

MODEL HORSE WITH CAVALRY EQUIPMENTS OF LATEST PATTERN.

The special changes in equipment consist in the adoption of the Shoemaker curb bit, with device to prevent shortening the cheek strap in pulling rein; the use of a carbine boot attached to the saddle in place of the old socket attached to saddle straps; the addition of an infantry haversack, with meat can, etc., to the equipment; adoption of a short canteen strap with spring hook for fastening to saddle; and arrangements for attaching saber to saddle or belt at will by detachable saber slings after the model of the old Stuart attachment. The saddle has been improved in outline and made flatter under the bars. The Mills woven-loop cartridge belt is used, with buckle in place of belt plate; and a narrower carbine sling is adopted.

The model shows the horse equipped for the field, and a lay figure of cavalry private stands by the side.

Kelton check-rein attachment. This is shown on the horse. It consists of a spring enclosed in rubber and attached to the bit, an extra rein leading from it. The rein can be caught over the pommel of the saddle, bringing slight pressure on the bit and controlling the horse, but leaving him some freedom of motion.

Figure 45 shows the construction of this attachment, and figure 46 represents the use on the horse. The model horse was furnished through the courtesy of Mr. Mosby and Mr. Fisher, Society of Cincinnatus in this city.

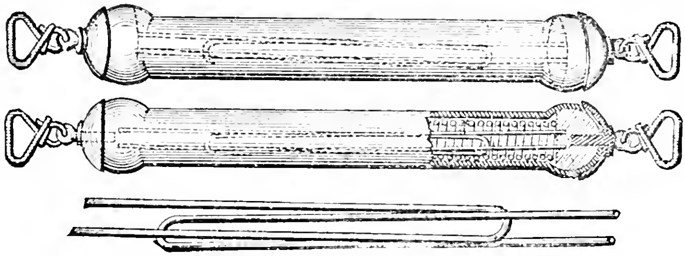


Fig. 45.

Fig. 46.

SIGNAL SERVICE EXHIBIT.

This consists mainly of instruments used in observations for forecasting the weather. Besides these instruments a full kit for field signaling with flags and torches is displayed. Daily weather maps and reports are shown.

The instruments include mercurial and aneroid barometers, and a large number of thermometers; common, sub-standard, minimum, solar-radiation, wet and dry bulb thermometers.

There are also the following instruments, which require to be more fully described:

1. Sensitive minimum thermometer for ground radiation.

In this form of thermometer a degree of sensibility is claimed to be attained equal to mercury for terrestrial radiation. The bulb consists of a long cylinder of glass, hollow, and about which a second cylinder is blown and united at the open ends, so as to leave a thin space between them to contain the alcohol. The stem of the thermometer is connected to a middle point in the outer cylinder. In this form of bulb there is a large surface, both internal and external, for the air to come in contact with, and the volume is small, making the instrument extremely sensitive.

2. Piche evaporimeter.

This consists of a glass tube nine inches in length, graduated to show the contents in cubic centimetres and tenths. It is filled with water (preferably distilled water) and suspended vertically by an eye at the top. On the lower open end of the tube is a disk of paper, kept in place by a brass spring, attached to a slitted collar that moves along the tube.

Evaporation takes place from the surface of the paper. The amount, in cubic centimetres, in any time is given by the difference in the readings of the top of the column of water at the beginning and end of the time. The amount of paper surface from which evaporation takes place varies slightly in the different instruments, depending on the diameters of the glass tubes, which vary from 14.0 to 15.5 millimetres. There is about 11 square centimetres of surface exposed. The evaporation from a paper surface, such as is furnished with these instruments, is about one and one-third times greater than that from an equal surface of water contained in a shallow dish.

The object of observations with these instruments is to ascertain the relation between the amount of evaporation and the mean daily temperature and dew-point, as determined by the whirled wet and dry thermometer and the wind velocity.

3. Standard rain gauge.

The standard rain gauge of the Signal Service consists of three parts, viz: The *collector*, the *receiver* and the overflow. The collector is funnel-shaped, eight inches in diameter at the top. The receiver is cylindrical, 2.53 inches in diameter, and 20 inches deep. The overflow is 6 inches in diameter and 22 inches deep.

