No. 798,290. PATENTED AUG. 29, 1905.

A. W. McARTHUR & J. G. CRAWFORD.

ELECTRICALLY ACTUATED RECIPROCATING TOOL.

APPLICATION FILED AUG. 26, 1901. RENEWED JAN. 21, 1905.

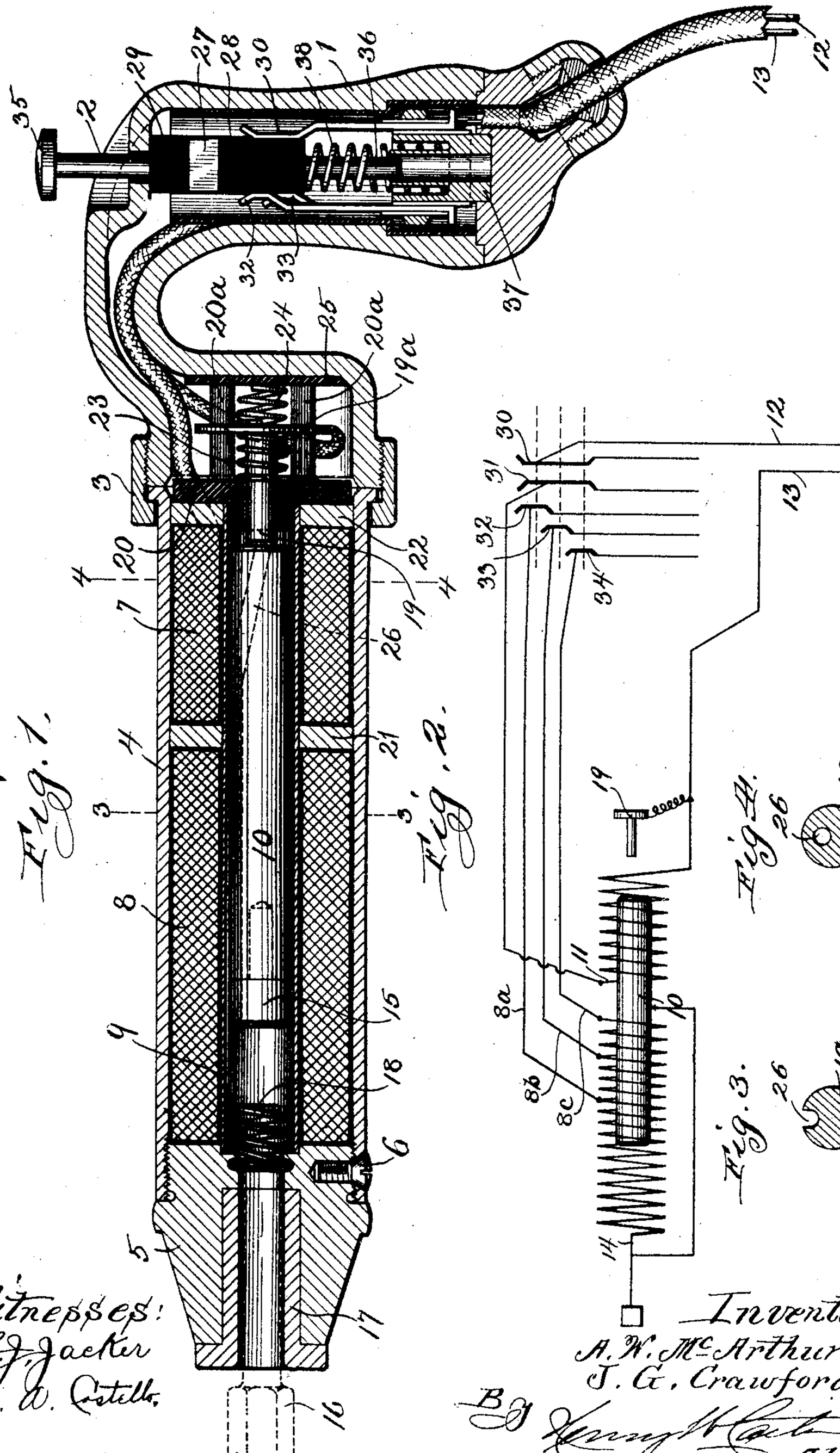

Fig. 1.

