(No Model.) 4 Sheets—Sheet 1.

H. S. McKAY.

ELECTRICAL RECIPROCATING MOTOR.

No. 503,213. Patented Aug. 15, 1893.

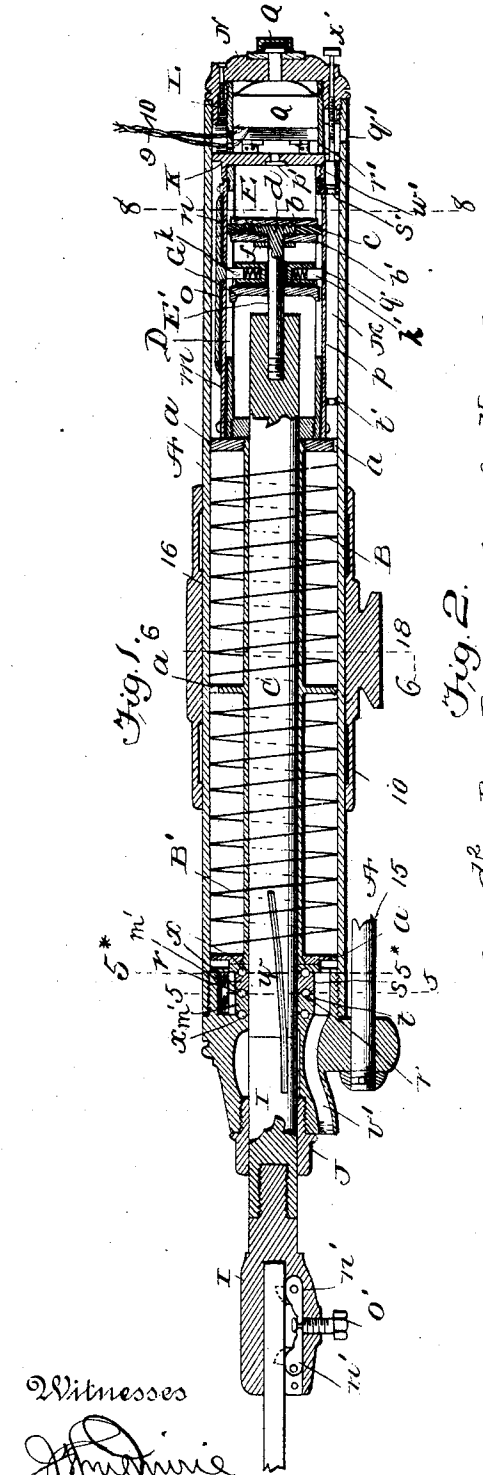

Fig. 1.

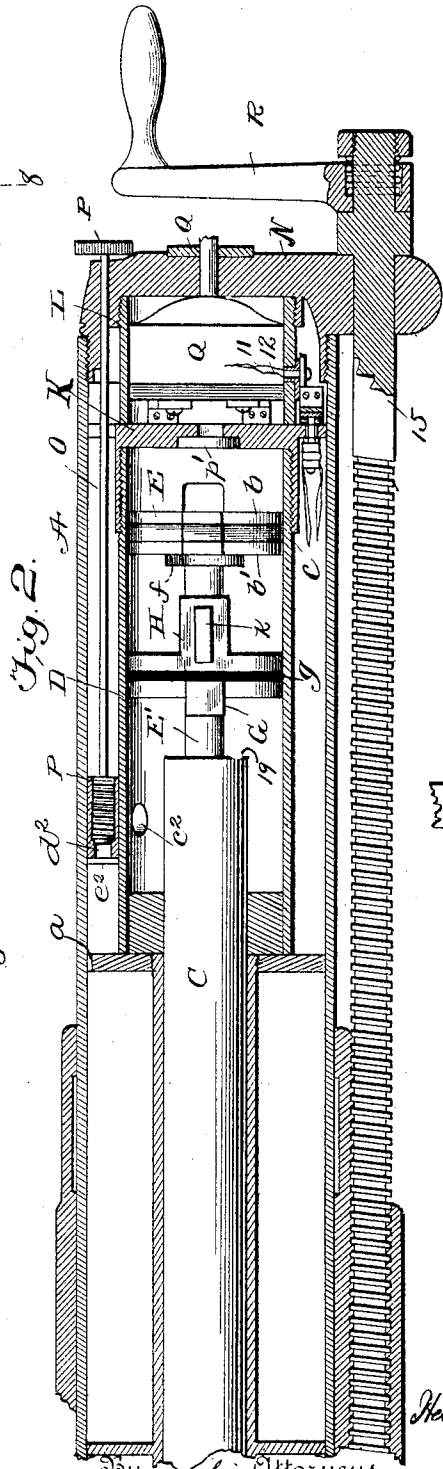

Fig. 2.

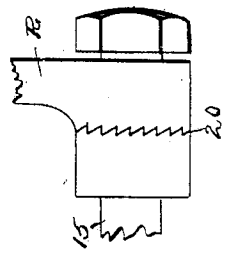

Fig. 10.

