(No Model.) 4 Sheets—Sheet 1.

H. S. MAXIM.

APPARATUS FOR ADJUSTING, POINTING, OR TRAINING CANNON.

No. 407,487. Patented July 23, 1889.

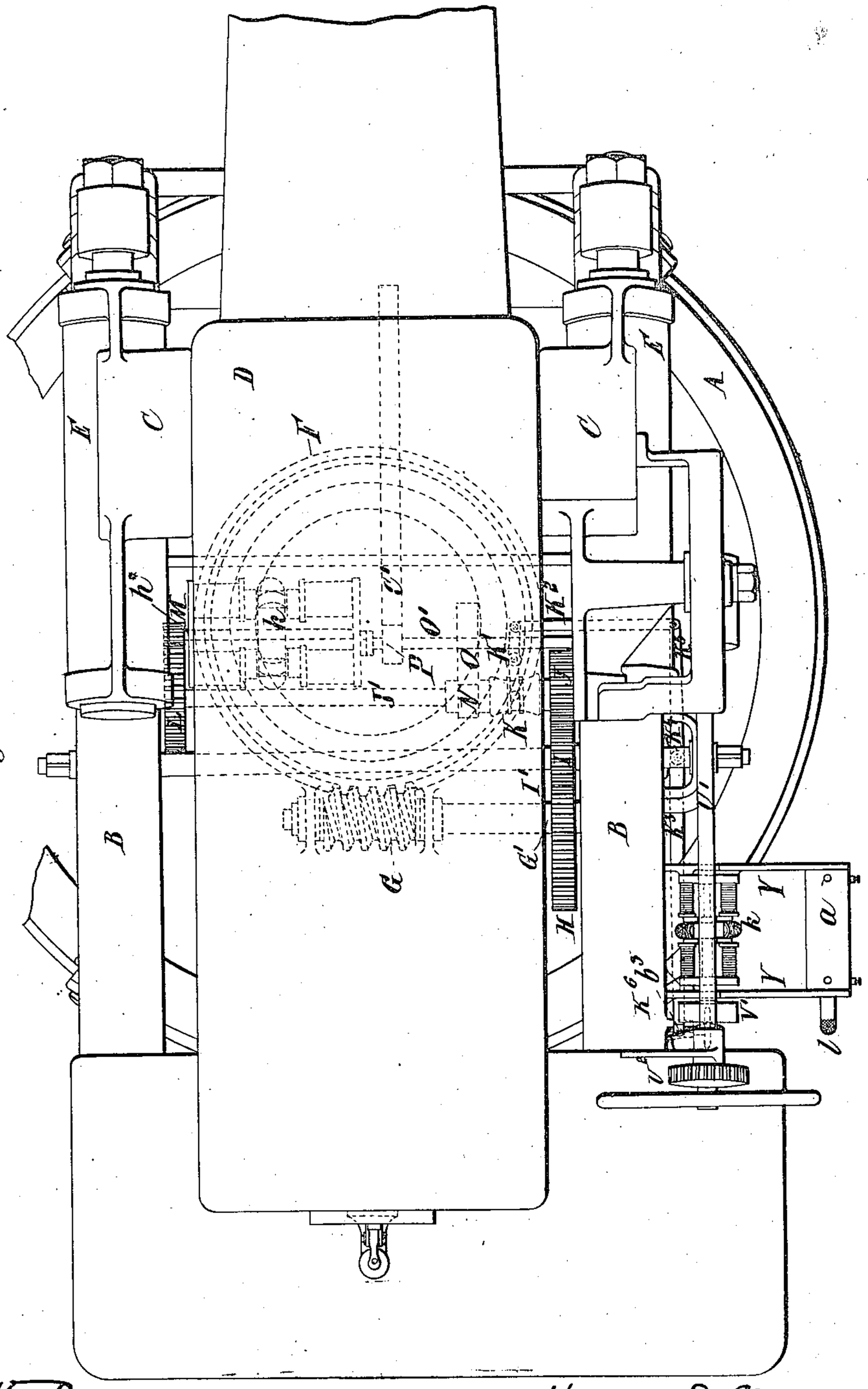

Fig. 1.