Fig. 2.

Fig. 4.

Fig. 3.

Witnesses:
R. J. Jacker
R. W. Costello.

Inventors:
A. W. McArthur
J. G. Crawford
By Henry H. Eaton
Atty

UNITED STATES PATENT OFFICE.

ALONZO W. McARTHUR, OF LYNN, MASSACHUSETTS, AND JOHN G. CRAWFORD, OF CHICAGO, ILLINOIS.

ELECTRICALLY-ACTUATED RECIPROCATING TOOL.

No. 798,290. Specification of Letters Patent. Patented Aug. 29, 1905.

Application filed Augus. 26, 1901. Renewed January 21, 1905. Serial No. 242,105.

To all whom it may concern:

Be it known that we, ALONZO W. McARTHUR, of Lynn, in the county of Essex, State of Massachusetts, and JOHN G. CRAWFORD, of Chicago, Illinois, have invented certain new and useful Improvements in Electrically-Actuated Reciprocating Tools, of which the following is a specification.

This invention relates to improvements in electrically-actuating reciprocating tools, and is more particularly applicable to percussion-tools—such as hammers, riveters, drills, and the like—although capable of being advantageously employed in any connection requiring a reciprocating motor.

The object of the invention is to provide an improved construction in devices of the character referred to; and it consists in the matters herein set forth and particularly pointed out in the appended claims.

The invention will be fully understood from the following detailed description of the construction illustrated in the accompanying drawings, in which—

Figure 1 is a longitudinal section of an electric hammer embodying our invention in one form. Fig. 2 is a diagrammatic view of the electrical connections thereof. Figs. 3 and 4 are sectional details of the plunger, taken on lines 3 3 and 4 4, respectively, of Fig. 1.

In its general form and appearance the electrical hammer thus illustrated closely resembles an ordinary pneumatic tool designed for similar service. 1 designates its handle, and 2 a switch in the handle by which the action of the hammer is controlled. Removably attached to the handle in any suitable manner, as by a coupling 3, is a tubular outer casing 4, having a nose-piece 5 screwed into its outer end and held there by a set-screw 6. This casing 4 incloses the solenoids or coils 7 and 8, which actuate the plunger, and also incloses a renewable inner tube or bushing 9, that forms the guiding-chamber for the plunger 10. The coil 7, which retracts the plunger, surrounds the rear or inner end of the tube 9 and will ordinarily be shorter than the coil 8, which surrounds the front or outer end of the tube 9 and projects the plunger.

The electrical connections of the two solenoids are shown diagrammatically in Fig. 2 of the drawings. One end 11 of the rear or retracting coil 7 is connected through the switch 2 with the leading-in wire 12, while its other end is directly connected with the other leading-in wire 13, so that this coil is constantly in circuit and continuously energized whenever the tool is put in operation by the closing of the switch. One end of the front or projecting coil 8 is likewise connected by taps 8^a, 8^b, and 8^c with the leading-in wire 12 through the switch 2; but the other end 14 of this coil is grounded on the metallic frame of the hammer, and its circuit is then completed through the metal plunger 10 intermittingly and only during such times as the latter occupies approximately its innermost position.

The plunger is simply an elongated piece of iron or steel the front or percussion end of which is desirably hardened or provided with a renewable hard-metal head 15, by which the blow is delivered to the shank of any suitable tool 16. The shank of this tool is inserted through a renewable hardened bushing 17 in the nose-piece 5 and projects at its extremity far enough into the tube 9 to receive the impact of the plunger. A slight cushioning of the latter is herein shown as provided for at this end of the stroke by a coil-spring 18, the resilient action of which tends to start the plunger on its return movement. When the device is used as a motor, the plunger will simply be connected in any suitable manner with the part or mechanism to be reciprocated or otherwise moved.

