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## THE MAXIM MACHINE GUN.

The mitrailleuse, or machine gun, as hitherto constructed, is a weapon in which all the functions of loading, cocking, firing, and extracting the empty shell from the gun are performed by turning a crank or by working a lever. The first successful gun of this kind was the invention of Dr. Gatling, an American. This gun was brought out during the war of the rebellion, and before metallic cartridges, which are so essential to the success of a machine gun, had reached their present degree of perfection.

Dr. Gatling did not succeed in getting his gun used to any extent in the war of 1860-64. The first machine gun which ever saw service in the field was the French mitrailleuse. This gun was large, absurd, and clumsy, and so heavy that it required to be drawn by horses; it would fire but 150 shots per minute. It did not comprise the necessary elements of success, and consequently failed.

The next machine guns to make their appearance were the Hotchkiss, the Lowell, the Nordenfelt, and the Gardner. All of these, except the Nordenfelt, were operated by a hand crank, the Nordenfelt alone being actuated by a reciprocating lever. All of these guns must necessarily be mounted upon a firm base, and be trained and elevated by screws and worm gears. If they were made to work freely upon a pivot or universal joint, they would not be firm enough to remain stationary while the crank or handle was being operated. The safe speed at which a machine gun can be fired depends in a great measure upon the kind and age of cartridges used. For instance, if cartridges have been made for some time, a trifling amount of moisture may have accumulated in the powder near the primer. When this dampness occurs, the cartridges are said to hang fire, that is, they do not explode at the instant of being struck. Suppose that one cartridge in a thousand should hang fire; it would be necessary to operate the gun sufficiently slowly on the entire series to give this slow cartridge time to explode, otherwise it might be drawn from the barrel before it exploded, or in the act of exploding, in either of which cases it would disable the gun. To this may be attributed a great deal of the trouble in operating machine guns, and their liability to get out of order when most needed. In the gun of which we publish illustrations herewith and which is the invention of Mr. Hiram S. Maxim, of Hatton Garden, London, slow cartridges do not offer an obstacle to the rapid firing of those which will explode quickly, from the fact that no cartridge can be drawn from the gun until it has exploded, as it requires the force of its own explosion to unlock the block from the barrel and extract the empty shell. In Mr. Maxim's new gun there is but one barrel, and all the functions of loading, cocking, firing, withdrawing the empty shell from the barrel, and ejecting it, are performed by the recoil resulting from the explosion. This gun may be likened to a small engine, the barrel under the influence of the recoil acting as the piston, the block as the crosshead, and the sear and trigger as the valve gear. The cartridges to the number of 333 are placed side by side in a canvas belt, secured together with brass eyelets and strips. One end of this belt is connected to the arm, and the gun is operated by hand until the first cartridge is driven into the barrel. Then the trigger is pulled, this cartridge explodes, the breech bolt is unlocked from the barrel, the empty case is extracted, moved to one side, a loaded cartridge is brought in front of the barrel, the arm is cocked, the cartridge pushed home, and the trigger pulled, when the explosion of the second cartridge operates the same as the first. Thus the firing may be kept up automatically without any action on the part of the attendant as long as there are any cartridges in the belt. Our engravings represent respectively a side view and a front view of the gun and its stand, a longitudinal section of the barrel and the mechanism, and a detail of the firing device. The weapon is mounted upon a tripod stand (Figs. 1 and 2), and between it and the top of the stand there is placed a magazine, which is protected from the enemy's fire by a pair of light shields. The gun can be rotated about the vertical axis by means of a handle (Fig. 1) which turns a tangent screw; or if the three-armed nut at the bottom of the axis be slackened, the barrel can be moved by hand to spread the fire over a considerable area. If a definite piece of ground is to be subject to the fire, such as a bridge, a pass, or a ford, the gun can be sighted in succession to each end of the space and its motion beyond those limits prevented by adjustable nuts on the screw spindle. The elevation of the barrel is altered by turning the hand wheel on the strut stretching from the stand to the rear of the gun. By slackening a clip on this strut the screw is thrown free, and the weapon can be elevated and depressed.