Witnesses

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(No Model.) 4 Sheets—Sheet 2.

H. S. McKAY.

ELECTRICAL RECIPROCATING MOTOR.

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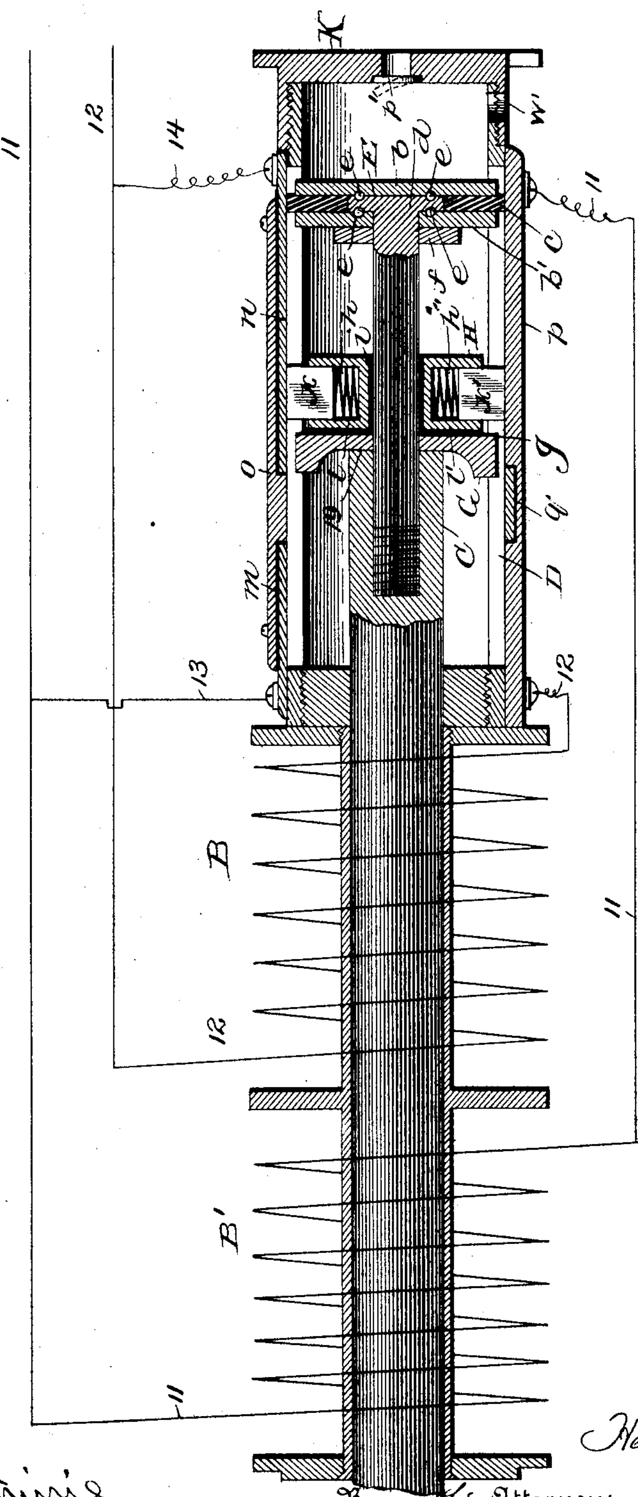
Fig. 3.



Witnesses

J. [illegible]

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(No Model.)