4. Standard snow gauge.

The standard snow gauge of the Signal Service consists of a cylinder 8 inches in diameter and 20 inches deep.

5. Draper's self-recording thermometer.

This is a metallic thermometer. Strips of steel and brass about twelve inches long are soldered throughout their length. The difference in their expansions cause changes in the curvature of the strips, one end of which is

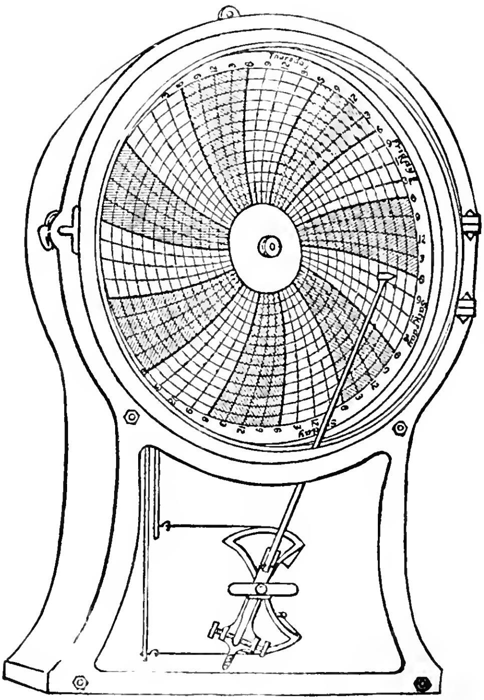


Fig. 47.

fixed. The movements of the other end, by a suitable device, produces a motion of the registering pen. The record being a line traced on a disk, has the advantage over such as make tracings on a cylinder, that the record for a week can be seen without inconvenience. The disk holding record paper is made to revolve once a week by means of clock-work. For the purpose of insuring greater accuracy in the record at times when the temperature is changing from rising to falling, or the reverse, the instrument is provided with two compound strips, so arranged as to curve in opposite directions, as temperature changes. See figure 17.

6. Robinson's anemometer.

The instrument used by the Signal Service for measuring the velocity of the wind is a modification of the Robinson anemometer, so arranged that it can be easily erected. The frame offers little surface to obstruct the passage of the wind, and the velocity may be read either directly from the anemometer itself, or the instrument may be connected with an electric self-register and a continuous record obtained upon prepared forms. The latter method is followed in the exhibit. The anemometer is set on top of the Exposition building, with electric connections running to the register.

