A DESCRIPTION

OF THE

HOTCHKISS

REVOLVING CANNON.

With Tables giving Results obtained in Experiments made with it.

BY

ALFRED KOERNER.

With Six Plates.

PRINTED FOR PRIVATE CIRCULATION.

1874.

An edited reproduction by
Americana Archives Publishing, Topsfield, Mass.

THE HOTCHKISS

REVOLVING CANNON,

ETC.

INTRODUCTORY HISTORICAL NOTE ON THE HOTCHKISS REVOLVING CANNON.

IT was during the Franco-German war, in 1870, that Mr. B. B. Hotchkiss first conceived the idea of constructing a simple machine-gun, which should fire a small cast-iron explosive shell with great rapidity, at very long ranges, and which should have no recoil to interfere with the continual operation of the gun, or the accuracy of its fire.

It was in the same year that the first gun of this kind, made at Vienna, was fired in the presence of the Austrian Artillery Committee, and though it was thereby proved to be excellent as to general principle, it left much to be desired from a ballistical point of view.

central shaft. The series of barrels are in this way placed in a rectangular frame, which is attached to the breech, the near end of the shaft penetrating the same to receive the rotary motion from the driving gear.

The breech itself is composed of a solid cast-iron breech-block, weighing 175 kilogrammes. This absorbs the greater part of the recoil. It has a door at the rear-end, which can be easily opened, so that the mechanism is freely accessible, and can, if necessary, be dismounted and put back into its place in a few minutes without the aid of any special tools.

A peculiar feature in this gun consists in the barrels remaining still during the discharge, so that there is no movement of any kind to impede the accuracy of fire. This stop or lost motion is obtained by the shape of the driving-worm, which is so constructed that the inclined driving-thread only covers half its circumference, the other half of the thread being straight. The effect of this is, that the barrels only revolve during half a revolution of the worm, and stand still during the other half revolution. The combination of the mechanism is so arranged that the loading, firing, and extracting takes place during this pause. This feature is of great importance for the accuracy of fire, and the durability of the system.

The worm-shaft projects through the breech on the right side,

and has a crank with which the whole system is moved; on the left side of the worm-shaft a small crank is attached, by which the loading and extraction of the cartridge-shells is effected in the following manner:—

On the interior face of the left side of the breech a cog-wheel is mounted, with two horizontal racks, the one being placed above, the other under, this cog-wheel, and parallel to the axis of the barrels, so that in moving one of these racks the other is moved by the cog-wheel in the opposite direction. Part of the lower rack forms a vertical slot, in which the small crank on the left side of the worm-shaft works. The rotation of the latter consequently gives an alternating and opposite movement to the two racks, so that while the one is going forward, the other moves back, and reciprocally.

The under-rack forms the extractor, the upper one moves a piston which drives the cartridges into the barrels, the cartridge being placed before the piston, in the trough in which it moves; and during the time the barrels are motionless it is introduced into the one standing before the trough. The cartridge is not, "driven-home" entirely, but its head is in view of an inclined plane cut into the metal of the breech, on which it slides when it is moved by the rotation of the barrels. This completes the introduction of the cartridge into its chamber. The piston itself

is a simple cylinder connected with the rack, and running in a slot in the conducting-trough.

When the racks are in their extreme positions, they remain still a moment. This stop is obtained by giving the slot in its centre part a circular shape concentrically to the shaft of the crank. This is necessary, because at the moment of the barrels arriving at the end of their course, the head of the cartridge-case becomes engaged in the hooks of the extractor, which would not be possible if it were in motion at the time.

The extractor is a large double-hook at the end of the bottom rack; it is very solid, and its proper working is certain under all circumstances.

After the cartridge is extracted from the barrel, it strikes against an ejector, which pushes it out of the extractor, and it falls to the ground through an opening in the under part of the breech. The firing-pin has an elongation, pointing downwards, which, by the operation of a spring, is pressed against a cam on the worm, and as the worm rotates, the cam drives the firing-pin back, and compresses the spring. The moment the firing-pin becomes liberated, it strikes the primer of the cartridge, and the discharge takes place.

To obviate the difficulties which exist in other systems, when the cartridges are piled one upon the other, the opening

of the introduction-trough is closed by a little door, which goes down by the weight of the cartridges, the first of which drops into the trough, and then the piston in moving forward raises the door, and allows no more cartridges to enter until the proper time.

All parts of the mechanism are very strong and durable, and hardly exceed in number those of an ordinary small-arm, there being besides the group of barrels, thirteen parts, viz. :—

1, 2. The breech-block with its door for closing the rear-end.

3, 4, 5. The crank-shaft, with its worm for moving the barrels, and small crank for working the loader and extractor.

6. The crank.

7, 8. The firing pin and spiral spring.

9. The extractor.

10, 11. The loading-piston and rack for moving it.

12. The cog-wheel for transmitting the movement of the extractor to the loading-piston, and,

13. The door for regulating the feed of cartridges.

THE OPERATION OF THE MECHANISM, THE RAPIDITY OF FIRE, AND THE NUMBER OF MEN TO WORK THE GUN.

The operation of the mechanism may be described as follows, supposing the crank to be in continual motion :—

A cartridge is placed in the introduction-trough, the piston pushes it into the barrel, then the barrels begin to revolve, and the cartridge is carried on till it arrives before the firing-pin which penetrates the solid part of the breech, and which has in the meantime been retracted by the action of the cam. Then, as soon as the cartridge has arrived into this position, the barrels cease to revolve, and the primer of the cartridge is struck by the firing-pin and discharged; then the revolution of the barrels begins again, and the fired cartridge-shell is carried on until it comes to the extractor, this in the meantime has arrived up to the barrels and the cartridge-head rolls into it. As soon as the head is laid hold of by the extractor, the barrels again cease to revolve, and during this period the cartridge-shell is withdrawn and dropped to the ground. As during every stoppage of the barrels the gun is supplied with a new cartridge, and the firing and extraction is also performed, during this time a continuous but slow fire is kept up. By supplying the gun in this manner with single cartridges, about thirty rounds per minute may be fired.

Should *rapid* firing be required, the gun is then supplied, not with single cartridges, but with "feed-cases," containing groups of ten cartridges each, and in this manner from sixty to eighty rounds per minute can be fired, with only three men to work the gun; viz., one man to train the gun and revolve the crank; one man to place the "feed-cases" containing the cartridges into the "feed-trough;" and a third man at the ammunition chest, to charge the "feed-cases," and to hand them to the charger.

Attached to the frame is a turn-table, which connects the cannon to the "trunnion-saddle," arranged in such manner that without displacing the carriage, a certain amount of lateral motion as well as of elevation may be given to the gun. Thus the gun is made to sweep horizontally along a line, by adjustment, between each single shot, or during rapid discharge.

THE AMMUNITION.

The ammunition for the Revolving Cannon consists of a centre-fire metallic cartridge of special construction, holding in each one the powder, the projectile, and the lubricating-wad, arranged like the similar ammunition generally used for small arms.

Two different kinds of projectiles are used, the one an explosive shell, and the other a case-shot. Nothing need be said

of the latter, as it does not differ from the common case or canister shot used in ordinary cannon.

THE SHELL.

The shell is of a novel construction; it is of cast iron, of a cylindro-ogival shape, slightly rounded at the rear end. The packing consists of a brass coat of about one calibre in length, and placed equidistantly from the centre of gravity. This coat is a piece of soft brass tubing, contracted with great pressure over the body of the projectile, it being provided with longitudinal grooves, and two grooves encircling it at the top and bottom ends of the packing. The coating is forced into these grooves, and any disturbance of it on the body at starting is thus obviated. These grooves serve at the same time as breaking-lines of the shell.

After the coating is attached to the projectile, some small saw-tooth-like grooves are cut into it, to reduce the strain while being forced through the rifling of the barrel. These grooves can be filled with a lubricating substance, and this is then carried perfectly between the projectile and the bore of the barrel.