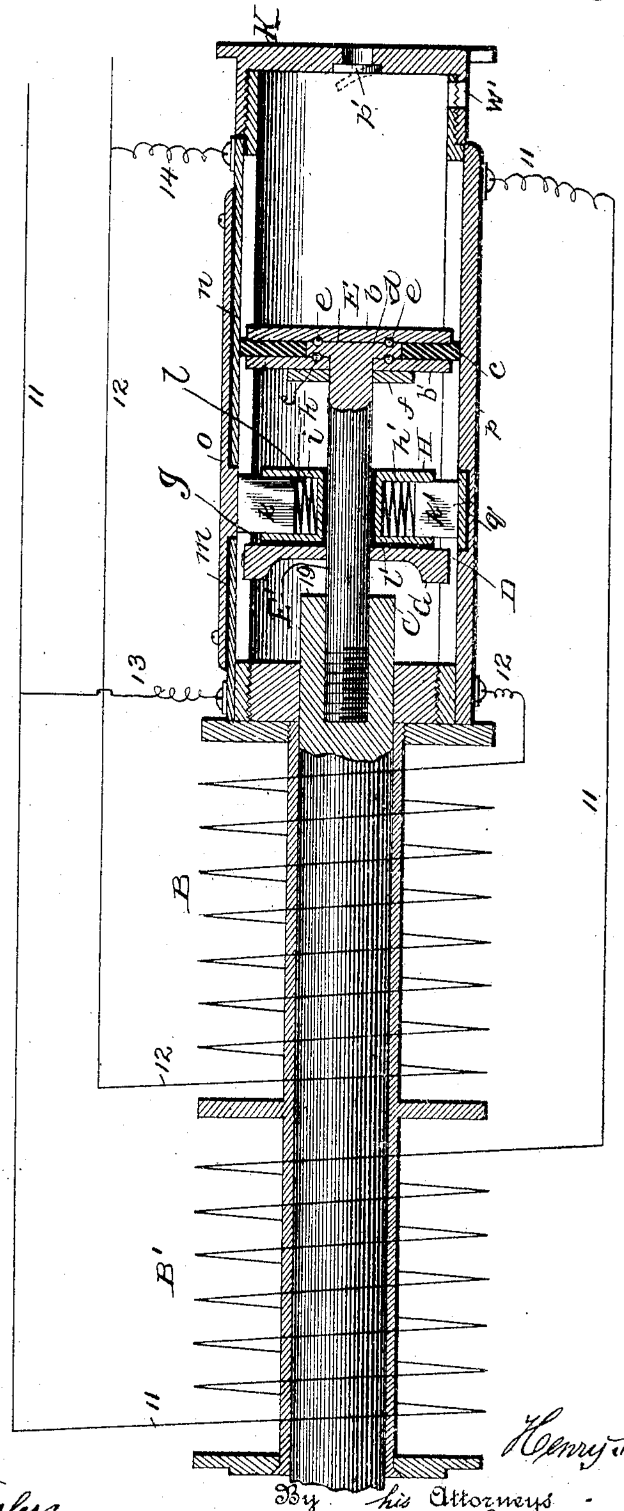
4 Sheets—Sheet 3.

H. S. McKAY.

ELECTRICAL RECIPROCATING MOTOR.

No. 503,213. Patented Aug. 15, 1893.

Fig. 4.



Witnesses.

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(No Model.) 4 Sheets—Sheet 4.

H. S. McKAY.

ELECTRICAL RECIPROCATING MOTOR.

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Fig. 5.

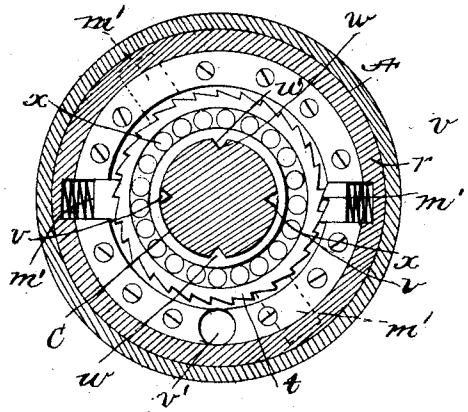


Fig. 6.

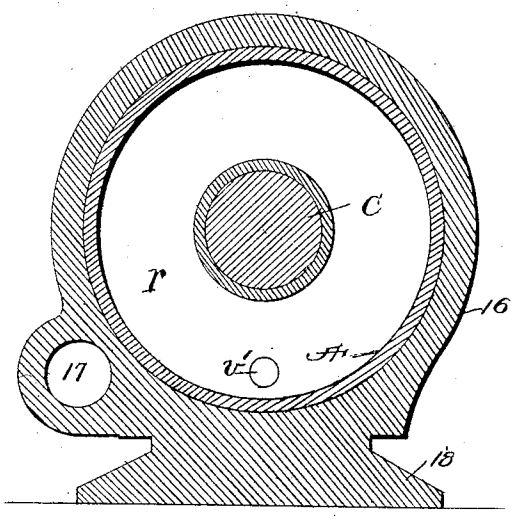


Fig. 5*

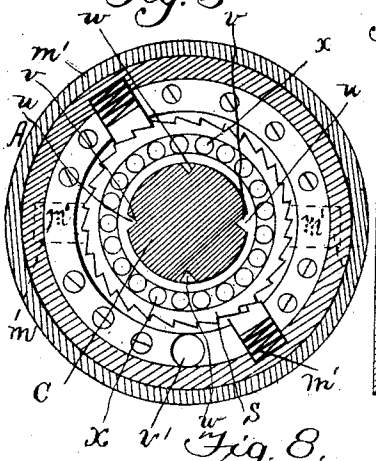


Fig. 7.

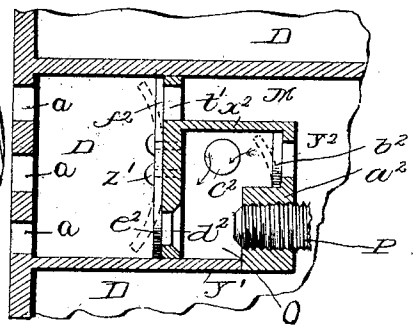


Fig. 8.

