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3,209,180

ELECTRICALLY OPERATED TOOL

Filed May 21 1964

2 Sheets-Sheet 1

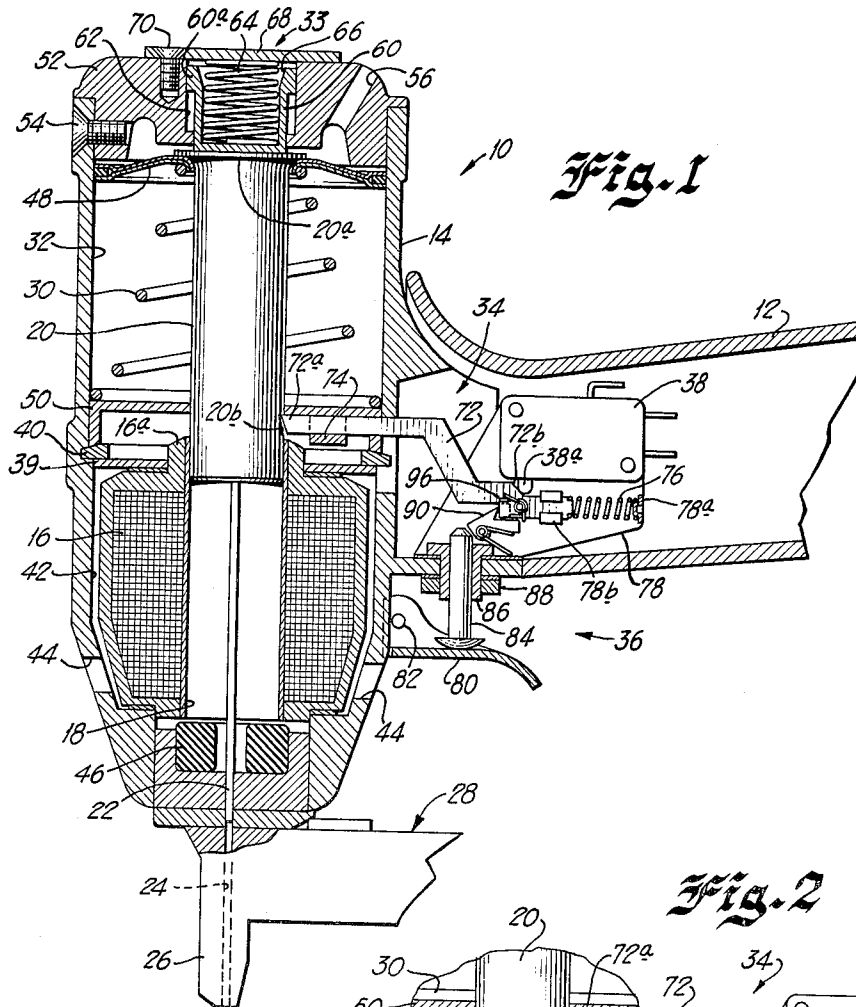


Fig. 1

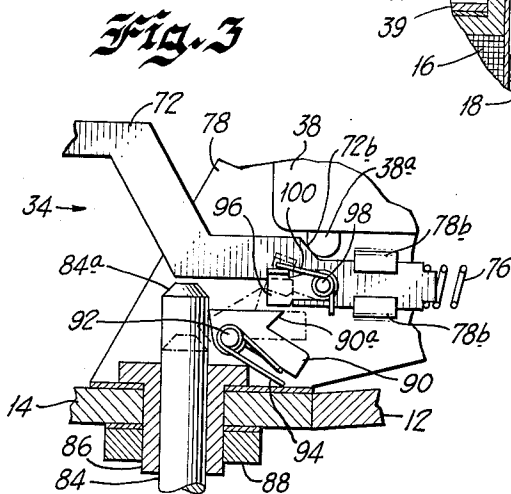


Fig. 3

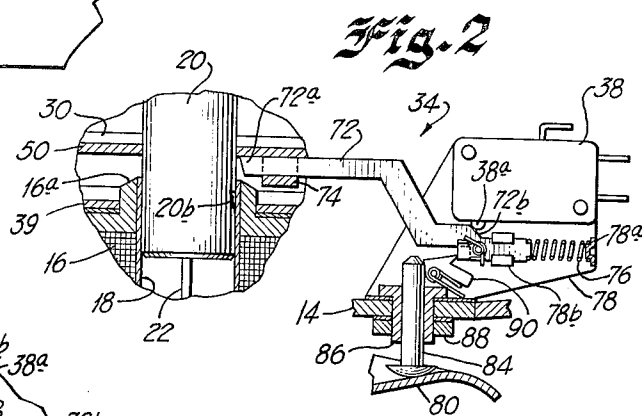


Fig. 2

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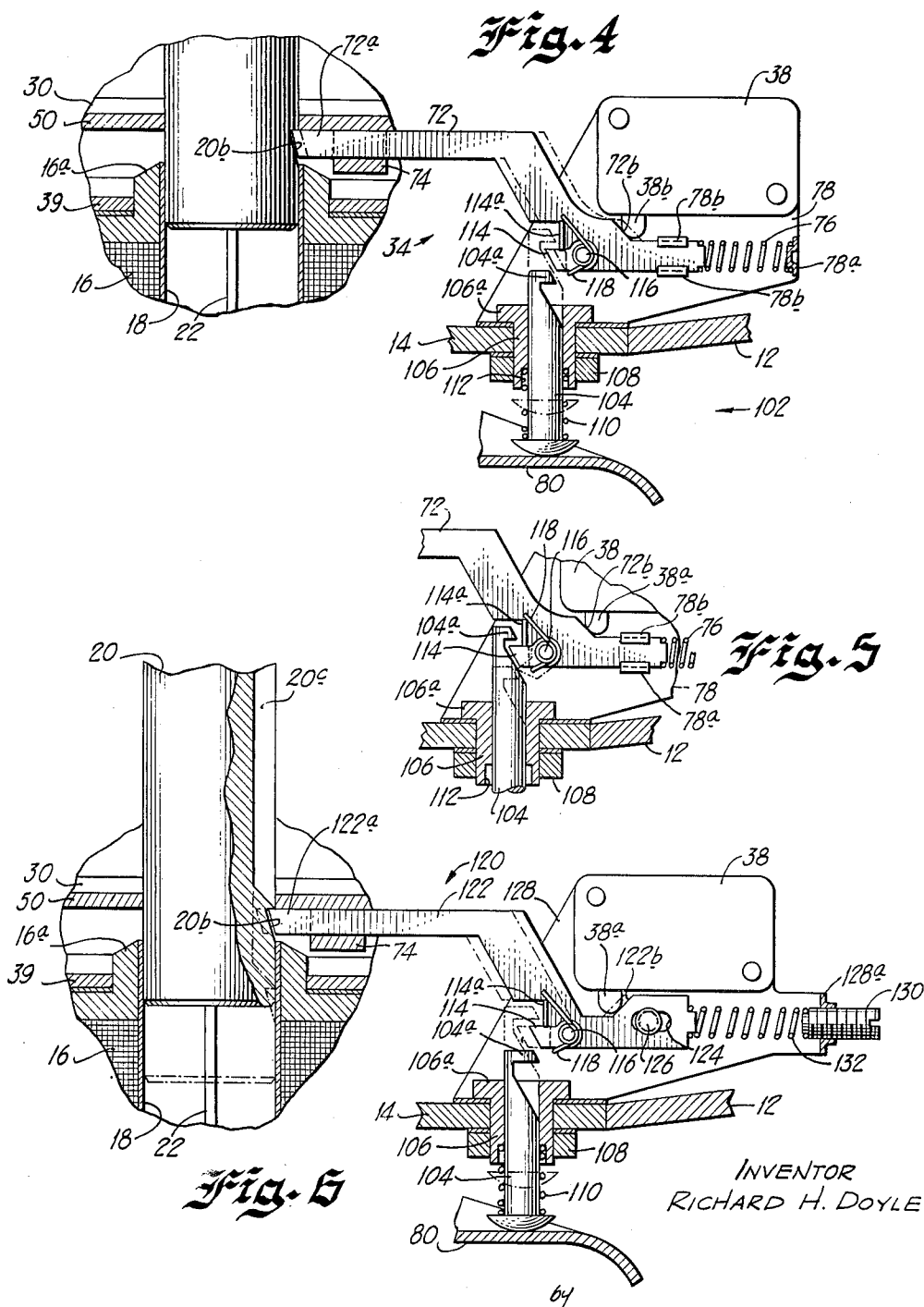
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2 Sheets-Sheet 2



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ELECTRICALLY OPERATED TOOL

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15 Claims. (Cl. 310-15)

This invention relates to an electrically operated tool and, more particularly, an electrically operated tool for driving fasteners.

The copending application of Richard H. Doyle et al., Serial No. 161,651, filed December 22, 1961, now Patent No. 3,141,171, discloses an electrically operated single stroke tool for driving fasteners, such as staples. This tool includes an operating winding having an axial opening through which a magnetic armature connected to a driver element is moved in response to a momentary energization of the winding. The flux field resulting from the energization of the winding acts on the stationary armature and places it in movement to actuate the fastener driving element to drive a fastener in a single power stroke. The armature and fastener driving element are restored to a normal position by suitable return means, such as a resilient return spring, at the conclusion of the power stroke.