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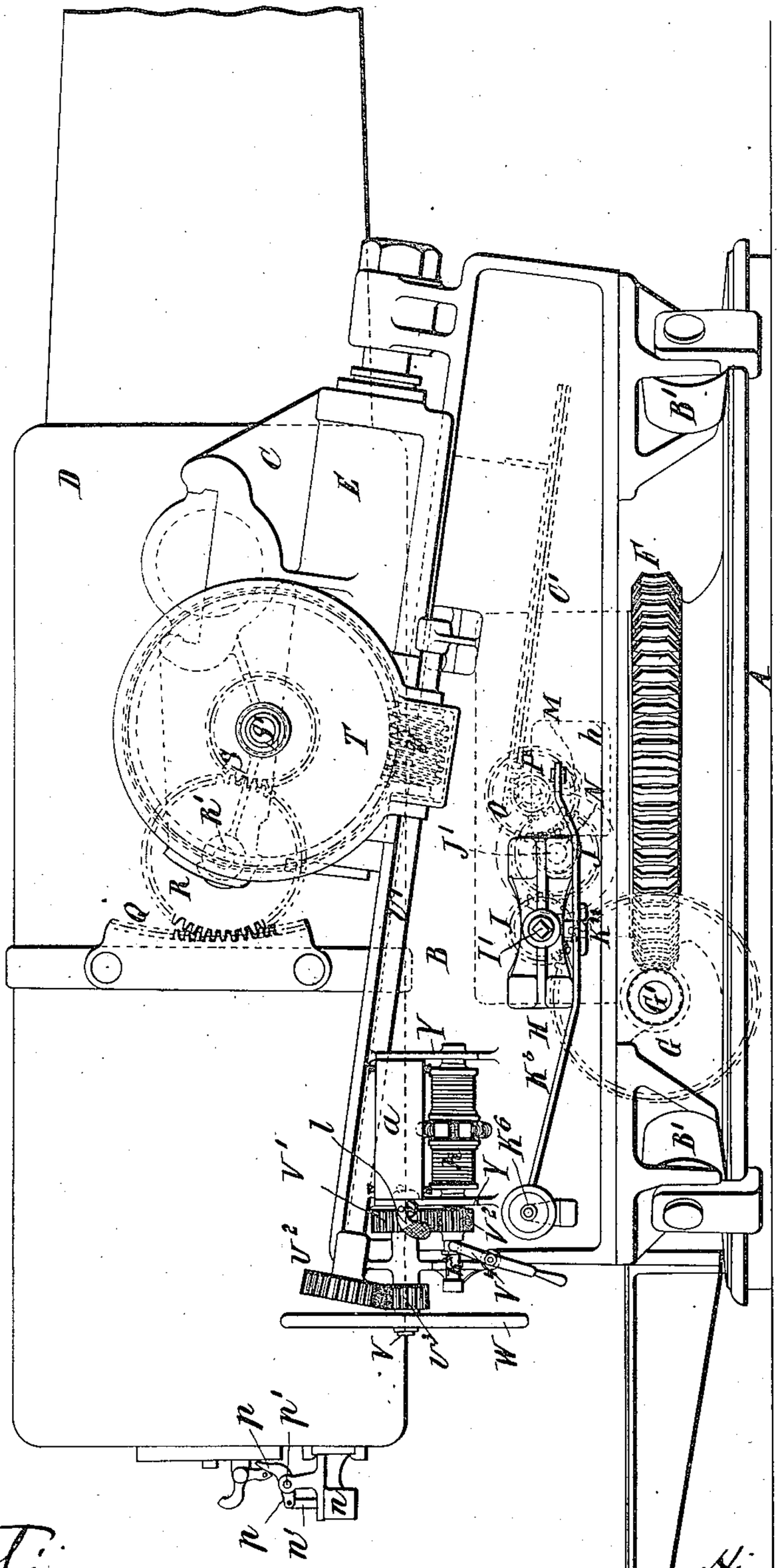
Fig. 2.



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APPARATUS FOR ADJUSTING, POINTING, OR TRAINING CANNON.

No. 407,487. Patented July 23, 1889.

Fig. 3.