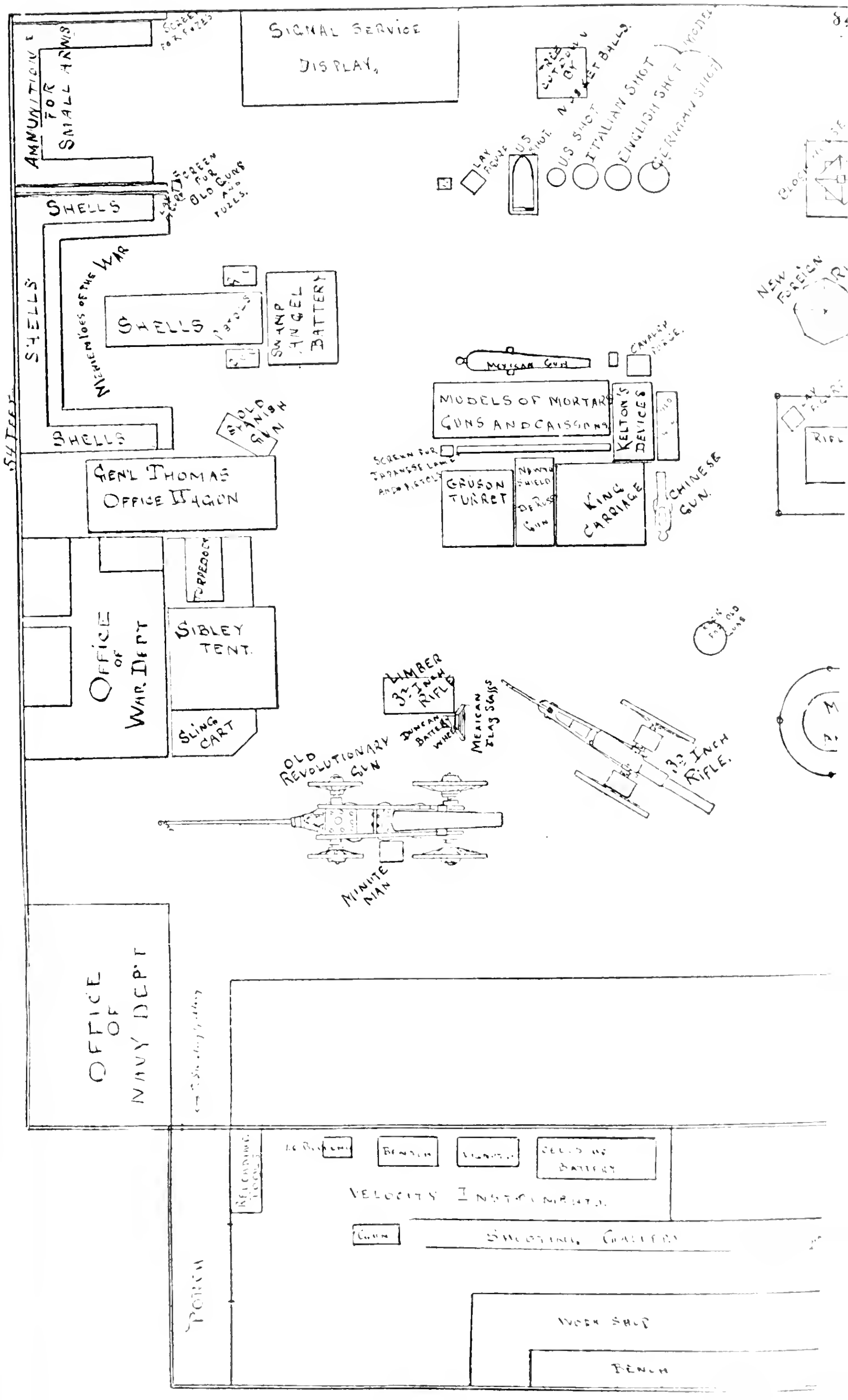
The velocity of the air, or wind, ranges from an almost imperceptible movement to that of one or more miles per minute. On account of the friction resulting from the moving air in contact with the surface of the earth, or objects upon the earth, the movement of the air is retarded near the surface. It is estimated that the effect of this friction decreases from 20 to 50 per cent. for the first hundred feet above the earth, and gradually diminishes until it is believed to have but little effect at an elevation of 10,000 feet. To reduce the effect of this friction instruments designed to measure the velocity of the wind should be placed as far above the earth and away from obstructions as practicable.

The rapidity with which the air moves upon the earth's surface at the several points of observation has an important bearing upon future meteorological conditions, and careful judgment should be exercised in selecting points of measurement where the influence of surrounding objects is reduced to a minimum, and the instrument is supported upon a firm basis and kept in good running order.