In efforts to increase the driving power of this type of tool, it has been determined that a substantial part of the input energy to the output winding is expended in placing the armature and driving element in motion so that a somewhat limited amount of energy remains to accelerate the armature. The acceleration of the armature and driving element to high speeds increases the kinetic energy available for driving the fasteners, and it would be desirable to provide an electrically operated tool in which a greater part of the input energy can be used efficiently in the fastener driving operation.

Accordingly, one object of the present invention is to provide a new and improved electrically operated tool.

Another object is to provide an electrically operated tool including new and improved means for efficiently converting input electrical energy into movement of an armature.

Another object is to provide an electrically operated tool for driving fasteners including means for imparting an initial movement to a magnetic armature and subsequently energizing the operating winding through which the armature moves.

A further object is to provide an electrically operated tool including means for latching an armature in a given position and control means for sequentially releasing the latching means and energizing an operating winding.

A further object is to provide an electrically operated tool of the type having an operating winding with an axial opening through which a magnetic armature moves in which the armature is first placed in movement by an auxiliary power means and is then subjected to the driving force resulting from the energization of a main operating winding.

Another object is to provide electrically operated tool of the type having an operating winding with an axial opening through which a magnetic armature moves and in which a biased armature is held in a given position by a latch means which is released when the tool is to be operated and which, when released, causes the timed energization of the operating winding.

Another object is to provide an electrically operated tool including new and improved means for controlling the release of a normally latched armature and the timed energization of an operating winding.

A further object is to provide an electrically operated tool in which energy derived from an armature return

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means is stored and used to place the armature in motion at the beginning of the next power stroke.

In accordance with these and many other objects, an embodiment of the present invention comprises an electrically operated tool of the type having a housing with a vertically extending head portion, in the lower end of which is disposed an operating winding having an axial opening. A magnetic armature disposed in an upper portion of the head portion is connected at its lower end to a driver blade that extends through the axial opening to be slidably received within a drive track formed in a nosepiece structure carried on the lower end of the housing and to which staples or other suitable fasteners are supplied by a magazine assembly. The armature and blade are normally latched in an elevated position by a latching assembly. In this latched position, a biasing means is stressed to apply forces tending to move the armature through the axial opening in the winding.

When the tool is to be operated, suitable control means, such as a trigger actuated control assembly, are actuated to release the latching element so that the biasing means overcomes inertia and places the armature in movement through the axial opening in the operating winding. This control linkage then actuates a control switch so that the operating winding is energized to provide a flux field for driving the armature and fastener driving element through a power stroke. The mechanism is such that when the operating winding is energized, the latch element is freed to return to its normal position. Thus, at the termination of the power stroke, an armature return spring restores the armature to its normal position and compresses the biasing means to store the energy by which the armature is first placed in motion during the next operating stroke. When the armature and blade have returned to this position in which energy is stored in the biasing means, the latch means latches the armature in this position regardless of the position of the manually actuated control means.

The energy stored in the biasing means when the armature is latched in its normal position at the end of each power stroke provides means for overcoming the forces of inertia and for initially placing the armature in movement at the beginning of the next power stroke. By timing the application of the energizing potential to the operating winding so that it follows the release and the initial movement of the armature, a greater portion of the electrical energy supplied to the operating winding is effective to impart kinetic energy to the connected armature and driver blade and, thus, to increase the driving power of the tool without requiring an increase in the energy supplied to the operating winding.

Many other objects and embodiments of the present invention will become apparent from considering the following detailed description in conjunction with the drawings in which:

FIG. 1 is a fragmentary sectional view of an electrically operated fastener driving tool embodying the present invention shown in a normal condition;

FIG. 2 is a fragmentary view of a control assembly in the tool shown in FIG. 1, which assembly is illustrated during manual actuation;

FIG. 3 is an enlarged fragmentary sectional view illustrating the control assembly following manual operation and prior to release;

FIG. 4 is an enlarged fragmentary sectional view of an electrically operated tool forming a second embodiment of the invention, the tool being shown in a normal condition;

FIG. 5 is a fragmentary view of a portion of the mechanism shown in FIG. 4 illustrated in an operated condition; and

FIG. 6 is a fragmentary sectional view of an electrically

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operated tool forming a third embodiment of the present invention.

Referring now more specifically to FIGS. 1-3 of the drawings, therein is illustrated an electrically operated tool which is indicated generally as 10 and which embodies the present invention. The tool 10 is of the same general construction as that disclosed and described in detail in the above-identified copending Doyle et al. application and includes a housing consisting of a rearwardly extending hollow handle 12 joined at its forward end to a vertically extending housing or head portion 14 having a downwardly and inwardly tapered lower portion in which is disposed an operating winding 16 having an axial opening 18 through which a magnetic armature 20 is adapted to move. A fastener driving element or blade 22 is secured to the lower end of the armature 20 and is adapted to enter a drive track 24 formed in a nosepiece structure 26 to which staples or other suitable fasteners are sequentially supplied by a magazine assembly indicated generally as 28. When the winding 16 is energized, the connected armature 20 and driver blade 22 are moved downwardly to engage and drive a fastener, and these elements are restored to a normal position by an armature return spring 30 disposed in an upper cylindrical chamber 32 in the head portion or housing 14 of the tool.