The coating of the projectile is conical at its front part, corresponding with the cone in the projectile chamber, so that

it is exactly centered in the bore as soon as the forward movement commences. Its rear end is cylindrical to within about one-third of its length.

The shell is turned smooth all over, and is 0.4^{mm}* in diameter less than the bore of the barrel. This projectile is made with great care and exactness, with only a very small deviation in dimension.

THE FUSE.

The fuse employed is that known as the Hotchkiss percussion fuse used in large quantities during the last war in America.

It consists of a gun-metal body, closed at the front end with a nose screw, forming the ogival point of the projectile; it has a conical hole at the rear, which is closed with a lead plug (the safety-plug) pressed in very tightly, so that the plug projects a little through the base of the body-case, towards the inside.

The plunger is composed of lead cast into a brass casing to strengthen it, and to prevent the lead being upset by the shock of discharge. A brass wire is cast into the lead of the plunger, and holds it suspended in the case, the wire going through the hole in the bottom of the case, and being held securely in position by the safety-plug. The plunger has a nipple cast into the lead,

* In these pages the French measurements of length and weight are thus abbreviated :—"met." for metre; "cm." for centimetre; "mm." for milimetre; "kil." for kilogramme; "gr." for gramme.

and is primed with an ordinary gun-cap; in its axis it has a powder-chamber containing the igniting charge.

The operation of the fuse is thus:—The safety-plug is dislodged backwards into the interior of the projectile by the shock of discharge, the wire then being not held tight in the hole, the plunger is disengaged and rests on the bottom of the fuse case, and is free to move in the line of axis. When the flight of the projectile is suddenly retarded by its striking any object, the plunger, in consequence of its inertia, is driven forward, and the primer strikes against the nose-screw, thus igniting the powder in the channel, and so firing the bursting charge of the projectile.

The Hotchkiss percussion-fuse is extremely simple in its construction, and requires no adjustment before use. It is perfectly safe in transport, and during all manipulations with the projectiles, as the plunger is held securely by the safety-plug, which must receive the great shock of the discharge to discharge it from its hole, and thus liberate the plunger.

THE CARTRIDGE CASE.

The cartridge-case consists of a spirally-rolled tube of sheet-brass, strengthened at the head with an inside and an outside

cup. The head is punched-out of sheet iron, and is fastened to the cups with three rivets.

The primer consists of a case holding the anvil, and is closed at the bottom end by the cap containing fulminate; it is fitted into a hole which penetrates the head and both cups, and it projects through into the inside of the cartridge-case.

This cartridge, which can be manufactured with great facility, on account of its simplicity, has proved itself to be of a very durable quality, and it can be used repeatedly.

The construction of the body of the cartridge allows it to expand to the chamber of the gun without the metal being stretched, so that after the discharge it contracts itself again to its previous diameter, thus leaving the fired case perfectly loose in the chamber for extraction.

THE LUBRICATOR.

The lubricator consists of a wad of felt 6^{mm} thick, dipped in a solution of mixed tallow and beeswax. A paper disc is placed between the lubricating wad and the charge, to prevent the powder getting damaged by the greasy surface of the lubricator.

The projectile is merely pressed into the neck of the cartridge and is not clenched, as there is enough friction to

hold it absolutely secure. Of course the ammunition is, as in the case of all modern small arm ammunition, which it resembles, rendered safe against influences of weather and danger of explosion.

PRINCIPAL DIMENSIONS AND WEIGHTS, &c. OF THE GUN.

Calibre	37^{mm}
Total length of bore	1276^{mm}
Length of rifling	1140^{mm}
Rifling; one turn in (Twist and depth of grooves uniform.)	1250^{mm}
Number of grooves	12
Width of lands	2.5^{mm}
Depth of grooves	0.5^{mm}
Number of barrels	5
Diameter of barrel over the powder chamber	88^{mm}
Diameter of barrel at the muzzle	62^{mm}
Weight of each barrel	35^{klg}
Radius of sights	687^{mm}
Vertical distance of the line of sight from the common axis of the barrels	53^{mm}
Horizontal ditto. ditto.	165^{mm}
Weight of gun	475^{kil}
Total weight of gun with traversing apparatus	525^{kil}

PRINCIPAL DIMENSIONS AND WEIGHTS OF THE AMMUNITION.

(*a*) EXPLOSIVE-SHELL.

Length of body	93 mm
Entire length with fuse	111 mm
Length of brass coating, equidistant from centre of gravity	38 mm
Diameter of body	36.6 mm
Diameter of brass coating	38 mm
Weight of body of the projectile	495 gr
Weight of fuse	100 gr
*Weight of bursting charge	25 gr
Total weight of projectile complete for firing	520 gr

(*b*) CASE-SHOT.

Length of case	111 mm
Exterior diameter of case	36.5 mm
Number of balls	24
Diameter of each ball	16 mm
Average weight of each ball	30 gr
Total weight of shot	900 gr

(*c*) CARTRIDGE-CASE.

Length of cartridge case	120 mm
Diameter of head	45·5 mm
Diameter of body near the head	41.7 mm
Diameter of body in front	37·5 mm
Weight of cartridge case	110 gr

(*d*) CHARGE OF POWDER.

Charge	120 gr
Proportion of charge to weight of projectile	4·33
Weight of complete cartridge	750 gr
Length of complete cartridge	207 mm

* It would be advisable to use either gun-cotton or picrate-powder for the bursting charge, as these would throw the fragments forward with more force than ordinary gunpowder, and thus produce a greater destructive effect.

THE CARRIAGE.

For the Revolving Cannon a special carriage has been constructed; this was found necessary, as the ordinary field gun-carriage is not provided with the means for procuring an excellent and immoveable rest for this gun.

The trail of the carriage consists of two brackets of steel plate, connected by three transoms and bolts, the rear-end being connected by the trail eye-piece. The brackets diverge against the trunnions.

The trunnion-bearings, and the bearings for the axle-tree, are riveted to the outside of the brackets, and are fitted in the ordinary manner.

The axle-tree is of steel, the arms being slightly conical. The wheels have metallic naves and ring-tires. The nave consists of two parts: the inside flange with the pipe box, and the outside flange. The spokes are cut in a conical form at their "hub" ends, so that they fill the nave flanges, and the two parts of the nave are bolted together with the spokes with six screws.

These wheels are very strong, and have been found practical and economical in service, and they allow spokes to be easily substituted for others when broken.

The elevating arrangement consists of a screw working in a gun-metal nut, resting in the oscillating bearing; this nut is revolved by conical gear wheels from the left side of the trail, the top end of the screw being attached to the trunnion saddle plate.

The handspike is hinged to the trail so as to fold back in travelling. A tool-box is placed between the trail, this at the same time makes a solid connection of the trail brackets.

The carriage of the Revolving Cannon is usually provided with a light steel shield for the protection of the gunners from small arms fire.

This shield is of three parts, made to fold together, thus forming seats for two men. It can immediately, when coming into action, be unfolded, and only the muzzles of the barrels and the wheels of the carriage are exposed to the enemy. The steel plates are 6 mm. in thickness.

Two boxes are attached to the axletree, each to carry three feed-cases loaded with ten rounds of ammunition.

On the carriages not provided with a shield, these ammunition boxes are protected by light steel plates in front, and have a lid of steel, which, when raised, forms a small protecting-shield, and

when closed, they form seats for two gunners, so that with two or three gunners on the limber, a sufficient number of men to serve the piece would be taken into action with the gun itself.

To check the recoil of the gun, a brake of the following construction is used :—

Each axle-arm has a screw cut on its extremity, this carries a nut, forming a conical cap, partly enveloping the front side of the wheel nave, which is likewise conical, to fit the inside of the cap ; this has a short crank, by which it can be revolved on the axle. When screwed-up, this cap grips the cone of the nave of the wheel, and the tighter the cap is screwed-up so the wheel turns with the more difficulty on its axis, until it gets immovably locked on the axle by the friction of the cones. When the cap is unscrewed, it is disengaged from the wheel, which then can turn freely on the axle. The screws on the ends of the axle-arms have right and left-handed threads, so that the caps become tightened by the effect of the recoil.