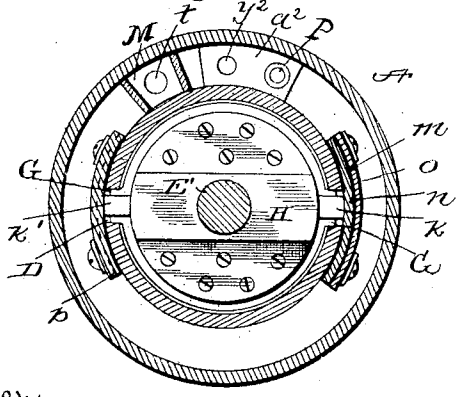
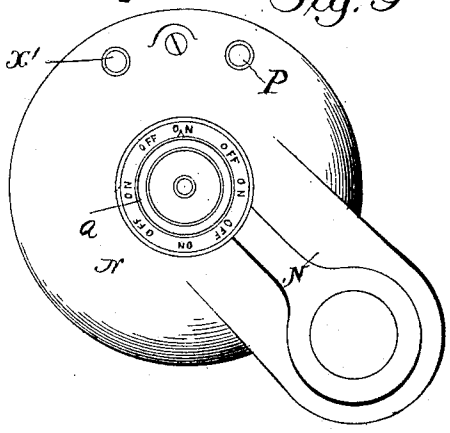


Fig. 9



Witnesses

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UNITED STATES PATENT OFFICE.

HENRY S. McKAY, OF BOSTON, MASSACHUSETTS.

ELECTRICAL RECIPROCATING MOTOR.

SPECIFICATION forming part of Letters Patent No. 503,213, dated August 15, 1893.

Application filed May 13, 1892. Serial No. 432,821. (No model.)

To all whom it may concern:

Be it known that I, HENRY S. McKAY, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Means for Electrically Giving Reciprocating Motion; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters and numerals of reference marked thereon, which form a part of this specification.

My invention relates to electrical mechanism for operating reciprocating tools or other devices, and said invention is designed as an improvement over the means shown and described in my Patent No. 475,410, dated May 24, 1892.

My improvements consist more especially in the means for making and commutating the electric circuit, and in the pneumatic speed regulator for the armature and connecting parts.

My improvements also consist of certain other features as more particularly hereinafter described.

In the accompanying drawings I have illustrated my invention as applied to a reciprocating drill, or cutter, or hammer, and my invention is particularly applicable for this purpose. My invention may, however, be applied to various other devices to which reciprocating motion is to be given.

In the accompanying drawings: Figure 1 illustrates a longitudinal section of a tool and operating mechanism to which my invention is applied. Fig. 2 is a longitudinal section of the same enlarged, and partly broken away, but through a different plane from Fig. 1. Fig. 3 is an enlarged view of a similar section to Fig. 1, showing the electric connections but the tool-end of the machine being broken away and the outer casing removed. Fig. 4 is a similar view to Fig. 3, but showing the commutator in a position midway between the contact plates. Fig. 5 is a cross section enlarged through the line 5—5 of Fig. 1. Fig. 5* is a similar section through the line 5*—5* of Fig. 1. Fig. 6 is a similar section through the line 6—6 of Fig. 1, but with the solenoids removed. Fig. 7 is a detail enlarged with the outer casing partly broken away. Fig. 8 is a cross section enlarged through the line 8—8 of Fig. 1. Fig. 9 is a rear end view enlarged, showing the relative positions of the switch, and regulating air-inlet valves. Fig. 10 is a detail enlarged.

Similar letters and numerals represent like parts in all the figures.

A is the outer casing of the apparatus in which are inclosed the electro-magnetic devices, the reciprocating armature and the operating mechanism.

B B′ are two solenoids placed end to end about midway within the casing A, the end flanges of the supports or spools of which solenoids have transverse openings *a* for a purpose hereinafter to be described.

C is the reciprocating armature or plunger which is of a length slightly greater than the two solenoids B B′.

D is an inner casing or cylinder inclosed within the outer casing A beyond the solenoid B.

E is a piston inclosed in the cylinder D, formed of two disks *b b′* separated from each other by packing *c*. The disk *b′* has a concentric hole, and the piston-rod E′ is of non-magnetic material, and revolubly attached to said piston by passing through said hole, and provided with a circular head *d* which is inclosed between the two plates *b* and *b′* and within a hole in the packing, said head having ball bearings *e e* between the same and said disks. A collar *f* of insulating material is secured to the piston-rod E′ outside of the disk *b′* for a purpose hereinafter described, and said rod is longitudinally and adjustably attached to the end of the armature C beyond the solenoid B, by being screwed into the end of said armature.

G is a slide of non-magnetic material extending across the casing D between the armature C and piston, and adapted to move in longitudinal slots in said casing.