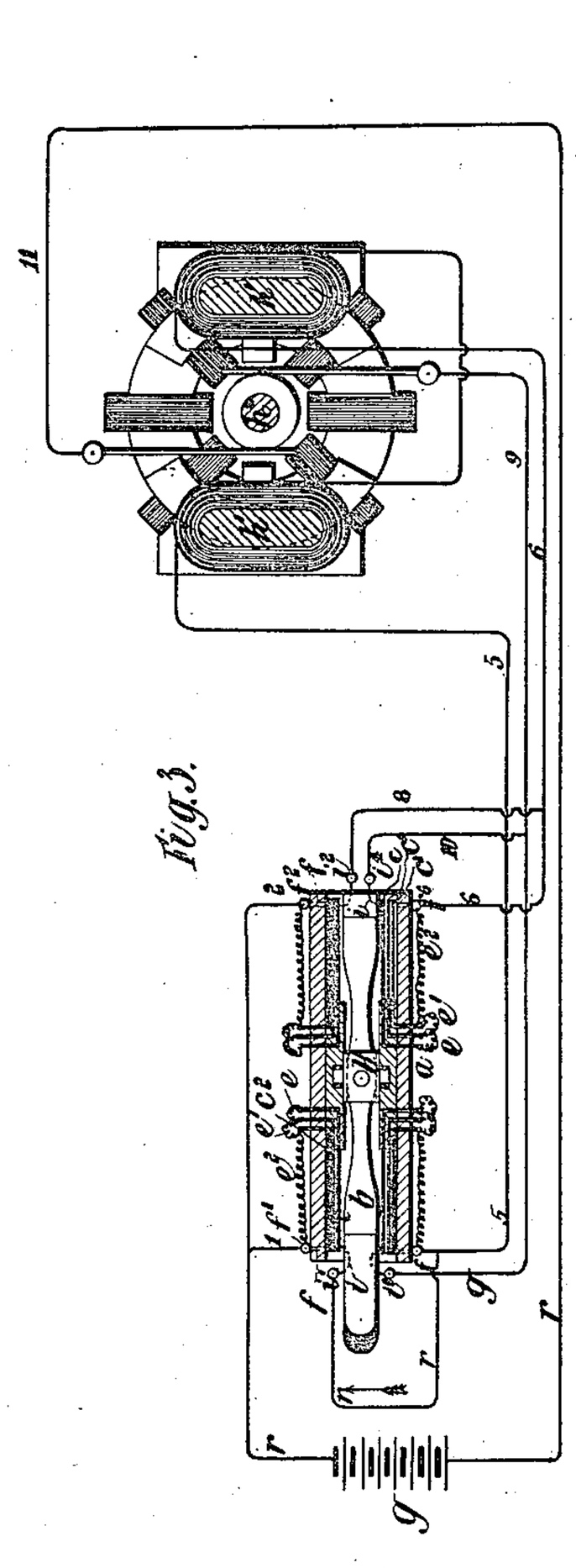
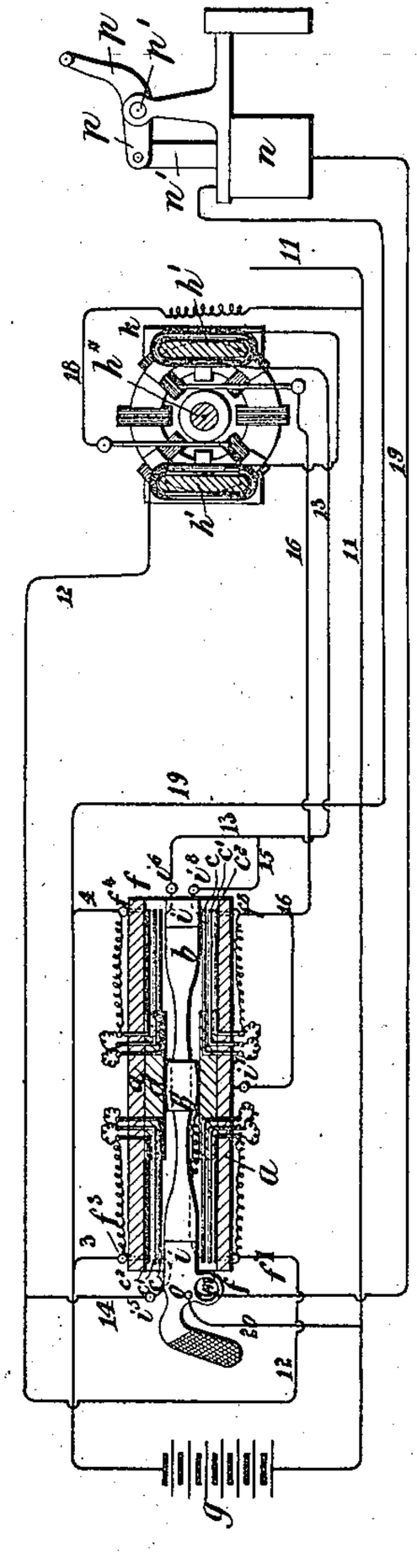


Fig. 4.



Witnesses:
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Fig. 5.