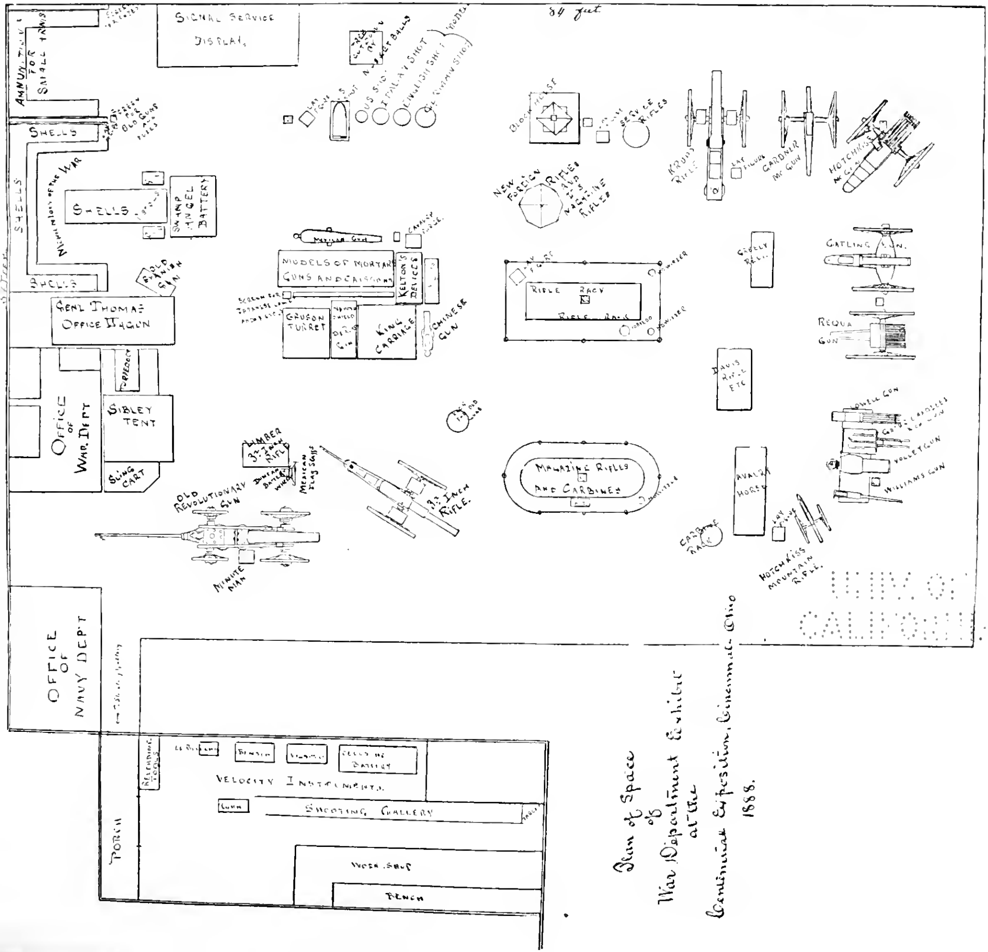
CORRECTIONS.

Read "General H. L. Abbot" for "General H. L. Abbott." Page 16, No. 30.

Read "Major Geo. W. McKee" for "Major Geo. W. Meker." Page 61.

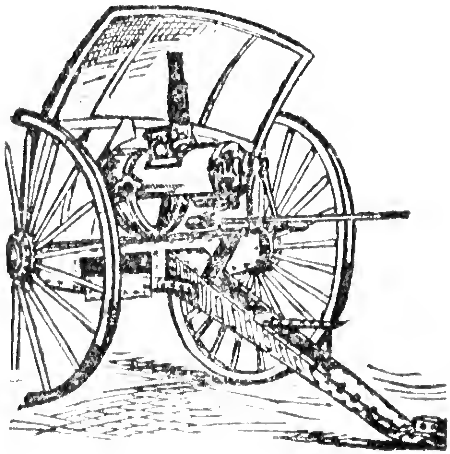


Signal Service Display
Ammunition for Small Arms
Shells
Shells
Shells
Shells
Mementoes of the War
Swamp Angel Battery
54 Feet
Old Spanish Gun
Gen'l Thomas Office Wagon
Torpedoes
Office of War Dept
Sibley Tent
Sling Cart
Limber 3½ Inch Rifle
Mexican Flag Staffs
3½ Inch Rifle
Old Revolutionary Gun
Minute Man
Mexican Gun
Models of Mortars Guns and Caissons
Kelton's Devices
Gruson Turret
King Carriage
Chinese Gun
U.S. Shot
Italian Shot
English Shot
Office of Navy Dept
Velocity Instruments
Bench
Shooting Gallery
Work Shop
Bench
Porch



Plan of Space of War Department Exhibit at the Centennial Exposition, Cincinnati, Ohio 1888.

UNIV. OF CALIFORNIA



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