This brake is used at the same time as an ordinary travelling-brake, and it can be applied without the carriage being stopped, as is necessary with the shoe-brake commonly used on gun carriages.

PRINCIPAL DIMENSIONS AND WEIGHTS OF THE CARRIAGE.

Weight of carriage, with wheels, ammunition boxes, and accessories, complete	530 kil.
Weight of steel shield	150 kil.
Weight of wheels, each	85 kil.
Diameter of wheels	1400 mm
Weight of trail on the ground	45 kil.
Weight of trail when hooked on limber-hook	20 kil.
Track of wheels	1500 mm
Angle of trail with the ground	17°30′
Height of trunnions above the ground	1060 mm
Extreme angles of elevation and depression	−5°+25°
Greatest angle of dispersion with horizontal training apparatus	3°

THE LIMBER AND THE AMMUNITION-CHEST.

The limber resembles in general construction the French Government service limber; it consists of a frame-work of wood, placed upon wheels of equal size and construction as those of the gun-carriage.

The axletree is of steel, it has no axletree-bed, but is attached directly to the "futchells."

The trail of the gun-carriage hooks up to a hook-pintail attached to the axletree. The limber has a swing splinter-bar to which the traces of the horses are attached, and the shaft is arranged for double draught.

The limber carries an ammunition-chest made of wood, conveying four hundred rounds of ammunition, and it is fitted with four boxes, each containing one hundred rounds. The cartridges are held immovably in the boxes when the lids are closed, to prevent their being injured in travelling over rough roads. The ammunition-chest is covered with painted sail-cloth, and is rendered water-tight; the corners are protected by angle-irons, and it is attached to the limber by two hooks and screws.

The weight of the limber, with ammunition-chest complete is 300 kil.

SUMMARY OF PRINCIPAL WEIGHTS.

	Kil.
Gun, with lateral training apparatus . . .	550
Carriage, with all accessories	420
Limber, wth ammunition chest	300
Four hundred and sixty rounds of ammunition .	345
Four gunners	240
Total . . .	1855

This weight distributed over six horses, gives 309 kil. per horse, a very low rate, the usual weight for the draught of a horse in light artillery being about 350 kil.; so that this gun possesses that which in modern warfare is so necessary—the quality of easy transportability to a satisfactory extent.

BALLISTICAL RESULTS OBTAINED WITH THE HOTCHKISS REVOLVING CANNON AT GAVRE, IN JANUARY, 1874.

Initial velocities measured at $25^{met.}$ distance from the muzzle. French Ripault powder, density of charge, 0.908.*

Weight of charge	$100^{gr.}$	$110^{gr.}$
Weight of projectile	$507^{gr.}$	$507^{gr.}$
Mean initial velocity	$421.7^{met.}$	$432.9^{met.}$

RANGE, DEFLECTION, AND DEVIATION.

Weight of projectile $507^{gr.}$, charge $100^{gr.}$ Ripault powder.

Total angle of elevation	34° 47′
Velocity of wind { parallel to line of fire	$3.1^{met.}$ *
Velocity of wind { perpendicular to line of fire	$1.1^{met.}$ †
Density of air	1.247
Mean range	$4014^{met.}$
Mean deflection to the right	$32.2^{met.}$
Mean deviation { longitudinal	$25.0^{met.}$
Mean deviation { lateral	$1.5^{met.}$
Mean angular deviation (in minutes)	0′ 14″
Mean deviation in velocity	0.0114^{met}

* From ahead. † From right.

From the above table it will be seen that the accuracy of fire is more remarkable than has been known to have been

---

* Since this period, some new ballistical improvements have been made on this gun, and at trials made by the French Government at Bourges in June, 1874, a mean initial velocity of $458.8^{met.}$ was obtained with $110^{gr.}$ of powder, and a projectile weighing $507^{gr.}$

The ranges at this trial were :–

Elevation	2° 40′	5°	10°	15°	20°	25°	30°	35°
Range in met.	1003	1723	2842	3460	3916	4240	4580	4700

obtained from any other gun, the proportion of the mean longitudinal deviation to the range being only 0.00623, and that of the mean lateral deviation 0.00039, whilst the mean variation in velocity $0.0114^{met.}$ is practically nothing.

MAXIMUM RANGE.

The maximum range of the Hotchkiss Revolving Cannon of the model of 1874, with a projectile weighing $520^{gr.}$ and a charge of $120^{gr.}$ is about $5000^{met.}$. The corresponding angle of elevation is 35°. The projectiles ricochet up to about $3000^{met.}$

BURSTING OF THE PROJECTILES.

A number of projectiles charged with $25^{gr.}$ of musket powder were burst by means of electricity, in a wooden box measuring one cubic metre, filled with wet sand, so that all the fragments were obtained after the explosion.

The average number of fragments from each projectile were fifteen of iron, three of the brass coating, and the fuse, comprising:

Three pieces weighing between	$100^{gr.}$	and	$50^{gr.}$		
Five	„	„	$50^{gr.}$	„	$25^{gr.}$
Eleven	„	„	$25^{gr.}$	„	$10^{gr.}$

In all cases the bottom of the projectile came off in one piece, weighing about $80^{gr.}$. The lines of rupture generally pass through the cuts under the brass coating.

SENSITIVENESS AND GENERAL ACTION OF THE PERCUSSION-FUSE.

At the trial of the Revolving Cannon at Gavre several shots were fired into the sea at angles of — 2′, + 15′, + 2°, + 3°, + 5°, and all the projectiles burst on striking the water.

Twenty-five fuses were fired at different angles from 20° to 34° 47′, and no missfire occurred.

At a trial in Roumania, in July, 1874, three hundred and twenty shots were fired at elevations from 3° to 6° 30′, and no fuse was found which had not acted properly.

PENETRATION OF THE PROJECTILES.

The gun was placed at 150$^{met.}$ distance before a target of oak 12$^{cm.}$ thick. Three shots were fired, all penetrating the target, the first shot bursting a few metres behind it. The second shot burst 400$^{met.}$ and the third shot 300$^{met.}$ behind the target after having struck the ground.

Three shots were fired against a cast-steel plate, 10$^{mm.}$ thick, at the same distance of 150$^{met.}$ from the gun. The first two shots penetrated the plate, and burst a few metres behind it. The third shot, which was directed against an oak framework 25$^{cm.}$ thick, to which the plate was fastened, penetrated the latter, and burst inside the wood, tearing and splitting it about 1200$^{mm.}$ in length.

GENERAL REMARKS ON THE SYSTEM.

On thus examining the results obtained by the Revolving Cannon, it is found to be an arm of very superior capacity and of well-calculated proportions. The power of the powder is utilised in a high degree, for with a projectile weighing $520^{gr.}$, and with a charge of about one-fifth, there results an initial velocity of $458^{met.}$ and a range of about $5000^{met.}$; an effect which only recently has been obtained with regular field artillery, whilst the precision of the fire in both range and direction is remarkable In the greatest degree, surpassing anything that has been obtained up to the present time.

The trajectory of the gun is, for an effective range, low, and a very precise, rapid, and effective fire can be kept up at a range of $4000^{met.}$, corresponding with an elevation of $20°$.

This machine-gun has, besides its great accuracy and range, the peculiar and valuable advantage of firing explosive projectiles, producing the greatest moral and physical damage to the enemy, and enabling at the same time to rectify its fire by observing the explosions of falling projectiles, thus giving it an incontestible superiority over all other machine guns and mitrailleuses.

As there is no recoil and no change of direction during the fire, the gun, once laid, will continue to throw from sixty to

eighty explosive shells per minute, at ranges approaching to those of field artillery, on the same spot, or on various points of any line requiring the same elevation, without any further operations than those of supplying the gun with cartridges, turning the crank, and regulating the lateral adjustment.

The essentially mechanical arrangement of the system is simple and compact; the working parts are strong and of simple form, and they are all encased within the solid breech, and not one of them is exposed to the shock of discharge.