Secured to the slide G, but separated therefrom by insulation *g*, is a frame or casing H of conducting material, formed of two chambers *h* and *h′* which are separated by an annular thimble *i* through which passes the piston rod E′, the inner wall of said thimble being covered by insulating material, which

thus insulates the piston rod E′ from the frame H. Said frame does not extend quite to the walls of the casing D, but extending out from both chambers *h* and *h′* are yielding contact blocks *k k′* which are retained in their outwardly extending positions and given their yielding quality by spiral springs *l l′* which are inclosed within the chambers *h h′* between said blocks and the thimble *i*.

The longitudinal slots in the inner casing D are covered by two caps. One of said caps is formed of three pieces *m n* and *o;* the two parts *m* and *n* are attached to the casing D but insulated therefrom, leaving a space between their two inner ends; the piece *o* has an inwardly extending portion which fits into the space between the pieces *m* and *n*, and said piece *o* is secured to the pieces *m* and *n* by its overlapping portions, but insulated from said pieces *m* and *n*. The other cap is formed of two pieces *p* and *q;* the piece *p* extends entirely over the slot in the casing D, and the piece *q* which is of a length corresponding to the inner surface of the piece *o*, and directly opposite said surface, is set into a recess in the inner surface of the piece *p*, and is secured to but insulated from said piece *p*.

I is the tool-stock of non-magnetic material, which is secured to the outer end of the armature C in any appropriate manner, and extends beyond the end of the casing A. The outer portion of the tool-stock I reciprocates in a stationary cylindrical sleeve J. The inner end of the sleeve J terminates in a circular enlargement or casing *r* in which two ratchet wheels *s* and *t* are adapted to revolve. The armature C and a stock or shank I pass loosely through holes in the centers of the ratchets *s* and *t*. Splines *u* extend from the ratchet *s* into its central hole, (see Fig. 5*) and other splines *u′* extend from the ratchet *t* into its central hole (see Fig. 5). These splines *u* and *u′* engage respectively with straight and spiral grooves *v*, *w*, in the armature C and stock I, the spiral groove *w* being clearly shown in Fig. 1, but the straight groove *v* being covered in said figure and of common construction, it is not shown in elevation in the drawings. The adjacent surfaces of the box *r* and the ratchets *s* and *t*, and the contiguous surfaces of said two ratchets are provided with ball bearings *x* to enable the ratchets to rotate freely in the box *r* and independently of each other. Spring-doors *m′* pass through the side of the casing *r* and engage with the teeth of the ratchets *s* and *t*, and serve to lock the same and prevent their turning in one direction. During the inward movement of the armature C and shank I, said armature and shank will be caused to turn somewhat by reason of the spiral groove *w* riding over the splines *u′* of the ratchet *t*, the dogs *m′* of said ratchet preventing its rotation, and the ratchet *s* will be rotated by the straight grooves *v* of the armature C engaging with the splines *u* of said ratchet. On the outward movement of the armature and stock, the straight grooves in the armature will ride over the splines in the rachet *s*, and the ratchet *t* will be turned in one direction by the spiral grooves *w*, thus allowing the outward movement of the armature and stock to be straight and direct.

Laterally pivoted to the tool-end of the stock I, are two cam levers *n′*, with the cams of said levers extending into the tool socket, and with the outer or longer arms of said levers approaching each other. The ends of said outer arms are yoked or bifurcated, and encircle a smooth rounded depression in a screw *o′* which passes through the slot I. The inward and outward rotation of said screw will thus cause the long arms of the lever *n′* to move toward the socket and away from the same respectively, and consequently press the cams of said levers against the tool and hold it, or withdraw them from the same and release it.

K is a cap covering the outer end of the inside cylinder D, and having a transverse opening covered by a valve *p′* on the inside of the cap K. A series of holes *q′* extend through the wall of the outer casing A, beyond the cap K, and another series of holes *r′* extend through the wall of a short casing L beyond the cap K.

M is an oblong chamber bounded by two longitudinal partitions or walls extending between the two casings A and D and the portions of the walls of the casings inclosed between said partitions, and two transverse partions at each end of the longitudinal walls. Holes *s′ t′* extend through the two ends respectively of said chamber. The transverse openings *a* extend through the flanges of the solenoid spools, and a longitudinal passage *v′* extends from the outer end of the solenoid B′ to the tool end of the machine.

N is a cap which covers the end of the casing A at the end opposite the tool stock. A hole or opening *w′* extends through the casing D and is situated above the opening *s′;* and a regulating screw-valve *x′* extends through the cap N down to the opening *s′* and is adapted for regulating the size of the passage between said opening and valve, and also incidentally of the opening *w′*.

O is a box mounted on two sides by the walls of the casing A and D (the wall of the casing A being removed in Fig. 7), the other walls of said box O being one of the longitudinal partitions x^2 of the chamber M; another longitudinal partition is parallel with the wall of chamber M, the transverse partition *z′* in which is the hole *t′*, and another transverse partition a^2 parallel with the last named and having an opening y^2 covered by a valve b^2 on the inner side of the wall a^2. An opening c^2 extends from said box O into the inner casing D in front of the piston E. An opening d^2 extends from the box O through the partition *z′* into the annular space between the two casings A and D, and said opening is

covered by a valve e^2 on the outer side of said partition. The valve t' is also covered by a similar valve f^2 in a similar manner.