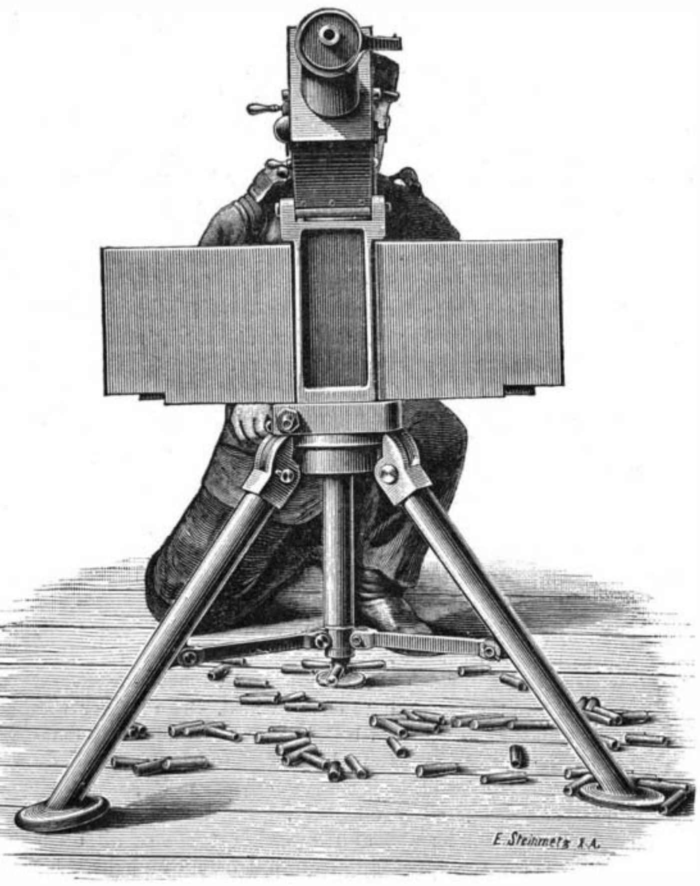


Fig. 2.

We will now consider the mechanism by which the loading and firing is effected. The barrel, B, which is inclosed in a water jacket (Fig. 5), is capable of a longitudinal motion of about seven-sixteenths of an inch upon the explosion of a cartridge, and moves back, pushing before it the breech bolt, the sear, and the rest of the moving parts. Its motion is in the first instance opposed by two springs, which are forced outward by the toggle arms. As soon as the arms have passed the center, the springs begin to close again, and aid the motion of the barrel. At first, as we have already said, the barrel and the block or breech piece, A, travel back at the same speed, but for the spent shell to be extracted and the new cartridge to take its place, the block, A, must leave the barrel a considerable distance for the other mechanism to come into play.

The two are at first fixed together by the locking latch, C, which is held down by the stop, N. A slight