The completion of the circuit of the front coil 8 through the metal plunger 10 and at the inner end of the stroke of the latter is accomplished by a movable contact-piece 19, which is mounted to slide within an insulating-collar 20. This contact-piece is directly connected with the leading-in wire 13, so that as soon as the plunger touches it the circuit is completed through the front coil and the latter is energized to project the plunger again, the path of the circuit being from the leading-in wire 12 through the switch and one of the taps 8^a, 8^b, or 8^c to the coil 8 and from the latter through the metallic frame, plunger, and contact-piece to the leading-in wire 13. The several taps 8^a 8^b 8^c will be connected with the coil 8 at different points along its length, so as to cut in more or less of the length of said coil, according to the strength of the blow desired, the operative tap at any given time being determined by the position of the switch 2, which is controlled by the operator. To provide a more nearly com-

plete magnetic circuit for the lines of force set up by the two coils 7 and 8, the latter are herein shown as separated by an iron or steel disk 21, and a similar disk 22 occupies the inner end of the outer casing immediately back of the rear coil 7 and in front of the insulating-collar 20, within which the contact-piece 19 slides. Guide-lugs 20^a for the rear end of this contact-piece are provided on the collar 20, and oppositely-acting springs 23 and 24 engage a flange 19^a on the contact-piece in such manner as to cushion its movements in both directions, these springs being insulated from the frame of the hammer by the collar 20 and by a rear insulation 25, provided for the purpose. Of these springs the rear one 24 is the heavier and serves also to cushion the plunger 10 at the rear end of its stroke, the front spring 23 serving to return the contact-piece to its normal position after contact with the plunger is broken.

To prevent the movements of the plunger from being obstructed by compression of air within the ends of its inclosing tube 9, the end spaces within said tube are connected by a passage 26, through which the air can escape from one end to the other of the tube as the plunger reciprocates. Owing to the rapid movement of the plunger, the air rushes through this passage with considerable force and advantage is taken of the resulting blast to destroy the arc which tends to form at the rear end of the plunger each time the latter is separated from the contact-piece, the air-passage at this point being directed toward the point of contact, so that the current of air forced through the passage will blow out the arc as fast as it forms. As herein shown, such air-passage 26 is formed directly in the plunger itself and extends in the shape of a groove along the surface of a plunger to a point near its rear end, from whence it is drilled obliquely into the body of the plunger until it emerges almost centrally at the end of the latter directly at the point of contact between the plunger and contact-piece.

The switch 2 may be of any desired construction suitable for the purpose intended. As herein shown it is a plug-switch comprising a metallic section 27, located between insulating-sections 28 and 29 and adapted as the plug is depressed to be brought into contact first with spring switch-blades 30, 31, and 32 and then successively with other switch-blades 33 and 34, the blades 32, 33, and 34 being connected, respectively, with the taps 8^a, 8^b, and 8^c of the front coil, the blade 31 with the end 11 of the rear coil, and the blade 30 with the leading-in wire 12. The switch is mounted in the grip portion of the hammer-handle and is provided with a thumb-piece 35, which extends through the wall of the handle to within convenient reach of the thumb of the operator's hand. Its lower end is provided with a guiding-stem 36, which slides within an insulating-bushing 37 in the handle, and a spring 38 is applied at this point to normally raise the plug and hold its metallic section 27 out of contact with the switch-blades. When the plug is depressed against the resistance of this spring, its metallic section will be forced between the switch-blades to establish connection between the leading-in wire 12 and both the front and rear coils. Connection with the front coil 8 will be established first through tap 8^a and then in succession through taps 8^b and 8^c, connection being broken with tap 8^a as it is made with tap 8^b and broken with tap 8^b as it is made with tap 8^c, but always remaining established with the rear coil as long as the front coil is connected through any one of its taps. The rear coil will thus be continuously energized whenever the switch is closed, and in using the tool if the plunger does not happen to rest against the contact-piece 19 at the instant of closing the switch the influence of this rear coil will immediately retract it against said contact-piece. This in turn will complete the circuit through the front coil, which by reason of its greater strength and aided by the rear coil-spring 24 will draw the plunger out again in spite of the tendency of the rear coil to hold it retracted. As the plunger moves out its magnetic attraction will draw the contact-piece along with it until the contact-piece strikes a suitable limiting-stop, which in this instance is formed by the spring 23, when the latter is so compressed that its coils or leaves are closed solidly together. This breaks the circuit through the front coil and ends for the time being its projecting influence on the plunger; but the momentum already acquired will continue to force the plunger forward until it strikes the shank of the tool and is arrested by the blow which it imparts to the latter. The influence of the rear coil assisted by the front recoil-spring 18 then immediately retracts the plunger, and the process is repeated, the plunger being maintained in a state of continuous and rapid vibration as long as the switch remains closed.