P is a screw regulating valve extending through the cap N and partition a^2 to the opening d^2 for regulating the size of the passage through said opening.

The above named chambers, passage-ways, openings and valves constitute a pneumatic regulator for the velocity of the stroke of the piston E.

The two wires 9 and 10 from an electric generator pass through the casings A and L between insulation, and to which wires the two pole-pieces or contacts of any suitable switch Q are adapted to be connected and disconnected, said switch being within the casing L. The two wires 11 and 12 from the switch Q pass by suitable connections and properly insulated to the annular chamber between the casings A and D. The wire 11 passes to and around the spool of the solenoid B', (forming the coil of said solenoid) and then passes to the plate p to which it is connected. The wire 12 passes to and around the spool of the solenoid B (forming the coil of said solenoid) and then passes to the plate p. The two coils B and B' are thereby connected in series through the conducting plate p. The wire 11 is connected with the conducting plate m by a short wire 13, and the wire 12 is connected with the conducting plate n by a short wire 14.

Fig. 9 illustrates the rear end of the device, showing the outer end of the switch Q, the operating milled heads of the valves P and x', and the lateral projection of the head N for supporting the outer end of the tool adjusting screw.

15 is a screw-rod journaled at each end in bearings which are fixed at or near the two ends of the casing A, and the screw portion of said rod between the two journal bearings passes through a screw-threaded hole 17 in a casing 16 surrounding the casing A and in which casing 16 the casing A and the inclosed mechanism is adapted to slide. By the rotation of the screw-rod 15 in either direction, the machine can be moved forward or backward relatively to the casing 16. The dovetailed projection 18 furnishes means by which the casing 16 may be attached to a tripod or other support. The adjustable means above described for regulating the position of the casing A and inclosed mechanism relatively to the casing 16, will consequently regulate the position of the casing A relative to said support.

A crank R is connected with the outer or upper end of the rod 15 by clutch mechanism 20 to enable the operator to turn the feed rod 15 by rotating the crank in one direction or to turn said crank R in the other direction independently of said rod.

The operation is as follows: When the piston E is in the position shown in Figs. 1, 2 and 4, with the transverse frame H and the yielding block k midway between the plates or pieces m n, and the switch Q connecting the wires of the apparatus with the circuit wires, the current will pass from the wire 11 through the solenoid B' to the plate p through the wire 12 and solenoid B, and the other end of the wire 12 to the main circuit, thus completing the circuit through both solenoids, energizing the same equally, and so that the armature C will not be attracted in either direction, and will consequently remain at rest as well as the frame H and piston E. If, however, the armature C and tool-stock I be allowed to drop by gravity or be drawn toward the tool-end of the casing A, the contact blocks k k' will come in contact with the plate m, and that part of the block p nearest the solenoids, when the current will pass through the wires 11 and 13, the plate m, block k, frame H, block k', plate p, wire 12, solenoid B, and the other end of the wire 12 to the main circuit thus short-circuiting and cutting out the solenoid B', and energizing the solenoid B. This energizing of the coil B will attract the armature C until a point about midway between its ends arrives at the magnetic center of the solenoid B; but said armature always remaining within the solenoid B' for its entire length. When the armature is near the end of its stroke, the shoulder 19 will strike the slide G, and push it outward until the block k reaches the plate n, when the current will pass from the wire 11 through the solenoid B', the other end of wire 11 to the plate p, through the block k'; frame H, block k, plate n, wire 14 and wire 12 to the main circuit, thus short-circuiting and cutting out the solenoid B. The solenoid B will then be energized and attract the armature C until a point about midway between its ends arrives at the magnetic center of the solenoid B', but said armature remaining within the solenoid B for its entire length. Said armature will draw down the piston E until it strikes the frame H, when said frame and the slide G will be drawn toward the solenoids, the block k will be brought into contact with the plate m, the solenoid B will be energized, short-circuiting and cutting out the solenoid B', and the previous action will be repeated, without the armature losing its magnetism or the electric circuit being broken. The screw-threaded piston rod screwing into the end of the armature provides for the regulation of the length of the piston stroke, as the more said rod is screwed into said armature the shorter will be the distance between the shoulder 19 and the piston, and consequently said shoulder and piston will act sooner upon the slide G and frame H, and the more said piston is withdrawn or unscrewed from the armature, the longer will be the distance between the shoulder 19 and the piston E, and said shoulder and piston will not act so soon as otherwise upon the slide G and frame H. The shorter the distance between the shoulder 19 and the piston E, the less dis-