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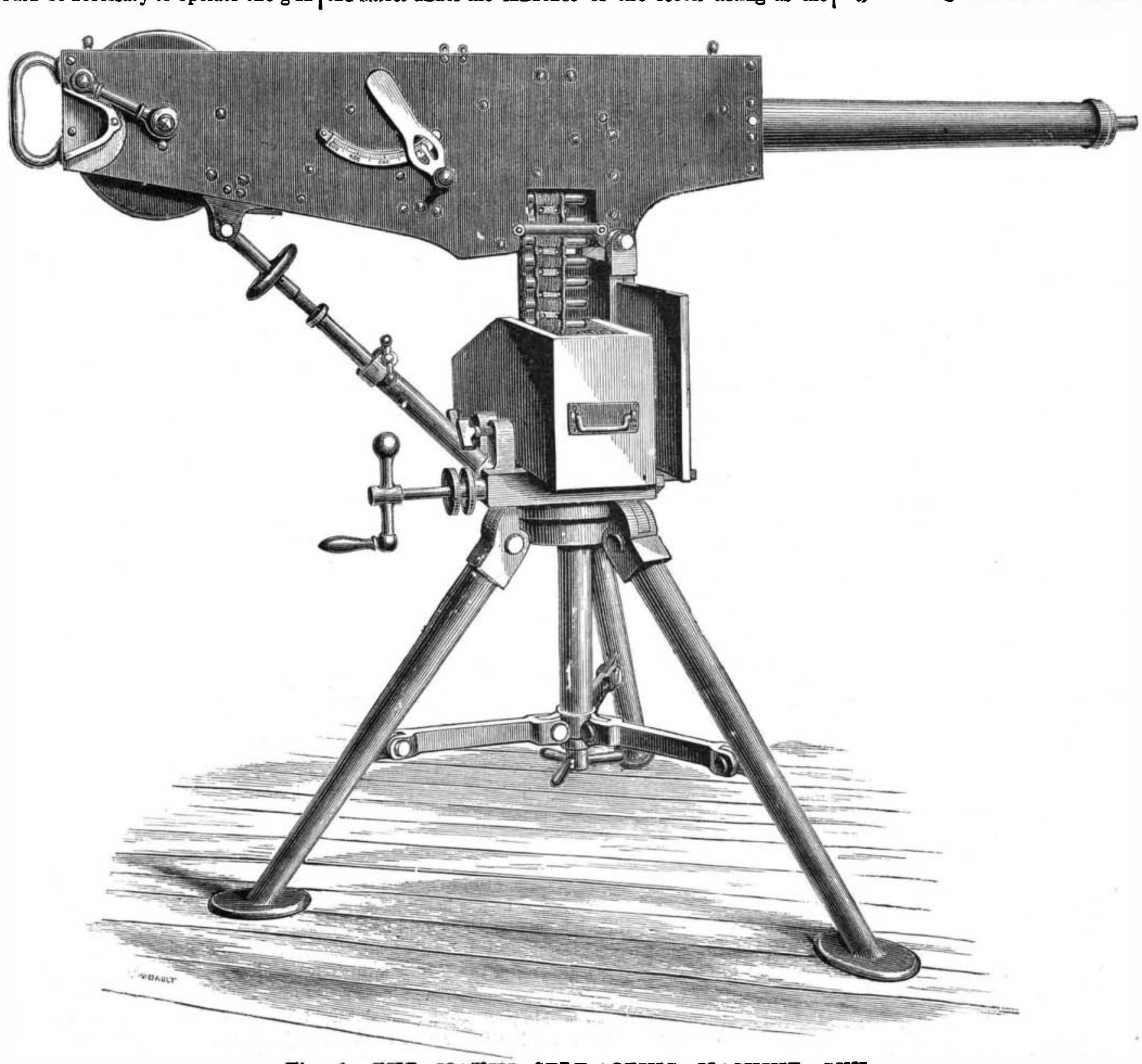

FIG. 1.—THE MAXIM SELF-ACTING MACHINE GUN.

### THE MAXIM MACHINE GUN.

*(Continued from first page.)*

motion carries the catch free of the stop, and a little more lifts the catch, by its tail coming in contact with the stop. The bolt and the barrel are then free of each other, and the former receives a rapidly accelerated motion from a lever pivoted on the barrel, and moves with it. As the barrel approaches the end of its stroke the point of the lever meets a stop, and commences to rotate about its pivot. In doing this it forces forward a piece connected to the block, first with a slow motion and then with a gradually augmenting one, as the leverage of one arm increases and that of the other diminishes while the lever rolls over the stop and the piece. By the action of the lever the barrel is arrested, while the block and the mechanism attached to it continue to move until the crank, I, gets on to the back center. As soon, however, as the block has commenced to leave the barrel, and before the latter has come to rest, the extractor, M, strikes the peg which stands in its path, and turning on its pivot on the barrel, draws the shell about ¼ inch out of the gun. This extractor has two arms, shown in dotted lines, which take hold of the empty cartridge at each side, and withdraw it with certainty. The extraction is completed by a hook shown (Fig. 5) attached to the crosshead.

This hook runs under a fixed spring, which is curved upward at each end to reduce the pressure when the shell is being started, and when it is about to be released. The empty cartridge case is deposited in one of the pockets of the cylinder, G, which is partially rotated just as the crank reaches the back center, and is carried round to be dropped out after the next shot. This cylinder is visible in Fig. 4, where a shell is seen in the act of falling out. The partial rotation of the cylinder brings the next pocket, which has already been charged, into a line with the barrel, and now the first series of operations is complete. The recoil has taken place, the breech block unlocked, the shell first started, and then completely extracted and removed, and the new cartridge brought into position for loading.

The next series, which is about to commence, consists in cocking the hammer or striker, pushing the cartridge home, locking the breech piece, and releasing the sear. As the crank approaches the back center the tail, D, of the cocking lever meets the stud, J, and the catch is caught and detained by the sear. The main spring, which is somewhat indistinctly shown coiled round the striker, is thus compressed, and held ready for action. When the crank has passed the center the breech block moves toward the barrel, pushing the cartridge before it until the latter is home and the block is locked by the catch, C.