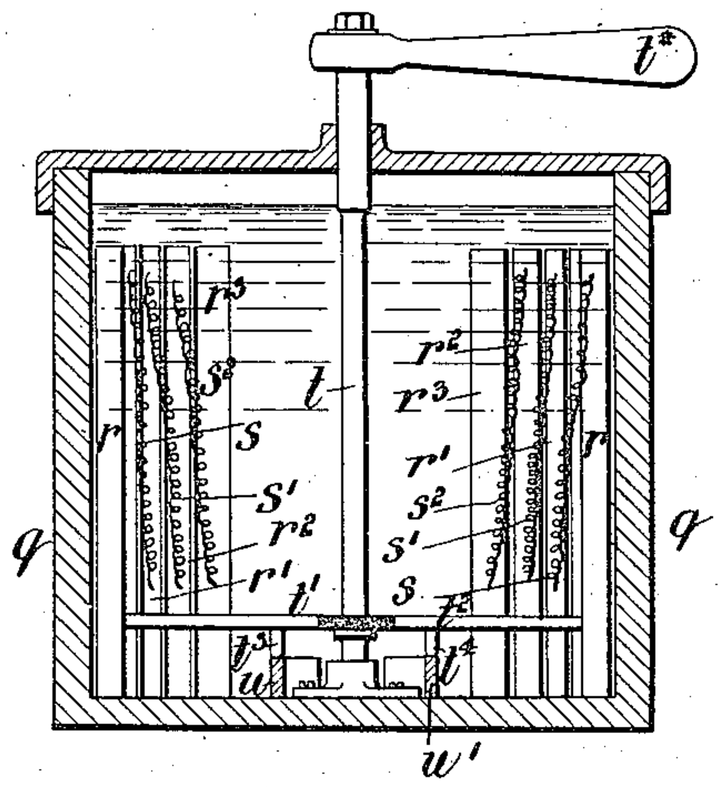
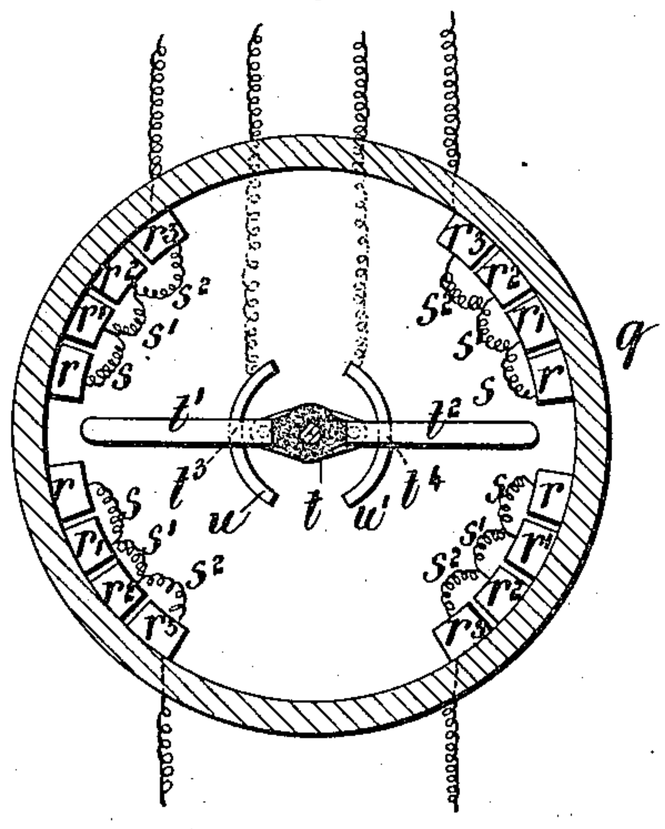


Fig. 6.



Attest:
Robt F. Gaylord
Frank E. Hartley

Hiram S. Maxim
By Duncan, Curtis & Page.
attys.

UNITED STATES PATENT OFFICE.

HIRAM STEVENS MAXIM, OF LONDON, ENGLAND.

APPARATUS FOR ADJUSTING, POINTING, OR TRAINING CANNON.

SPECIFICATION forming part of Letters Patent No. 407,487, dated July 23, 1889.

Application filed August 22, 1887. Serial No. 247,511. (No model.) Patented in England October 17, 1884, No. 13,762; in France April 10, 1885, No. 168,195; in Italy June 6, 1885, No. 18,466; in Belgium June 20, 1885, No. 69,347; in Sweden August 17, 1885, No. 882, and in Austria-Hungary August 19, 1885, No. 35 and No. 1,751.

To all whom it may concern:

Be it known that I, HIRAM STEVENS MAXIM, mechanical engineer, a citizen of the United States of America, and a resident of London, England, have invented new and useful Improvements in Apparatus for Adjusting, Pointing, or Training Cannon, (for which I have obtained a patent in Great Britain, No. 13,762, dated October 17, 1884; France, No. 168,195, dated April 10, 1885; Belgium, No. 69,347, dated June 20, 1885; Austria-Hungary, No. 35 and No. 1,751, dated August 19, 1885; Italy, No. 18,466, dated June 6, 1885, and Sweden, dated August 17, 1885, No. 882,) of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to improvements in and apparatus for effecting by the aid of electricity the operations requisite in adjusting, pointing, or training cannon or heavy guns, either on land or on a ship or vessel. Heretofore there has been no pointing or training gear for large guns which can be operated with sufficient rapidity to allow such guns to be properly directed or pointed at torpedo-boats or other objects moving at a high speed and within a short range. Moreover, considerable skill is required in the manipulation of the apparatus usually employed for training large guns.