The intensity of the blow will depend upon the effective length of the front coil and upon the length of plunger travel during which the coil remains in circuit. The effective length of the coil at any particular time is determined by the tap through which the circuit through the coil is completed. If the switch is only slightly depressed, so as to establish connection with the coil through the tap 8^a, the shortest length of coil will be energized and the lightest blow will result. If further depressed, so as to establish the connection through the tap 8^b, a greater length of the coil will be energized, with a resulting increase in the intensity of the blow, and if forced clear in, so as to establish the connection through the tap 8^c, the entire coil will be energized and the intensity of the blow

will be at its maximum. Additional taps may of course be provided and the number of possible gradations in the strength of the blow correspondingly increased.

The length of plunger travel during which the front coil will be energized is determined by the stop which limits the movement of the contact-piece, and where such stop is formed by the spring 23, as in the present instance, such length of plunger travel will be determined by said spring 23. Consequently by varying the proportions of the spring or otherwise providing for a different point of separation between the contact-piece and plunger the latter may be arranged to travel through any desired fraction of the stroke before the front coil is cut out, and the intensity of the blow may thus be varied beyond the limits of regulation afforded by the switch.

One important advantage of the construction thus described is that it requires but a single make-and-break contact to accomplish the reciprocation of the plunger, and this contact, furthermore, is by our improvement so constructed as to avoid any frictional or rubbing surface or joints. There is consequently no tendency for the engaging parts of the contact to wear away, and since the arc which tends to form between them is kept down by the blast of air which rushes through the port 26 as the plunger is projected these parts do not burn away and are practically indestructible.

It will be understood that the several features of improvement herein set forth are capable of being utilized separately and in other connections, as well as conjointly and as herein shown. The use of separate coils or sets of coils for projecting and for retracting the plunger and the feature of intermittingly energizing only that coil or set of coils which moves the plunger in one direction while continuously energizing the coil or sets of coils which moves the plunger in the other direction may be found of advantage, for example, in tools employing a different form of contact. On the other hand, the improved contact herein shown may be employed with coils otherwise arranged or energized, while the utilization of the plunger movement to generate an air-blast by which to destroy or keep down the arc at the contact-points may be generally employed to advantage in tools or motors of this character without regard to their particular construction in other respects.

It will also be understood that various changes may be made in the details of the construction shown without departing from the broad spirit of the invention claimed.

We claim as our invention—

1. An electrically-actuated reciprocating tool provided with a plunger, an intermittingly-energized coil for moving the plunger in one direction, and a separate continuously-energized coil for moving the plunger in the opposite direction.

2. An electrically-actuated reciprocating tool provided with a plunger, an intermittingly-energized coil for projecting the plunger to strike a blow, and a separate continuously-energized coil for retracting the plunger.

3. An electrically-actuated reciprocating tool provided with plunger-actuating coils, a magnetic plunger connected in a coil-circuit, a movable magnetic contact-piece connected in the circuit and engaged by the plunger to complete the circuit, and means for separating the contact-piece from the plunger after it has been magnetically drawn by the plunger through a portion of the stroke.