The brass coating of the projectiles affords an excellent bearing for the grooves of the rifling, and at the same time obviates the difficulties of leading and fouling of the bore, while the saw or tooth-like grooves cut into it reduce the friction to the greatest possible extent, thus giving a satisfactory velocity with a minimum of strain on the gun.

The metallic cartridge always produces an absolutely gas-tight closure of the breech.

Another feature of this arm, to be well estimated in actual service, is its facility of manipulation. The operation of loading is simple, and the gunners only require the briefest instruction, as, besides the laying of the gun, nothing is necessary but to supply it with cartridges, and to revolve the crank.

COMPARISON OF THE RESULTS OF THE HOTCHKISS REVOLVING CANNON WITH THOSE OBTAINED BY OTHER GUNS AT GAVRE.

A part of the before-mentioned trial at Gavre in July, 1873, comprised some practice with a revolving cannon under exactly the same conditions as with four Gatling guns of different calibres, which had shortly before been under experiment by the same commission, with a view of comparing the effects of these different kind of arms.

The guns under test were as follows :—

Nature of Arm.	Weight of Projectile.	Charge.	Bursting Charge.	Weight of Gun.
36.68^{mm} Revolving Cannon . .	490.00$^{gr.}$	85.00$^{gr.}$	20.00^{gr}	475$^{kil.}$
25.5^{mm} Gatling Gun	256.85$^{gr.}$	31.77$^{gr.}$	—	347$^{kil.}$
16,6^{mm} „ „	97.52$^{gr.}$	19.33$^{gr.}$	—	335$^{kil.}$
11^{mm} „ „	24.20$^{gr.}$	5.16$^{gr.}$	—	170$^{kil.}$
11^{mm} Mountain Gatling . . .	24.20$^{gr.}$	5.16$^{gr.}$	—	64$^{kil.}$

FIRST EXPERIMENT: Firing against a battalion of Infantry in columns, divided into three troops or companies, represented by three Targets, each 1,80$^{met.}$ high, and 70$^{met.}$ long, placed at distances 70$^{met.}$ apart. Distance of all guns from the first Target, 1650$^{met.}$.

TABLE I.

NATURE OF ARM.	Angle of Elevation.	Number of Rounds Fired.	Expenditure of Ammunition in kil.	NUMBER OF HITS.			Total Number of Hits.	Percentage of Hits.	Number of Hits per kil. of expended Ammunition.	Effective Power.
				1st Target.	2nd Target.	3rd Target.				
36.68^{mm} Revolving Cannon . .	6°36′	80	53.6	3	39	13	55	70	1.04	36.40
11^{mm} Gatling Gun	8°25′	400	15.7	19	24	2	45	11.25	2.85	26.32
11^{mm} Mountain Gatling . . .	10°15′	435	17.1	6	10	0	16	3.70	0.89	8.62

The superiority of the Revolving Cannon is here well marked.

SECOND EXPERIMENT: Firing against a battalion of Infantry in columns, divided into platoons represented by 6 Targets each, 1,80$^{met.}$ high, and 35$^{met.}$ long, placed 35$^{met.}$ distance apart. Distance of all guns from first target, 1795$^{met.}$.

TABLE II.

NATURE OF ARM.	Angle of Elevation.	Number of Rounds fired.	Expenditure of Ammunition in kil.	NUMBER OF HITS.						Total Number of Hits.	Percentage of Hits.	Number of Hits per kil. of Ammunition expended.	Effective Power.
				1st Target.	2nd Target.	3rd Target.	4th Target.	5th Target.	6th Target.				
36.68^{mm} Revolving Cannon	6°30′	80	53.6	2	49	42	25	20	1	139	173.7	2.59	90.32
25.5^{mm} Gatling Gun . . .	6°1′	300	113.4	12	76	66	12	3	3	172	57.33	1.45	33.82
16.6^{mm} Gatling Gun . . .	6°14′	216	36.5	3	6	6	20	5	1	41	18.9	0.90	31.49

In this case, also, the Revolving Cannon much surpasses the other Guns.

By the aid of extracts from the "Official Report on Competitive Experiments of the Montigny Mitrailleur and Gatling Guns, at Shoeburyness, in August and September, 1870," there are means of making a comparison of the Hotchkiss Revolving Cannon with the guns under consideration at that trial.

The following tables comprise the practice at ranges of 1280$^{met.}$ and 1890$^{met.}$, as a comparison can only be then made if the ranges and other circumstances do not differ largely from each other.

TRIALS AT SHOEBURYNESS IN 1870.

First Experiment: Firing against a column of targets 16.44$^{met.}$ long, representing 90 infantry, divided into three troops or companies 18.30$^{met.}$ apart. Distance of all guns from first target, 1280$^{met.}$ Time of firing, two minutes.

TABLE III.

NATURE OF ARM.	Number of Rounds Fired.	Number of Hits.	Percentage of Hits.
25.5^{mm} Gatling Gun	255	99	38
16.6^{mm} „ „	239	236	98
11^{mm} „ „	545	104	19
Montigny Mitrailleur.	272	68	24

Second Experiment: Firing against a column of targets 8,22^{met} long, representing 45 infantry, divided into three troops or companies 27$^{met.}$ apart. Distance of all guns from first target, 1890$^{met.}$ Time of firing, two minutes.

TABLE IV.

Nature of Arm.	Number of Rounds fired.	Number of Hits.	Percentage of Hits.
25.5$^{mm.}$ Gatling Gun	238	99	41
16$^{mm.}$ „ „	338	164	48

CONCLUSIONS FROM THE FOREGOING.

In comparing the results obtained in Table I., we find that the number of hits per 100 shots fired with the Revolving Cannon, during an equal length of time, are six times greater than those obtained with the 11^{mm} Gatling Gun, and twenty times greater than with the 11^{mm} Mountain Gatling.

The number of hits per kil. of expended ammunition is less for the Revolving Cannon than for the Field Gatling, but more than for the Mountain Gatling, while the effective power* is :—

For the Revolving Cannon	36.40
For the Field Gatling	26.32
For the Mountain Gatling	8.62

In Table II. the percentage of hits of the Revolving Cannon is three times higher than the 25.5^{mm} Gatling, and nine times higher than that of the 16.6^{mm} Gatling, and the number of hits

---

* By the effective power of an arm is understood the compound quantity which is governed by the number of hits on the targets, the time of firing, the distance the targets are placed from the gun, and the dimensions of these targets.

In the determination of the effective power, there are, besides the unit of time, two quantities, which are fixed by the conditions of the practice, viz., the range and the dimensions of the targets, as these are chosen analogically to the circumstances under which the arms to be tested are subjected in actual service, we have the means of comparing different kinds of arms under the practical conditions they are employed in.

Observe that the effective power under the above stated conditions affords no judgment of the weight of ammunition expended ; and as there are certain cases where it is not only important to know what effect can be produced with an arm, but what quantity of ammunition it requires to produce this effect, it is necessary to compare these two figures with each other, and we can thus form a true judgment of the merits of the different arms.

This definition of effective power is used by the French Artilleries, and in the present case is taken out of the "Memorial de l'Artillerie de la Marine," 2$^{me.}$ livraison, 1874, where the comparative trials of the Hotchkiss Revolving Cannon with the other guns are reported.

per kil. of expended ammunition is nearly double of those obtained with the 25.5, and nearly three times that of the 16.6^{mm} Gatling. The effective powers are :—

For the Revolving Cannon	90.32
For the 25.5^{mm} Gatling	33.82
For the 16.6^{mm} Gatling	31.49

That is to say, in this case the Revolving Cannon obtained an effect nearly three times as destructive as the Gatling guns, with an expenditure of half the weight of ammunition.

Comparing the number of hits per cent. of the guns in Tables III. and IV. with the Revolving Cannon, in Tabies I. and II., the number of hits is higher for the Revolving Cannon than for all other guns.

Note the time of firing in Tables I. and II. was one minute, whilst the times of firing in Tables III. and IV. were two minutes, so that, considering the time of firing, the number of hits is much greater for the Revolving Cannon than for the other guns.