The momentum of the crank and crosshead is sufficient to carry the barrel forward until the toggle arms, *d d*, pass the center, and the springs, *e e*, are in a position to urge it to the end of its travel. If the gun is set for very rapid firing they do this immediately, and the sear coming into contact with the cam, K, the striker is released, and the cartridge fired. After the shots have been fired the same cycle of operations is repeated, with this difference that the crank, instead of starting from the position shown in Fig. 5, occupies the dotted position, and commences to rotate in the opposite direction. It never makes a complete revolution. But if the gun be not set for a rapid rate of firing, there is a pause after the breech is locked, and the length of the time is determined by the adjustment of a hydraulic buffer, resembling in principle a cataract cylinder. This appliance (L, Fig. 5) consists of a piston working in a cylinder with a by-pass between its two ends. This by-pass is a plug, and is provided with a handle working over a quadrant on the outside of the case. This quadrant is marked for speeds between *nil* and the maximum, according to the opening which is afforded between the two ends of the cylinder at the various angles. The rate of fire can be reduced in practice to one shot in every twenty-five seconds, and by very careful adjustment to one in fifty seconds. The operation of the hydraulic buffer is as follows: Upon the upper side of the barrel is a stop which, just before the end of the forward stroke, meets the piston of the buffer, as clearly shown in Fig. 5. Under the influence of the springs, *e e*, it forces the liquid through the plug until the barrel has moved far enough to lift the sear, and

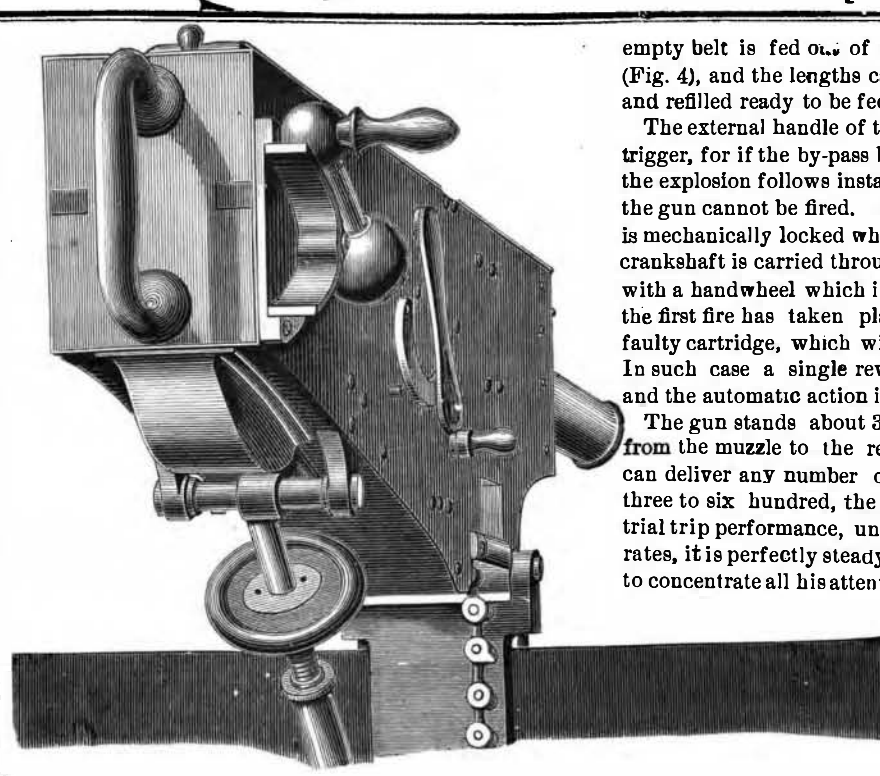

Fig. 3.

then the explosion takes place. There is a valve in the piston of the buffer to allow it to be returned quickly by a spring during the recoil of the barrel.