My invention is designed to provide for the performance of all the requisite operations with great rapidity by any person of ordinary skill and intelligence.

I employ electric motors for adjusting or turning the gun horizontally and vertically, and in some cases for moving the said gun longitudinally to and fro, and I provide a controlling apparatus whereby the currents can be varied in respect of their strength and direction by the simple movement of a lever or other suitable device, according to the desired direction and rapidity of movement of the gun. I prefer to so arrange the said lever or device that by turning the same around or about its fulcrum in either direction the necessary contacts will be made for causing the gun to be turned in the same direction.

In the accompanying drawings, Figure 1 is a plan, and Fig. 2 a side elevation, of a gun provided with means for working it according to my invention. Fig. 3 is diagram showing the controlling apparatus in horizontal section and illustrating the electrical connections between the said apparatus and the motor for training or traversing the gun. Fig. 4 is a diagram showing the said apparatus in vertical longitudinal central section and illustrating the electrical connections between the said apparatus and the motor for elevating and depressing the gun. Fig. 5 illustrates a controlling device of somewhat modified construction, the figure being a central vertical section of the same. Fig. 6 is a central horizontal section of Fig. 5.

Like letters of reference indicate corresponding parts throughout the drawings.

A indicates a base-plate, upon which the gun-carriage B is supported by means of the rollers B′, so that the said carriage is free to rotate thereon.

C C are cheeks or side pieces forming parts of the gun-carriage B.

D is the gun, which is mounted in the said cheeks or side pieces. These cheeks or side pieces are arranged to slide to and fro upon inclined planes at the top of the main portion or body of the carriage, and are provided with hydraulic buffers E for checking the recoil of the gun.

The mechanism for training or traversing the gun is as follows—that is to say: A worm-wheel F is firmly secured to the base-plate A, and a worm or endless screw G is geared with the said worm-wheel. This worm is fixed upon a shaft G′, which is carried in suitable bearings attached to or forming part of the carriage B. A toothed wheel H is fixed upon the shaft G′ and gears with a pinion I, fixed upon a shaft I′, which is made with square ends, so that wheels or crank-handles can be placed thereon and turned by hand to train or traverse the gun. The pinion I gears with a toothed wheel J, mounted loosely upon a shaft J′, but capable of being connected therewith by a clutch K. This clutch is operated by means of a forked lever K′, connected by a rod or link K^2 with a lever K^3, which is piv-

oted at K^4 and is coupled to a nut K^5, arranged to be moved to and fro between suitable guides by a screw-spindle K^6. A toothed wheel L is fixed upon the shaft J′ and gears with a pinion M, fixed on the armature-shaft h^* of an electric motor *h*. This motor is connected, as hereinafter described, with an electric generator and with a controlling apparatus, whereby it can be caused to turn the gun horizontally in either direction by means of the mechanism above described. When the gun is to be thus moved, the toothed wheel J must be connected with its shaft J′ by the clutch K.

To permit the motor *h* to be used for moving the gun D and cheeks C longitudinally to and fro upon the main portion or body of the carriage B, a pinion N is also mounted loosely on the shaft J′, and is arranged to be connected therewith, when necessary, by the clutch K. This pinion gears with a toothed wheel O, fixed on a shaft O′, on which is also fixed a pinion P, gearing with a rack C′, formed on or secured to the under side of the cheeks C.

The clutch K should act by friction, so that, although the gun can be moved slowly to and fro by the motor *h*, yet the rapid recoil of the gun will not impart any movement to the said motor. In some cases I use the motor *h* only for training or traversing the gun and provide a separate electric motor for moving the gun longitudinally to and fro.

The electricity which I employ is generated by dynamo-electric machines or other suitable means.

The mechanism for elevating or depressing the gun is as follows, viz: A toothed segment Q is firmly attached to the gun and is geared with a toothed wheel R, fixed upon a shaft R′, carried in bearings in one of the cheeks C. The wheel R is geared with a toothed wheel S, fixed upon the shaft S′, on which is also fixed a worm-wheel T, which is geared with a worm or endless screw U. This worm is fixed upon a shaft U′, which is geared by means of the bevel-wheels U^2 U^3 with a shaft V, on which is fixed a spur-wheel V′.

k is an electric motor for operating the mechanism for elevating or depressing the gun. This motor is arranged to be geared with the said mechanism by means of a pinion V^2, which is keyed to the shaft k^* of the motor *k* in such a manner that it will be rotated therewith, but is free to slide to and fro thereon. A forked lever V^4 is arranged in combination with the pinion V^2 for the purpose of putting the mechanism in and out of gear with the motor *k*. A hand-wheel W is fixed on the shaft V to enable the operations of elevating and depressing the gun to be effected by hand when necessary.