In the report of the "Memorial de l'Artillerie de la Marine," 2^{me} livraison, 1874, page 313, it says: "Le canon revolver Hotchkiss réalise un tir rapide et précis jusqu' à 3,500$^{met.}$ et sur des troupes placées en colonne, ou sur des tirailleurs présentant une grande pro-

fondeur, il peut produire, à des distances supérieures à la limite du tir efficace de l'infanterie, des effets plus considérables que les mitrailleuses Gatling."

It must also be remarked that these results were obtained with a Revolving Cannon of the first model, built in 1871, of inferior ballistical capacity, with a projectile weighing 490$^{gr.}$ and a charge of 85$^{gr.}$ Since this time the inventor has, from his own experiences, and according to some valuable suggestions and indications made by the committee of experiments at Gavre, augmented the power of his arm, so that there is reason to expect from the guns of most recent date, using a projectile of 520^{gr} and a charge of 120$^{gr.}$, results much superior to those obtained at Gavre in January, 1873, and it is to be regretted that sufficient data for making a comparison of the effects obtained with the latest models did not exist.

Judging from the general results, it may be concluded that the Hotchkiss Revolving Cannon is in most respects superior to, and can be used with greater advantage than, any other arm tested in the Tables from I. to IV.* for all purposes of defence, or on

---

* *The Memorial de l'Artillerie de la Marine, 2*^{me} *livraison,* 1874, *says, in page* 310: "*La justesse en direction est remarcable, la justesse en portée est satisfaisante, et le tir conserve sa reglarité jusqu' à la portée maxima de l'obus ou du boulet, soit* 3,600 *et* 4,000 *metres; le canon revolver a donc à cet égard une superiorité incontestable sur les mitrailleuses qui out déjà été examinées.*"

open ground at ranges approaching field artillery, for damaging materièl, and reaching troops behind cover; for the employment in advanced trenches or field works; and for repelling cavalry attacks and assaults on forts. This gun may be applied for offensive purposes in nearly all cases where light artillery can be advantageously used. It is, besides, a very valuable arm for marine use, when placed on the decks of ships, or for arming boats and for landing purposes.

For the last-named purposes, where it is not necessary that the gun should be absolutely without recoil, a lighter model is manufactured, its weight being only about 300 kil.

In the Hotchkiss Revolving Cannon the advantages of the Mitrailleuse are combined with the long ranges, precision, and moral effect of the explosive shells of artillery. The projectiles have also, to a certain extent, the penetrating power of the same.

The superiority of the Revolving Cannon over Mitrailleuses becomes the more remarkable the greater the distance at which it is used; whilst at ranges up to 250 or 300$^{met.}$ and for purposes of flank defence, case-shot also can be used with success.

It is evident therefore that both in mechanism and in general results, this arm possesses important advantages over all other systems of machine-guns.

The system of the Hotchkiss Revolving Cannon is not restricted to any particular calibre; it can be constructed either as a Mitrailleuse, which employs small-arm ammunition, or of calibres much larger than the before described gun, thereby affording the advantage of uniformity in the system of armament.

Two essentially different calibres besides the 37^{mm} calibre Revolving Cannon are now manufactured; the one is known as the "Hotchkiss Mitrailleuse," and another gun, designed specially for use in forts or fortified positions, this latter with a calibre of 52^{mm} and a projectile weighing $2^{kil.}$

THE HOTCHKISS MITRAILLEUSE.

This arm entirely resembles the Revolving Cannon in its construction, but it is generally made with nine instead of five barrels, the motion of the crank being accelerated by two helical wheels, to allow a speed of fire of about 150 shots per minute. This comparatively low speed has been adopted to insure the perfect and reliable action of the gun, as it is known that most of the defects in the working of other systems of Mitrailleuses are due, in great part, to the excessive speed at which the mechanism has to work, and the impossibility of being able to supply the gun with ammunition with the necessary precision and order.

The speed of 150 rounds per minute allows the application of the simple mechanism adopted for this arm, and it is also

with it to be less feared that ammunition may be unnecessarily wasted, as is the case with guns firing excessively fast.

As in the Revolving Cannon, the turning of the crank causes the automatic loading firing and extraction of the fired cartridge-shells, all these operations being performed continuously during the movement of the crank.

The cartridges are carried in feed-cases, packed parallel to each other, each case holding twenty-five cartridges. The cases are separately placed into the feed-trough, and from this they are automatically distributed to the barrels and fired.

The construction of the carriage is also similar to that of the Revolving Cannon.

A traversing apparatus on the gun enables it to be pointed in a horizontal direction as well as in elevation, without moving the trail of the carriage, and the balls can thus be distributed over a sector of a circle within its range during the fire, by adjusting the traverse.

The gun has no movement during fire, it being of sufficient weight to resist the recoil of each discharge.

This gun has many other valuable advantages, its superior ballistical features making it a very formidable weapon. Besides

this, the simplicity and durability of its mechanism better qualifies it for actual service than the Mitrailleuse guns hitherto constructed.

PRINCIPAL DIMENSIONS AND WEIGHTS OF THE HOTCHKISS MITRAILLEUSE.

Calibre		16mm
Number of barrels		9
Length		832mm
Rifling	Number of grooves	7
	Depth of grooves	0.5mm
	Width of lands	2mm
	Twist, one turn in	750mm
Diameter of barrels over the powder chamber		38mm
Diameter of barrels at the muzzle		26mm
Weight of gun		330kil.
Weight of gun with carriage and traversing apparatus, complete		800kil.

PRINCIPAL DIMENSIONS AND WEIGHTS OF THE AMMUNITION.

Charge of powder	25gr.
Weight of ball	100gr.
Length of ball in calibres	3.25
Length of cartridge-case	105mm
Weight of entire cartridge	160gr.
Length of entire cartridge	140mm

THE HOTCHKISS REVOLVING FORTIFICATION-GUN.

This gun is also identical in its general construction with the Revolving Cannon; but as it is designed to be employed as a gun of position, it is of a larger calibre, firing a projectile of $2^{kil.}$ with a charge of $0.500^{kil.}$

The inventor's idea is to enable a very quick, precise, and effective fire to be directed at any particular point within a range of 6000 to 7000 metres; that the gun shall be subject to no recoil or other movement preventing its continual action; and that the operations of loading, firing, &c., shall be performed automatically, so as to permit the delivery of 30 to 40 shots per minute without intermission.

For this the gun is mounted on a special standing carriage of sufficient weight, and fitted with the means of preventing recoil.

To obtain the required range and tension of the trajectory, the powder-charge is proportionally high, the calibre necessarily small, and the projectile very long, so that with a given weight of projectile, the proportion of weight to sectional surface shall be as large as possible.

The ammunition is similar to that of the Revolving Cannon. A metallic cartridge-case holds the charge, projectile, primer,

and lubricating wad combined in one. The projectile has a brass packing to take the rifling.

The cartridges are placed singly into the feed-trough of the gun, and from thence they are automatically distributed to the barrels, and then fired.

PRINCIPAL DIMENSIONS AND WEIGHTS OF THE HOTCHKISS REVOLVING FORTIFICATION GUN.

Calibre	52^{mm}
Total length of bore	1560^{mm}
Length of rifling	1226^{mm}
Rifling, one turn in	1250^{mm}
Twist and depth of grooves uniform.	
Number of grooves	14
Width of lands	2.5^{mm}
Depth of grooves	0.5^{mm}
Number of barrels	3
Weight of each barrel	85^{kil}
Total weight of gun	$1650^{kil.}$

PRINCIPAL DIMENSIONS AND WEIGHTS OF THE AMMUNITION.