This completes the description of the introduction, firing, and extraction of a cartridge, but it remains to explain how the charges are withdrawn from the belts mentioned above, and introduced into the pockets of the cylinder, G. The full

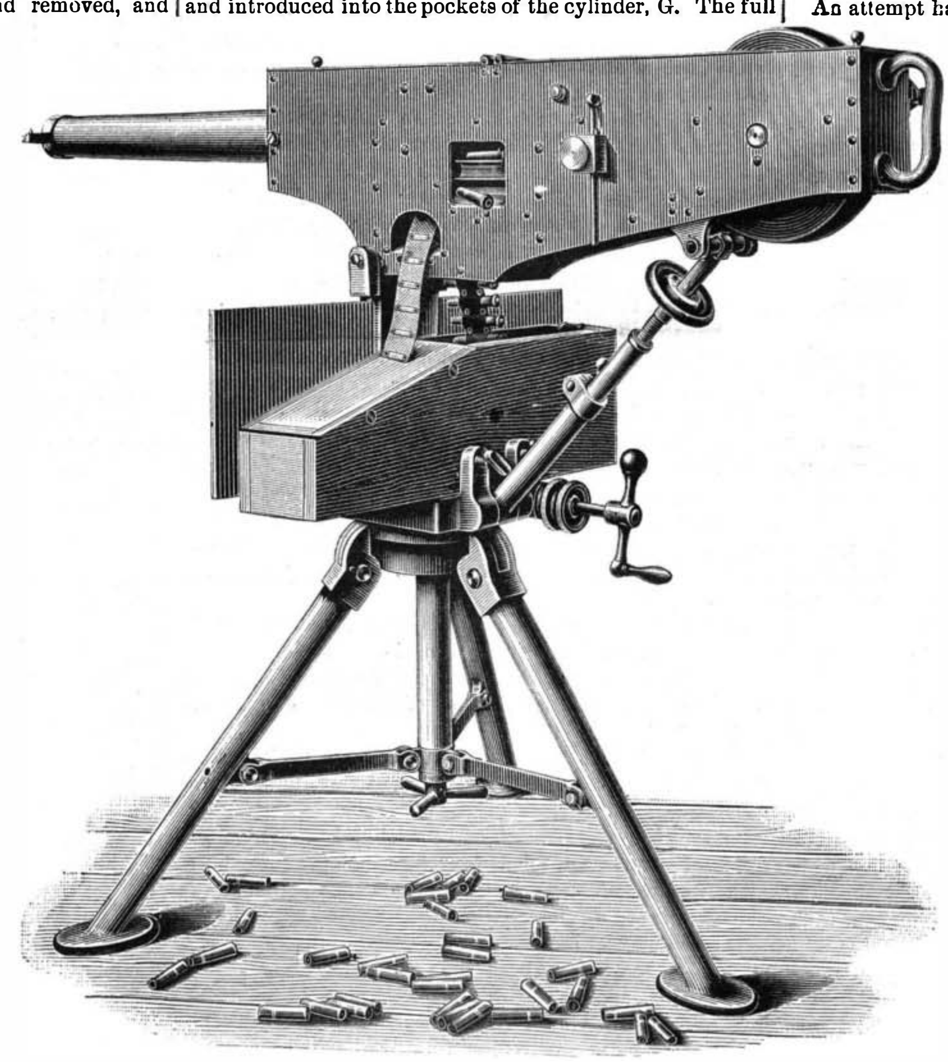

Fig. 4.

belt is drawn out of the magazine (Figs. 1 and 4), and passes over the wheel, F, which has recesses in each flange for the ends of the cartridges to rest in. This wheel is geared to the cylinder, G. In the firing position a hook or extractor, E, stands below the cartridge, and when the crosshead goes back this catches a cartridge and draws it into a pocket on the underside of the cylinder, where it leaves it to be carried upward to the barrel by the rotation of the cylinder. The empty belt is fed out of the opposite side of the machine (Fig. 4), and the lengths can be taken apart by unhooking and refilled ready to be fed in again.

The external handle of the hydraulic buffer also acts as a trigger, for if the by-pass be opened when the gun is loaded the explosion follows instantly, while if it be entirely closed the gun cannot be fired. As a means of precaution the sear is mechanically locked when the by-pass is stopped. The crankshaft is carried through the casing, and is furnished with a handwheel which is worked in starting the gun until the first fire has taken place. It is also used whenever a faulty cartridge, which will not explode, stops the action. In such case a single revolution throws out the obstacle, and the automatic action is at once resumed.