tance will the armature C have to travel to commutate the circuit from one solenoid to the other, and thus the quicker will be the stroke. When the piston E drops or is drawn toward the tool-end of the casing A, the air in the casing D in front of the piston E is forced through the hole c^2 into the box O, closes the valve y^2 of the opening b^2, passes down through the hole d^2 (opening the valve e^2) into the annular chamber between the casing A and D, through the transverse openings a in the spool flanges of the solenoids, (the course being spirally around the coils) and through the passage v' to the tool-end of the machine for the purpose of blowing away the dust made by the tool or for any other purpose. The screw-valve P by its adjustability on its seat above the opening d^2 regulates the passage of the air from the space in front of the piston E to the opening v', and can be used as an air cushion of varying resistance to the forward stroke of said piston. During the above operation, the air will be drawn from outside the machine through the openings q' in the casing A, and with the air in the annular chamber between the casings A and D, it is drawn through the openings r' in the casing L and through the opening of valve p' to the back of the piston. On the upward or outward movement of the piston E the air back of the same closes the valve p', is forced through the opening w' in the casing D, down through the chambers M and valve-opening t through the transverse openings a in the flanges of the spools in a spiral direction, and out through the opening v', the screw valve x' serving the purpose by its adjustability on its seat above the opening s' to regulate the passage of the air from the space behind the piston E to the opening v', and can be used as a cushion of varying resistance to the backward stroke of said piston. During the above operation, the air will be drawn from the annular space between the casings A and D, through the valve opening b^2 into the box O, and through the hole c^2 below or in front of the piston, closing the valve e^2 and thus preventing the air from being drawn back from around the coils. The air which has been drawn through the hole c^2 in front of the piston E serves as a cushion to the next downward stroke of said piston, as above described,

What I claim as new, and desire to secure by Letters Patent, is—

1. In combination with two or more electro magnetic devices, an armature adapted to be reciprocated by said devices, the reciprocating stock secured to said armature and having a spiral groove or grooves and longitudinally parallel groove or grooves, two ratchets inclosed in a casing and each provided with a spline or splines, with the spline or splines of one ratchet engaging with the spiral groove or grooves in the stock, and the spline or splines of the other ratchet engaging with the longitudinally parallel groove or grooves, and spring dogs extending through the casing and engaging with the teeth of both ratchets all as and for the purposes set forth.

2. In an electro-magnetic reciprocating tool or engine, the combination with the armature, a commutator composed of a sliding frame and fixed contacts, said frame adapted to be directly operated by the armature or by a longitudinal extension thereof, but insulated from the armature, said frame supporting yielding contact pieces and a conducting medium connecting said pieces and said pieces adapted to slide over and make electrical connection with the fixed contacts to alternately energize and short circuit the magnetic devices, all as and for the purposes set forth.

3. In an electro-magnetic reciprocating tool or engine, the combination with the armature, a commutator composed of a sliding frame and fixed contacts, said frame provided with yielding contact pieces extending on opposite sides thereof, and a conducting medium connecting said pieces, and said fixed contacts also situated on opposite sides of the sliding frame and adapted for electrical connection with the yielding contacts during their sliding movement, whereby the magnetic devices are alternately energized and short circuited, all as and for the purposes set forth.

4. In an electro-magnetic reciprocating tool or engine, the combination with the armature, a commutator composed of a sliding frame and fixed contacts, said frame adapted to be operated by the armature or by a longitudinal extension thereof, yielding contact pieces extending from opposite sides of said frame, and a conducting medium connecting said pieces, and the fixed contacts also situated on opposite sides of the frame for electric connection with the yielding pieces, and said fixed contacts of both sides with the interposed insulation serving as guides for the yielding contact pieces, and the combination serving to alternately energize and short circuit the magnetic devices as set forth.

5. In an electro-magnetic reciprocating engine, the combination of the armature, a sliding frame connected with said armature and having yielding contact pieces extending from said frame and connected by a conducting medium, contact plates m n secured to one side of the slide support and insulated therefrom, and separated by an insulated plate which forms the slide bearing for one of the yielding contacts between the two fixed contact plates, and a contact plate having its contact surfaces opposite those of the plates m and n, and insulation separating said surfaces,—and said contact plates, surfaces and insulated separator serving as guides for the yielding contacts, and for the purposes set forth.

6. In combination with a sliding contact, the three stationary plates m n and o, the two plates m and n being at some distance apart, and the plate o overlapping the plates m and n, and having an inwardly extending portion

interposed between the adjacent edges of the plates *m n*, all of said plates *m*, *n* and *o* separated from each other by insulation, and with the contact surfaces of all of said plates with interposed insulation being in a continuous line with the movement of the sliding contact and presenting an unbroken surface, all as set forth.

7. A compound electric contact plate, composed of a part having a recess on its contact side, another plate fitted into said recess and insulated from the recessed part, and with the contact surfaces of both of said plates in the same plane, as and for the purposes set forth.

8. In combination with electro-magnetic devices and an armature adapted to be reciprocated by said devices, a non-circuit breaking commutator consisting of a sliding portion and fixed contacts, said sliding portion connected with the end of a reciprocating armature or with a longitudinal extension thereof on a line with the axis of said armature, and adapted to slide with the same, and the operation of said commutator causing the magnetic devices to be alternately energized and short circuited as set forth.