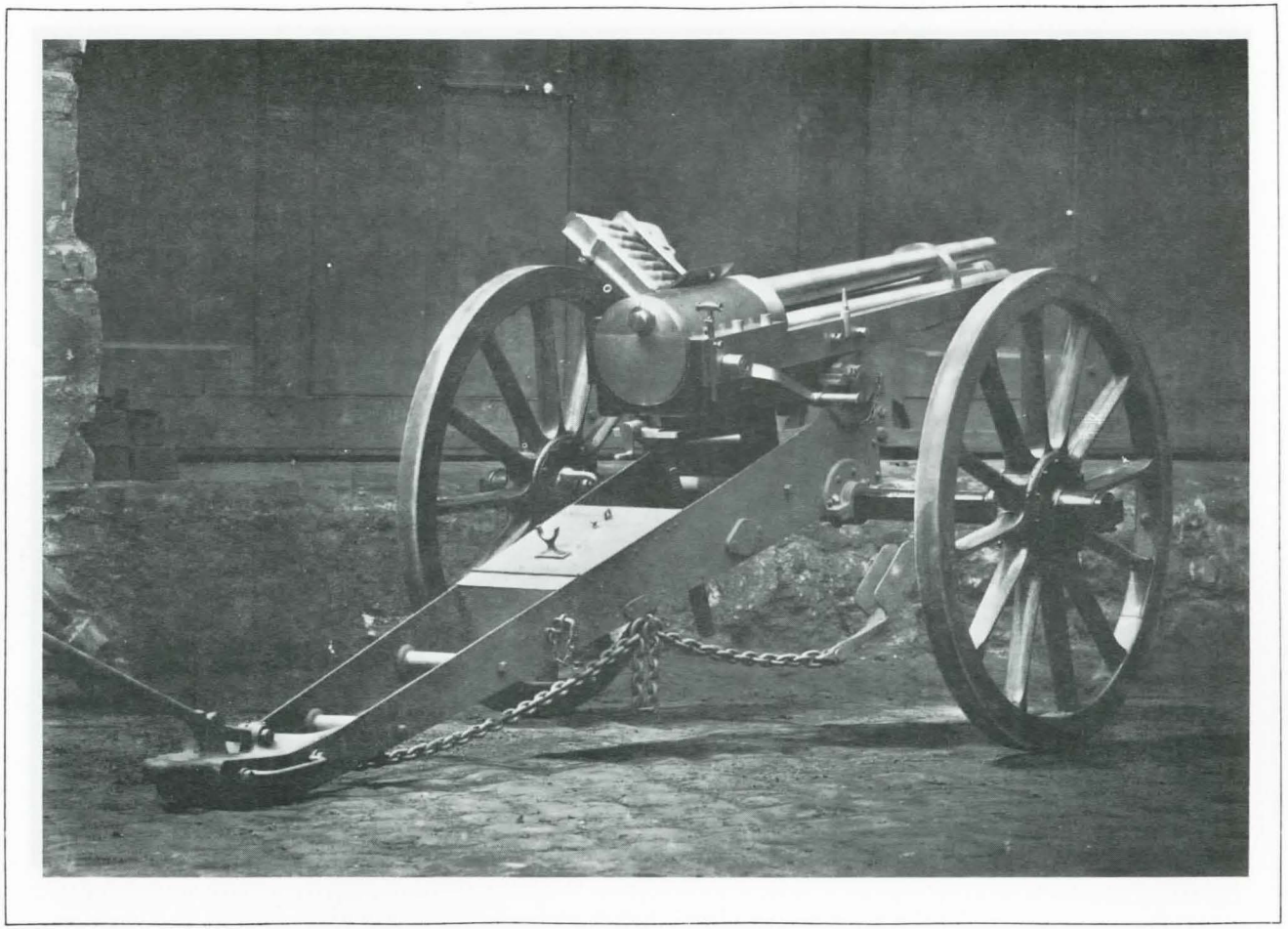
Weight of body of projectile	1.770^{kil}
„ „ percussion fuse	0.150^{kil}
„ „ bursting charge	0.080^{kil}
Total weight of projectile complete for firing	2.000^{kil}
Length of projectile	210^{mm}
Charge of powder	0.500^{kil}

Comparing various effects, the inventor is of opinion that a far more destructive result may be obtained from 30 to 40 rounds weighing $2^{kil.}$ each, from this gun during the time necessary to fire three to four projectiles weighing perhaps 25 to $30^{kil.}$ from a large ordinary fortification gun.

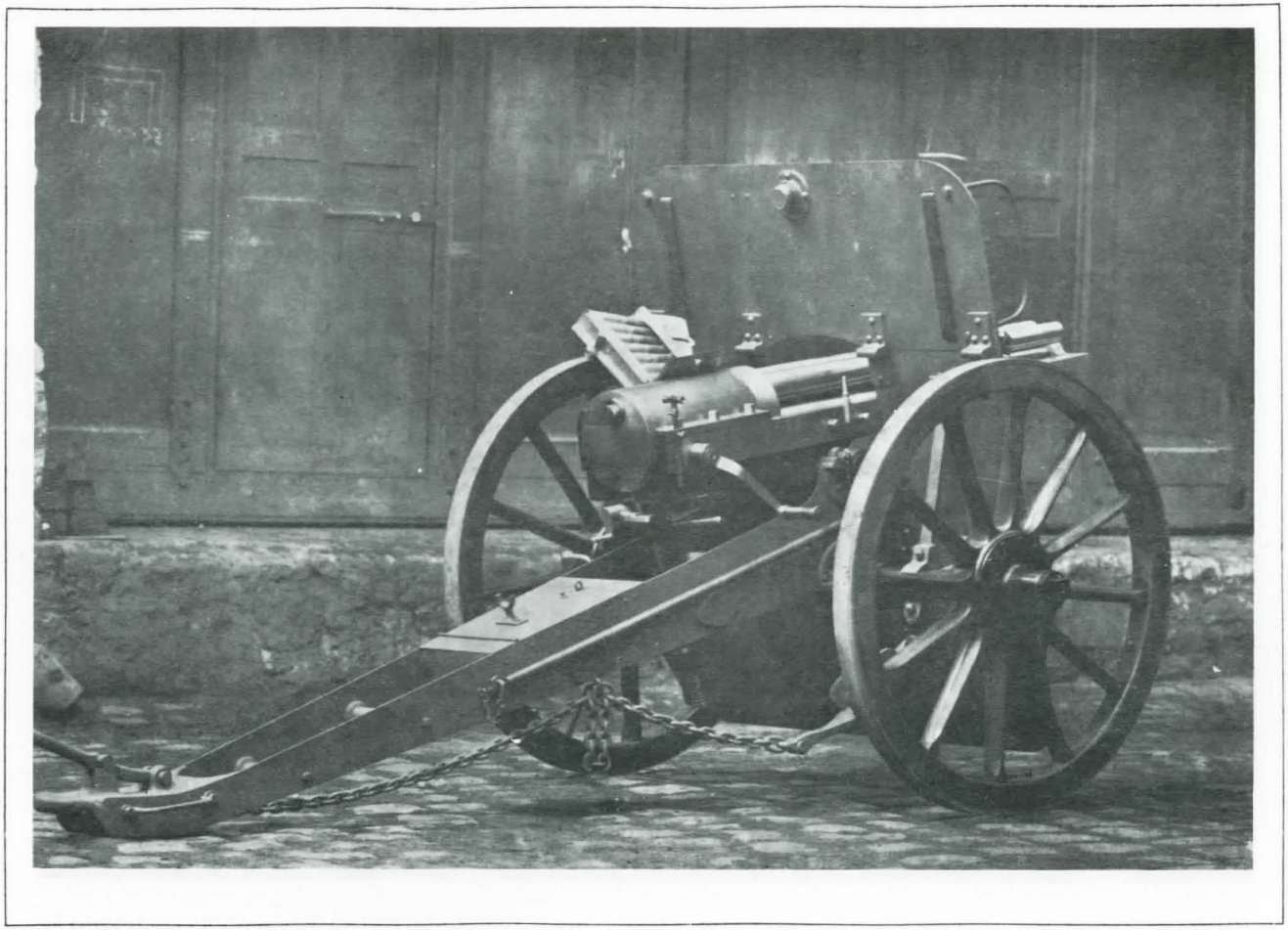
When rapidity can be combined with accuracy of fire the effect is certainly great, and the advantage is gained, with a rapidly-firing gun, to be able to produce a terribly destructive fire in decisive moments in an engagement, so that this gun, worked systematically and with deliberation, will no doubt produce very formidable effects. It will be found of particular value for clearing-away troops in the act of fortifying themselves, or when they are bringing siege-artillery into position; also for dislodging siege-batteries and repelling assaults. Its proper application in fortifications will make it almost impossible for an enemy to establish himself within its range.