The controlling apparatus is carried by the brackets Y, attached to the carriage B, which brackets also support the motor *k*. The said controlling apparatus is more clearly shown in Figs. 3 and 4, in which *a* indicates a hollow cylinder or case of insulating material. *b* is a lever arranged within the said cylinder or case and connected therewith by a universal joint at *b*′.

c c′ c^2 are springs, which are secured in a block *d*, of insulating material, within the hollow cylinder *a*. These springs are arranged in groups of three, as shown, or in any other convenient manner. Between the springs in each group are arranged resistance-coils *e e*′.

f f are conductors inserted in the cylinder *a* and projecting slightly within the same. These conductors are in contact with or form part of the terminals f' f^2 f^3 f^4 f^5 f^6 f^7 f^8. A resistance-coil e^2 is arranged between the spring c^2 of each group and the terminal with which it is connected. There are eight sets or groups of the said springs *c c*′ c^2, and each set or group thereof is provided with resistances *e e*′ e^2 and is connected with one of the said terminals. The terminals f' f^2 f^3 f^4 are connected with one pole of the electric generator *g* by the wires 1 2 3 4. The terminal f^5 is connected by the wire 5 with one end of the field-magnet coils of the motor *h* for traversing or training the gun, and the terminal f^6 is connected by the wire 6 with the other end of the said coils.

i i are conductors inserted into the lever *b* and projecting slightly from the exterior surface thereof into close proximity to the springs *c*. These conductors are in contact with or form part of the terminals i' i^2 i^3 i^4 i^5 i^6 i^7 i^8. The terminal i' is connected by the wire 7 with the wire 5, and the terminal i^2 is connected by the wire 8 with the wire 6. The terminal i^3 is connected by the wire 9 with one of the brushes of the motor *h*, and the terminal i^4 is connected by the wire 10 with the wire 9. The other brush of the said motor is connected by the wire 11 with the generator *g*.

The terminal f^7 is connected by the wire 12 with one end of the field-magnet coils of the motor *k* for elevating or depressing the gun. The terminal i^6 is connected by the wire 13 with the other end of the said coils. The terminal i^5 is connected by the wire 14 with the wire 12, and the terminal i^8 is connected by the wire 15 with the wire 13. The terminal f^8 is connected by the wire 16 with one of the brushes of the motor *k*, and the terminal i^7 is connected by the wire 17 with the wire 16. The other brush of the said motor is connected by the wire 18 with the return-wire 11, a small resistance (of three ohms, for example) being interposed between the said brush and the wire 11.

The traversing or training of the gun is effected by the means above described, as follows—that is to say: When it is desired to turn the gun so that its breech moves from right to left, the lever *b* is turned around or about its fulcrum in this direction, as indicated by the arrow in Fig. 3, until the terminals i' i^4 are put into electrical connection with the corresponding springs *c*. The cur-

rent from the generator g then flows through the wire 1 to the terminal f', and through the corresponding resistances e^2 e' e, spring c, and conductor i to the terminal i'. From this terminal the current flows through the wires 7 and 5 and through the field-magnet coils h' of the motor h, thence through the wire 6 to the terminal f^6, and through the corresponding resistances e^2 e' e, spring c, and conductor i to the terminal i^4, thence through the wires 10 and 9, to and through the armature-coils, and through the return-wire 11 to the generator g. The motor will thus be caused to rotate in the direction necessary for moving the gun, as above stated. By continuing to move the lever b in the direction indicated by the arrow in Fig. 3, the said springs c will be pressed against the springs c', and these springs will in turn be brought into contact with the springs c^2. The springs c^2 will then be pressed against the projecting ends of the conductors f. It will therefore be seen that one or more of the resistances e e' e^2 will be cut out of the circuit according to the angle through which the lever b is turned.

When it is desired to turn the gun so that its breech moves from left to right, the lever b is turned in the direction opposite to that indicated by the arrow in Fig. 3. The current from the generator g then flows through the wire 2 to the terminal f^2, and through the corresponding springs and resistances and conductor i to the terminal i^2, thence by wires 8 and 6 to the field-magnet coils h' of the motor h, and through these coils. It then flows through the wire 5 to the terminal f^5, and through the corresponding springs and resistances and conductor i to the terminal i^3, thence by wire 9 to and through the armature-coils, and through the return-wire 11 to the generator g; but it will be seen that in this case the current flows through the field-magnets h' in the opposite direction to that in which it flows when the lever b is turned in the direction indicated by the arrow, while the direction of the current in the armature-coils is unchanged. Therefore the direction of rotation of the motor will be reversed and the gun will be turned, as required.