4. An electrically-actuated reciprocating tool provided with plunger-actuating coils, a magnetic plunger connected in a coil-circuit, a movable magnetic contact-piece connected in the circuit and engaged by the plunger to complete the circuit, and a spring for separating the contact-piece from the plunger after it has been magnetically drawn by the plunger through a predetermined fraction of the stroke.

5. An electrically-actuated reciprocating tool provided with plunger-actuating coils, a magnetic plunger connected in one of the coil-circuits, a movable magnetic contact-piece connected in the circuit and mounted in the line of the plunger movement to receive the direct impact of the plunger, a recoil-spring applied to force the contact-piece toward the plunger, and an oppositely-acting spring applied to force the contact-piece away from the plunger after it has been magnetically drawn by the plunger through a portion of its stroke.

6. An electrically-actuated reciprocating tool provided with a plunger, plunger-actuating coils, a make-and-break contact device connected in a coil-circuit, and an air-passage around the plunger through which the air is forced by the plunger movement against the contact to blow out the arc.

7. An electrically-actuated reciprocating tool provided with a plunger, plunger-actuating coils, a contact device connected in a coil-circuit and an air-passage extending longitudinally of the plunger and through which a blast of air is forced by the plunger movement against the point of contact to blow out the arc.

8. An electrically-actuated reciprocating tool provided with a plunger, an intermittingly-energized coil for moving the plunger in one direction, a separate continuously-energized coil for moving the plunger in the opposite direction, and a switch for cutting the whole or a part of a coil in or out at will.

9. An electrically-actuated reciprocating tool provided with a plunger, an intermittingly-energized coil for projecting the plunger, a separate coil for retracting the plunger,

and a switch for cutting a whole or a part of a coil in or out at will.

10. An electrically-actuated reciprocating tool provided with a metallic plunger, a coil for moving the plunger in one direction, a separate coil for moving the plunger in the opposite direction, and means for intermittingly completing a coil-circuit through the metallic plunger.

11. An electrically-actuated reciprocating tool provided with a metallic plunger, an intermittingly-energized coil for moving the plunger in one direction, a separate continuously-energized coil for moving the plunger in the opposite direction, and means for intermittingly completing the circuit of the first coil through the metallic plunger during determined fractions of the plunger movement.

12. An electrically-actuated reciprocating tool provided with a metallic plunger, a coil for projecting the plunger, a separate coil for retracting the plunger, and means for intermittingly completing the circuit of the projecting-coil through the metallic plunger.

13. An electrically-actuated reciprocating tool provided with a metallic plunger, a coil for projecting the plunger, a separate coil for retracting the plunger, and means for intermittingly completing the projecting-coil circuit through the metallic plunger, and a switch for cutting the whole or a part of a coil in or out at will.

14. An electrically-actuated reciprocating tool provided with plunger-actuating coils, a magnetic plunger connected in a coil-circuit, a movable magnetic contact-piece connected in the circuit and engaged by the plunger to complete the circuit, means for separating the contact-piece from the plunger after it has been magnetically drawn by the plunger through a portion of the stroke, and a switch for cutting the coils in or out at will, substantially as described.

15. In an electrically-actuated reciprocating tool, the combination with an inclosing casing, of a plunger mounted to reciprocate within the casing, a coil inclosing the plunger and serving to move it in one direction, a separate coil inclosing the plunger and serving to move it in the opposite direction, and means for intermittingly energizing the coils, substantially as described.

In testimony that we claim the foregoing as our invention we affix our signatures each in the presence of two subscribing witnesses.

A. W. McARTHUR.
JOHN G. CRAWFORD.

Witnesses as to signature of A. W. McArthur:

EGBERT H. BALLARD,
F. C. JOHNSON.

Witnesses as to signature of John G. Crawford:

HENRY W. CARTER,
K. A. COSTELLO.