The author hopes that this description may serve to draw the attention of military authorities to Mr. Hotchkiss's system of arm, as it certainly deserves their serious consideration, and will doubtless bear its full share in the determination of future wars, for but little demonstration is needed to point out the fearful execution of which such an arm is capable.

LIST OF PLATES.



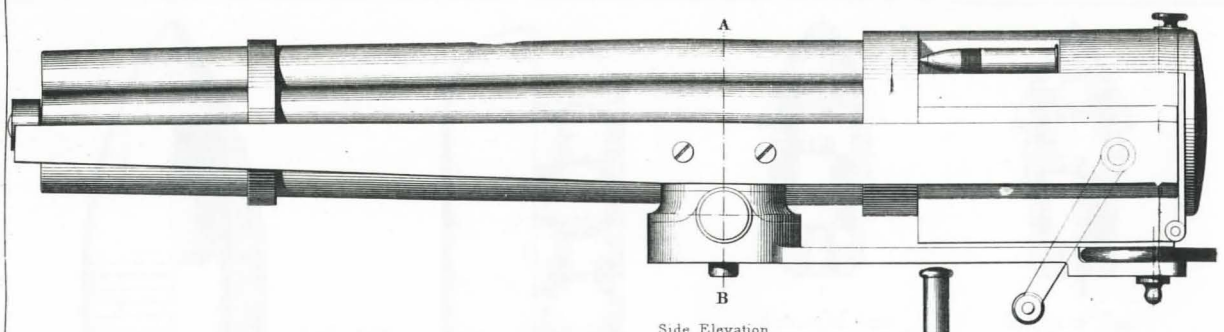
HOTCHKISS REVOLVING CANNON



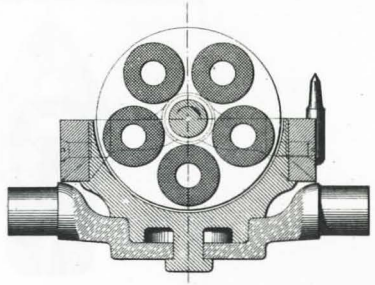
HOTCHKISS REVOLVING CANNON

HOTCHKISS REVOLVING CANNON

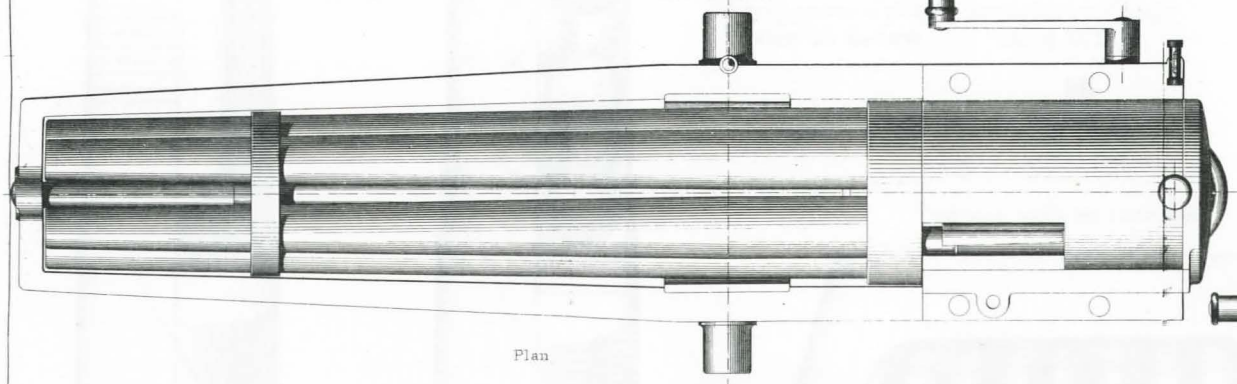
HOTCHKISS' PATENT REVOLVING CANNON



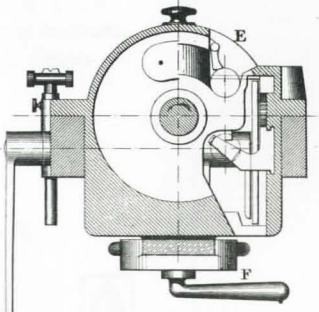
Side Elevation



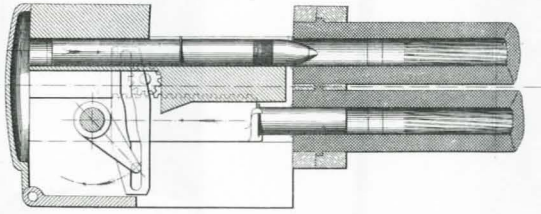
Vertical Section through **AB**.



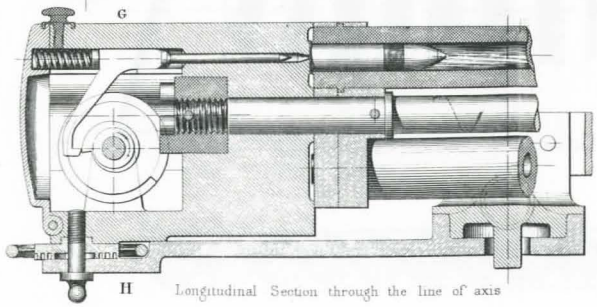
Plan



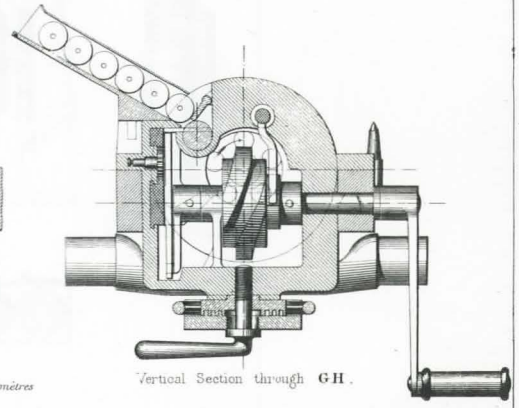
Front view of the breech



Longitudinal Section through **EF**.



Longitudinal Section through the line of axis

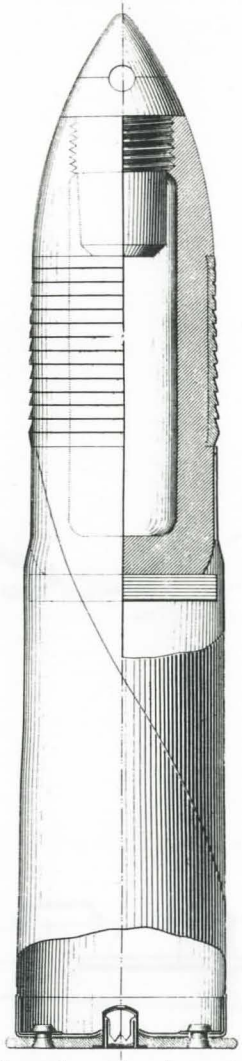


Vertical Section through **GH**.