By raising or depressing the lever b at its rear end the necessary contacts can be made for causing the motor k to rotate in either direction for the purpose of elevating or depressing the gun. The electrical connections with the motor k for this purpose are illustrated in Fig. 4, and are somewhat similar to those above described with reference to Fig. 3. The path of the current, when the lever is either raised or depressed, will be readily understood by referring to Fig. 4. Moreover, by moving the lever b obliquely in either direction the necessary contacts can be made for causing the current to flow through the field-magnets of both the motors h and k, so that the gun will be adjusted or turned horizontally and vertically and will move in the same direction as the lever. Therefore the gun can be turned in either direction by means of the electric motors by the simple movement of the lever b in the same direction, and by pressing the said lever with greater or less force against the springs c the resistance of the circuits can be regulated at will, according to the rapidity with which it is desired to alter the position of the gun.

In the device or apparatus shown in Figs. 3 and 4 the direction in which the current flows through the coils of the field-magnets is reversed in order to reverse the motion of the motor, the direction of the flow of the current in the armature-coils remaining unchanged. If desired, however, the connections are so arranged that the direction of the flow of the current in the armature-coils will be reversed, that in the field-magnet coils remaining unchanged. Moreover, I have shown in these figures three contact-springs in each group or series; but it is obvious that I might use any other suitable number of the said springs.

In Fig. 4 I have also shown very simple means for firing the gun by electricity immediately it is adjusted to the firing position. For this purpose I employ a pistol butt or handle l, which serves for the manipulation of the lever b. I also provide a trigger m in connection with the said lever. This trigger is electrically connected with one pole of the generator g by the wire 19, in which is interposed an electro-magnet n, and the said trigger is adapted to make contact when pulled with a terminal or contact-piece o, connected by the wire 20 with the other pole of the said generator. The electro-magnet n is made with a movable core n', which is coupled to one arm of a bent lever p, pivoted at p'. The other arm of this lever is suitably arranged for acting upon a hammer or other convenient device to fire the gun. It is obvious, however, that the electric current may be employed in any other suitable manner for firing the gun when the trigger m is pulled.

In Figs. 5 and 6 I have shown a modified form of the device or apparatus shown in Figs. 3 and 4. In these figures q is a box or case, of insulating material, in which are secured four groups or series of metal strips or pieces r r' r^2 r^3. The said strips or pieces in each group or series are connected by resistances s s' s', but are otherwise insulated from each other. A shaft t is arranged centrally within the box or case q, and is provided with a handle t^* for rotating it, and with arms t' t^2, which, when the said shaft is rotated, come in contact with the strips or pieces r r' r^2 r^3. The arms t' t^2 are insulated from each other, and are provided with studs or projections t^3 t^4, which bear upon metal segments u u'. These segments are also insulated from each other and serve as terminals, one of the said segments being connected with one pole and the other segment with the other pole of the generator. The metal

strips or pieces r^3 also serve as terminals, and are connected in any suitable manner with the motor.

The box or case q is filled or partly filled with water or other liquid, so that the electrical contacts will be made and broken in the said liquid. I thus provide for preventing sparking when contact is broken between the arms t' t^2 and the pieces r r' r^2 r^3. This provision is very important when strong currents are used—for example, such currents as are required for actuating the motor for training or traversing the gun.

The apparatus shown in Figs. 5 and 6 can be used in combination with either the motor for elevating or depressing the gun or that for traversing or training the gun. In some cases I combine the said apparatus with a device constructed substantially as described with reference to Figs. 3 and 4, but without the springs and terminals at the sides of the said device, so that the raising or depressing of the lever b or the rotation of the shaft t thereby will make the required connections for working the gun, as above described.

It will be seen from the foregoing description that I provide means whereby the aiming or pointing of cannon or heavy guns can be effected with great facility, rapidity, and accuracy by one man without any special knowledge or skill in the manipulation of the apparatus employed for working the gun. It will be seen, moreover, that with electrical apparatus such as that above described or other electrical devices for changing or regulating the current in the different circuits it will be possible to follow the course of a rapidly-approaching torpedo-boat or other object and fire effectively upon the same with guns throwing projectiles of the largest size.

As a large amount of electrical energy can be conveyed through a small flexible wire, it is evident that the apparatus necessary for the working of my invention will be much more convenient than hydraulic gear for which large, strong, and rigid pipes are necessary. An electric motor weighing one hundred-weight occupies very little space and will do the work of about seven men. My apparatus is therefore compact, does not greatly encumber the deck or platform on which it stands, and is but little liable to accident or disarrangement. Moreover, when required, the electricity will be available for other purposes than those above specified.