The gun stands about 3 feet high, and is 4 feet 9 inches from the muzzle to the rear of the firing mechanism. It can deliver any number of shots per minute from two or three to six hundred, the latter being, of course, a kind of trial trip performance, under favorable conditions. At all rates, it is perfectly steady, and the gunner is perfectly free to concentrate all his attention upon the aim, without having his vision or his steadiness interfered with by turning a handle. No one can fail to be struck, says *Engineering*, to which we are indebted for these notes, with the wonderful ingenuity and great promise of this new weapon. Its automatic action, its power of regulation, and its rapidity of fire must recommend it to the military authorities, while its steadiness and the small demands it makes upon the attention of the man in charge must greatly enhance its value in action, where it is not the number of shots, but the number of hits, that count.

### A New Electrical Lantern.

An attempt has been made by Mr. A. P. Trotter to construct lanterns which shall diffuse powerful lights, such as that of the electric arc, without incurring the loss entailed by the use of opal glass. This was done with certain lamps fixed at the Health Exhibition, by a special modification of prismatic lenses (such as are used for lighthouses), adapted for ordinary lanterns. The general shape of the lanterns is the same as that of the more improved street lanterns for powerful gas flames—an inverted cone closed at the top by an opal-glass cap in the form of a much flatter cone. The glazing of the lantern, however, instead of being with plane glass, is with specially moulded panes, bearing on them a number of prisms at one-fourth inch pitch. The prisms are formed on both sides of the glass, those on the front being horizontal, and those at the back running vertically. The effect is to break up the light source into a multitude of images of itself; care being taken that the angle of the prisms does not give a chromatic effect. Each pane so formed, for a 2 foot 6 inch lantern, is 14 inches long, tapering from 8 inches wide at the top to 2 inches at the bottom; and ten of these go to form the lantern. It is claimed that the absorption of light by such a lantern is only 10 or 15 per cent, as against 40 to 60 per cent with ground or opal glass.

### A New Camera Lucida.

A new camera lucida has been invented by Dr. Schroder, possessing many advantages over the well known contrivance of Dr. Wollaston. The pencil emerging from the eye piece of the microscope is reflected twice, as in the old instrument, but the view of the paper and pencil is obtained by means of another prism placed under the first; the pencil from the microscope is totally reflected, and cannot pass through the film of air between the prisms, and the paper is seen directly between the two prisms, which offer no more obstruction to the view than a thick piece of plate glass.

The position of the image does not shift when the eye is moved, and the painful strain caused by the bisection of the pupil in the Wollaston instrument is entirely avoided. Drawings can be taken either with the body of the microscope at the usual inclination of 45°, or in a vertical position, both more comfortable in every respect than the old horizontal one, and preventing disturbance of the illuminating arrangement by having to shift everything when a drawing is required.

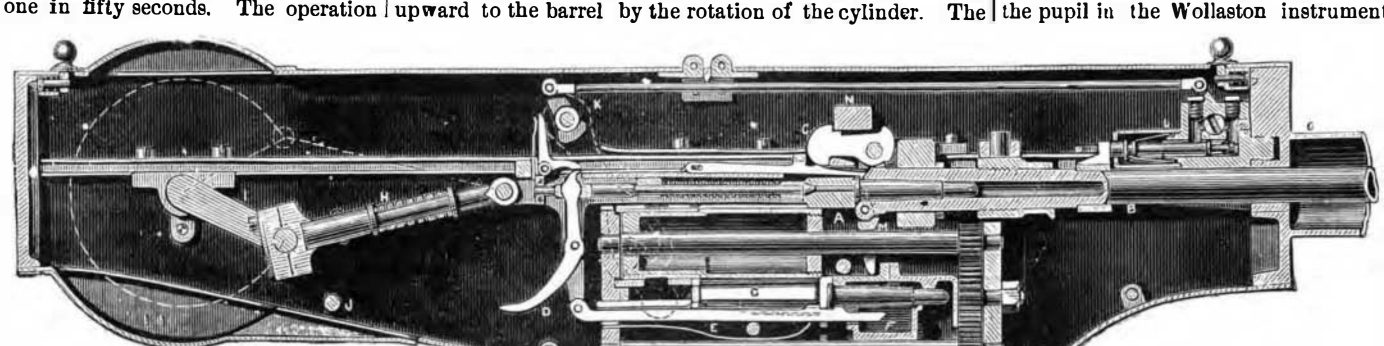

Fig. 5.—THE MAXIM SELF-ACTING MACHINE GUN.