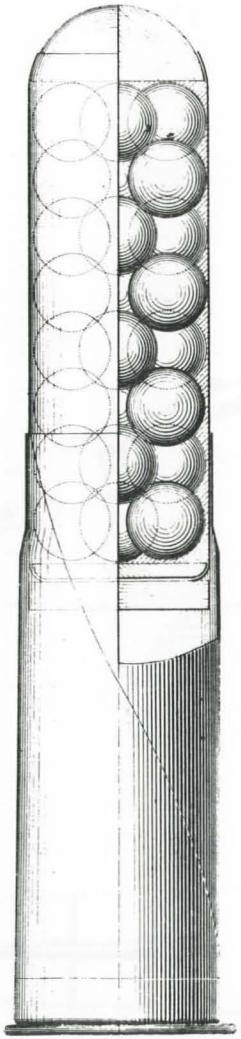
Scale of 0 10 20 30 40 50 60 70 80 100 Centimètres

Autog. J. Bronon et Courtier, Rue de Dunkerque 48. Paris

AMMUNITION FOR THE HOTCHKISS' REVOLVING CANNON

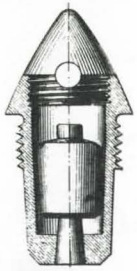


Full size



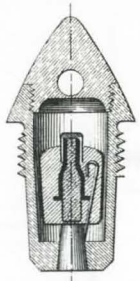
Cartridge with explosive shell

Cartridge with case-shot



Section of fuse showing position of plunger before the discharge

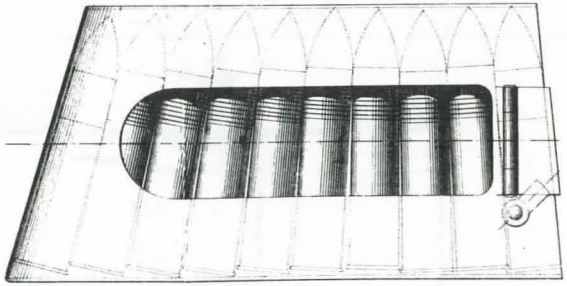
Section of fuse showing position of plunger during the flight



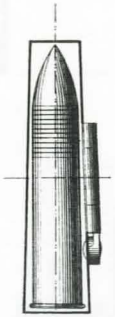
Section of fuse showing construction of plunger

Safety plug

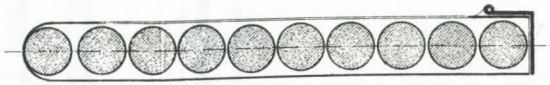
Feed case with ten cartridges Scale ¼



Plan



Vertical section

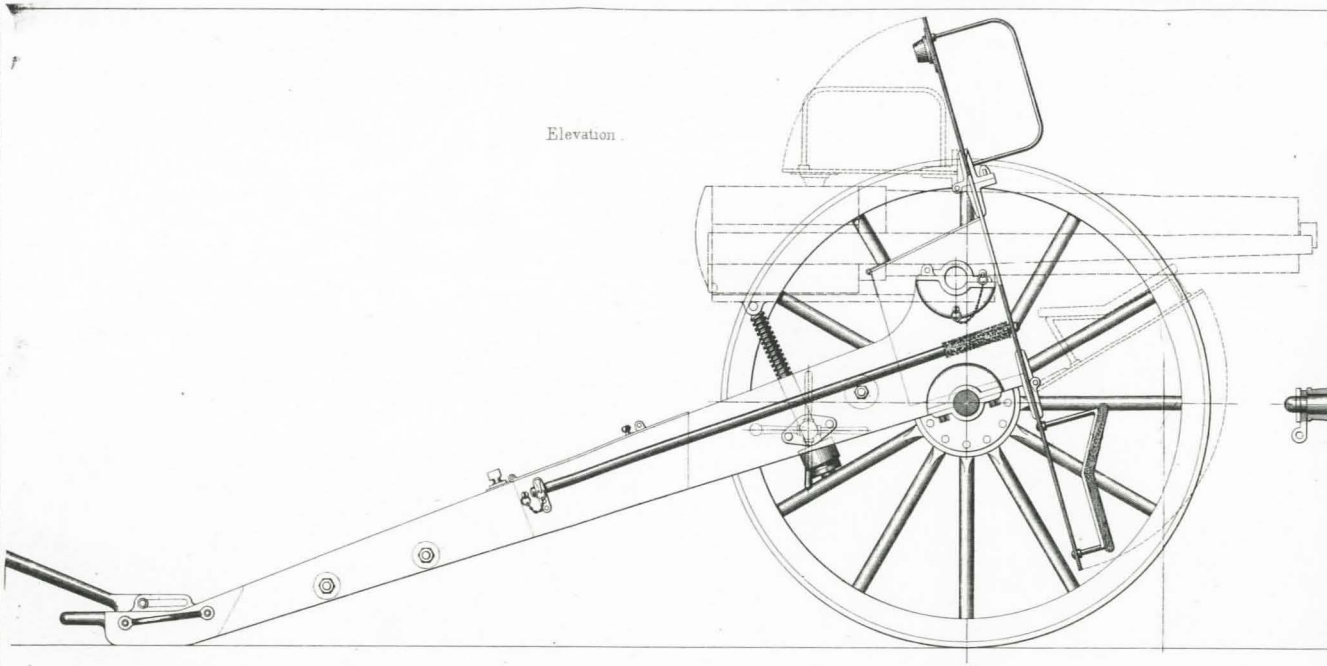


Longitudinal section

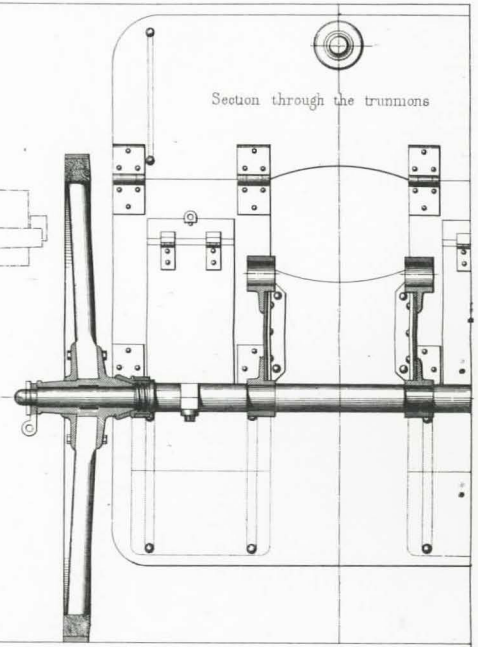
Autog. J. Broise et Courtier. Rue de Dunkerque, 43 Paris

CARRIAGE FOR HOTCHKISS' REVOLVING CANNON

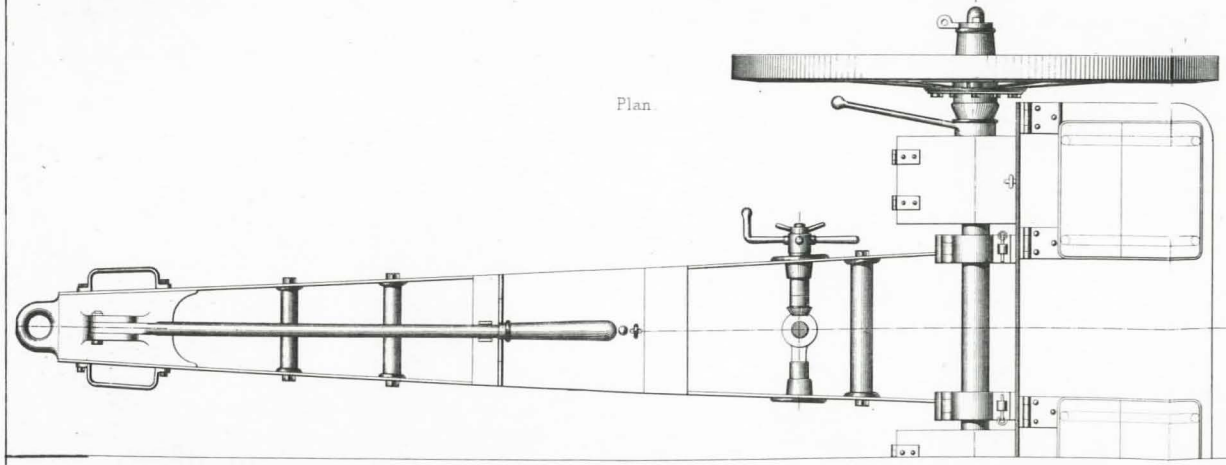
Elevation



Section through the trunnions



Plan



Elevating screw

Scale 1 10

Imp. J. Rivoire et Courtier, Rue du Dunkerque 43 Paris