There are many well-known ways of mounting cannon and heavy guns upon supports that are capable of horizontal and vertical adjustment, and various kinds of gearing have been employed to secure the necessary mechanical advantage to enable the said supports to be readily moved or controlled in the operation of pointing and training the cannon. My invention, however, does not reside, broadly, in the combination, with such gears, as the means of operating them, of an electro-magnetic motor.

I am also aware that electro-motors have been combined with gearing used for other purposes, and I do not claim to have discovered any new or unexpected action resulting from their application to this special purpose broadly; but my invention consists in the combination, with the two electro-magnetic motors adapted to operate the training-gears of a cannon, of independent circuits or, what is obviously the same, two independent branches of a circuit each including one of the motors, and a circuit controller and reverser connected with or included in both circuits and by the manipulation of which the motors are simultaneously or successively, and in either case independently, controlled both as to their speed and direction of rotation. This combination in its application to the purpose herein set forth secures new and highly-important results, as I have hereinbefore shown.

What I claim is—

1. The combination, with a gun and gun-carriage, of an electro-magnetic motor connected with the carriage, and gearing for communicating motion from the said motor to the gun, whereby the gun may be elevated or depressed.

2. The combination, with a gun-carriage, of an electro-magnetic motor connected therewith, and gearing for communicating motion from said motor to the carriage, whereby the gun may be trained, as set forth.

3. The combination, with the controlling-gears of the adjustable supports of a cannon, of electro-magnetic motors engaging, respectively, with such gears and adapted by their rotation to impart movement to the supports through the gears, a generator for producing the current to operate the motors, independent circuits including said motors, and a circuit controller and reverser connected with or included in said circuits and adapted to vary the strength and direction of the currents therein, as herein set forth.

4. The combination, with the vertically and horizontally adjustable supports of a cannon, and independent sets or systems of gears for adjusting the same for pointing and training the cannon, of two electro-magnetic motors engaging, respectively, with said gears and adapted by their rotation to impart movement to the supports through the gears, a generator for producing the current to operate the motors, independent circuit-connections between the generator and the motors, and a circuit controller and reverser connected with or included in said circuits and adapted to vary the strength and direction of the currents therein, as set forth.

5. The combination, with the horizontally and vertically adjustable supports of a cannon, of two electro-magnetic motors and intermediate gearing between said supports and

the motors, respectively, for pointing and training the cannon through the action of the motors, a generator for producing the current that operates the motors, circuits from the generator including the motors, respectively, rheostats or variable resistances and switch terminals in each of said circuits, and a contact lever or handle operatively combined therewith and adapted by its movement to vary the rheostats and switch-connections and thereby control the strength and direction of the currents in the motor-circuits, as herein set forth.

6. The combination, with the gun D, of the rack C′, movable with the gun on its carriage, the shaft J′, and rotary electro-magnetic motor L, gearing therewith and mounted on the carriage, the pinion F on shaft O′ and engaging with the rack C′, the gear-wheel O, engaging with a loose pinion on shaft J′, and the controlling-clutch K, for operatively connecting and disconnecting the shafts J′ and O′, as set forth.

7. The combination, with the gun D, of the worm-wheel F, secured horizontally to the base A, the shaft J′, and the electro-magnetic motor geared with the same, mounted on the gun-carriage, the intermediate gearing between the wheel F and the shaft J′, and the clutch K, for throwing said gear into or out of operation, as herein set forth.

8. The combination, with the gun D, of the worm-wheel F, secured horizontally to the base A, the shaft J′, and the electro-magnetic motor geared therewith, mounted on the gun-carriage, the worm-wheel G′, engaging with wheel F, the shaft G, carrying said worm, the gear-wheels H I J, connecting shafts G and J′, and the clutch K, for disconnecting the shaft J′ from the gears specified.

9. The combination, with the gun D, of the toothed segment Q, secured to the side thereof, the worm U, its shaft U′, and the rotary electro-magnetic motor mounted on the carriage and geared to the shaft U′, the gear-wheels R S, and worm-wheel T between the segment Q and worm U, as herein described.

10. The combination, with the horizontally and vertically adjustable supports of a cannon, of two electro-magnetic motors and intermediate gearing between the said supports and the motors, respectively, of a generator for supplying the current to run the motors, a circuit controller and reverser for varying the strength and direction of the currents transmitted to the motors, and an operating or controlling handle therefor formed or provided with a pistol grip or butt, as herein set forth.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses.

HIRAM STEVENS MAXIM.

Witnesses:
ROBT. M. HOOPER,
DAVID T. S. FULLER.