9. The combination with the electro-magnetic devices, an armature adapted to be reciprocated by said devices, and a non-circuit breaking commutator consisting of a sliding portion and fixed contacts and situated entirely beyond the end of the armature, a rod longitudinally adjustably secured to the end of the armature extending beyond the same and passing loosely through said sliding portion of the commutator, and provided with a lateral projection at or near its free end, whereby the operation of the armature and commutator will cause the magnetic devices to be alternately energized and short circuited as set forth.

10. In combination with the electro-magnetic devices and a reciprocating armature adapted to be reciprocated by said magnetic devices, a non-circuit breaking commutator composed of fixed contacts and a sliding frame of conducting material connected with said armature or with a longitudinal extension thereof, but insulated from the armature, and said frame having yielding outwardly extending contact blocks for making electric connection with the fixed contacts, whereby an electric current can pass from said contacts through said blocks and frame, and cause the magnetic devices to be alternately energized and short circuited as set forth.

11. In combination with electro-magnetic devices and a reciprocating armature adapted to be reciprocated by said magnetic devices, a non-circuit breaking commutator consisting of a sliding portion and fixed contacts, the sliding portion connected with said armature or with a longitudinal extension thereof, a slide secured to said sliding part of the commutator, and extending from opposite sides of said armature or extension, and parallel guide ways with which the ends of the slide engage, all as set forth.

12. In an electro-magnetic reciprocating tool or engine, the combination with the armature, a commutator composed of a sliding frame and fixed contacts, said frame adapted to be directly operated by the armature or by a longitudinal extension thereof, but insulated from the armature, said frame supporting yielding contact pieces and a conducting medium connecting said pieces, and said pieces adapted to slide over and make electrical connection with the fixed contacts to alternately energize and short circuit the magnetic devices, a casing inclosing the above mechanism of a diameter about that of the magnetic devices, and means for making electric connection between the electrical parts in the casing and an outside electric circuit.

13. In combination with two wires of an electric circuit, two or more electro-magnetic devices, an armature adapted to be reciprocated by said devices, and said magnetic devices connected with the circuit wires in series, a sliding commutator connected with the end of the armature or with a longitudinal extension thereof, contact points or surfaces situated in the line of movement of the commutator contacts, and electric connections made between said circuit wires, magnets and contacts, whereby the current is caused to pass through short circuits alternately, and alternately energize and cut out the magnets without breaking the circuit or the armature losing its magnetism.

14. An electro-magnetic reciprocating engine, having two or more electro-magnetic devices, an armature adapted to be reciprocated by said devices, a piston connected with said armature, and the piston cylinder, all inclosed in the engine casing, an opening in the side of the cylinder communicating with the chamber between said cylinder and engine casing, and passage-ways leading from said chamber to and around the electro-magnetic devices and to the outside air, and means extending to the outside of the casing for regulating the withdrawal of air from the cylinder, all as set forth.

15. An electro-magnetic reciprocating engine having two or more electro-magnetic devices, an armature adapted to be reciprocated by said devices, a piston connected with said armature, and the piston cylinder, all inclosed in a casing, a compartment inclosed between the walls of the cylinder and outside casing and two transverse walls, an opening in the side of the cylinder communicating with said compartment, and passage-ways leading from said compartment to and around the magnetic devices and to the outside air, all as and for the purposes set forth.

16. An electro-magnetic reciprocating engine having two or more electro-magnetic devices, an armature adapted to be reciprocated by said devices, a piston connected with said armature, and the piston cylinder, all inclosed

in a casing, a compartment inclosed between the walls of the cylinder and outside casing and two transverse walls, an opening in the side of the cylinder communicating with said compartment, and passage-ways leading from said compartment to and around the magnetic devices and to the outside air, and means extending to the outside of the casing for regulating the withdrawal of air from the cylinder, all as set forth.

17. An electro-magnetic reciprocating engine having two or more electro-magnetic devices, an armature adapted to be reciprocated by said devices, a piston connected with said armature, and the piston cylinder, all inclosed in a casing, the box O inclosed between the cylinder and outer casing, the opening c^2 in the cylinder and communicating with said box, and the valves e^2 and y^2 all as and for the purposes set forth.

18. An electro-magnetic reciprocating engine having two or more electro-magnetic devices, an armature adapted to be reciprocated by said devices, a piston connected with said armature, and the piston cylinder, all inclosed in a casing, the box O inclosed between the cylinder and outer casing, the opening c^2 in the cylinder and communicating with said box, and the valves e^2 and y^2 and a valve extending to the outside of the casing for regulating the withdrawal of air through the opening of valve e^2, all as set forth.

HENRY S. McKAY.

Witnesses:
L. H. COOK,
PENNINGTON HALSTED.