To increase the efficiency of the operation of the tool 10, a biasing assembly indicated generally as 33 is provided which is rendered effective to apply a downwardly directed biasing force to the armature 20. When the armature 20 and the driver element 22 are returned to their normal positions at the conclusion of the power stroke, these components are latched in these positions by a latching assembly or means 34. When a manual control means or assembly indicated generally as 36 is actuated, the latching means 34 is released to permit the armature 20 to move downwardly under the influence of the assembly 33, and an electrical switch 38 forming a part of the circuit for controlling the energization of the winding 16 is then actuated so that the winding 16 is energized only after the magnetic armature 20 has started to move downwardly under the force of the biasing assembly 33. This means that a greater percentage of the energy available in the form of the flux field developed by the winding 16 is effective to accelerate the downward movement of the connected armature 20 and driver blade 22.

As indicated above, the general construction of the tool 10 is similar to that shown and described in detail in the above-identified copending Doyle et al. application. In general, the winding 16, which is disposed within the lower portion of the head 14 of the tool, is "potted" in a dielectric composition which forms an upper bossed portion 16a that is received within a central opening in a spider construction 39. The spider 39 seats against a resilient washer or retaining ring 40 carried in a groove on the inner wall of the housing 14 so as to secure the winding 16 in its proper position within the lower end of the head portion 14. In this position, the outer wall of the winding 16 is spaced from the inner wall of the lower portion of the housing 14 to define an air conveying means or cavity 42 that is placed in communication with the atmosphere through a plurality of ports or passageways 44. A resilient bumper 46 disposed at the lower end of the housing 14 aligned with the armature 20 cushions the termination of movement of the armature 20 at the end of the power stroke.

To provide means for cooling the winding 16, a flexible, generally circular air impelling means or vane 48 is biased against a flanged upper end portion 20a of the armature 20 by the return spring 30. The lower end of the spring 30 rests on an annular supporting element 50 and biases this element into engagement with the stop ring 40. The outer periphery of the air impelling vane 48 slidably engages the inner wall of the chamber 32. The upper end of the chamber 32 is closed by a closure cap 52 which is secured in position by a plurality of machine screws 54.

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A passageway 56 in the closure cap 52 places the upper interior of the chamber 32 in communication with the atmosphere. The space in the chamber 32 below the vane 48 is placed in communication with the air conveying space 42 through suitable apertures in the spider construction 39 and the member 50. When the vane 48 is reciprocated by the armature 20 and the spring 30, the vane produces a flow of air through the ports 44 and the passageway 56 to provide a flow of cooling air through the conveying space 42 adjacent the outer surface of the winding 16 to prevent excessive heating of the tool 10.

The biasing assembly 33 is placed in an effective or energy storing condition in response to the return of the magnetic armature 20 at the conclusion of a power stroke and is manually released to move the armature 20 downwardly prior to the energization of the winding 16 so that the flux field developed by the winding 16 is used primarily to accelerate the downward movement of the armature. The biasing assembly, which is carried on the closure cap 52, includes a plunger or piston 60 slidably mounted in a recess or cylinder 62 in the closure cap 52 aligned with the magnetic armature 20. A compression spring 64 is disposed within a recess 66 in the piston 60 and is interposed between a lower wall of the piston 60 and a plate 68 that is secured to the cap 52 by a plurality of machine screws 70 in a position closing the cylinder 62. A flanged portion 60a on the piston 60 engages the lower wall of the cylinder 62 to limit downward movement of the piston 60.

When the armature 20 is returned from a position engaging the resilient bumper 46 by the return spring 30 following a power stroke of the tool 10, the lower wall of the piston 60 is struck by the flanged upper end 20a of the armature. The continuing upward movement of the magnetic armature 20 under the force of the spring 30 compresses the spring 64 and moves the piston 60 upwardly to the active or cocked position illustrated in FIG. 1 of the drawings. The latching assembly 34 holds the armature 20 in this position and thus retains the biasing assembly 33 in its effective position. When the latching assembly 34 is actuated to release the armature 20, the compressed spring 64 forces the piston 60 and the engaged armature 20 downwardly to impart an initial degree of movement or acceleration to the armature 20. Thus, when the winding 16 is energized, the flux field produced by this winding is effective to accelerate its downward movement, and a portion of this energy is not dissipated in overcoming the effects of inertia.

The latching assembly 34 for normally retaining the armature 20 in its upper position and for selectively releasing this armature for movement under the control of the assembly 33 and the winding 16 in response to the actuation of the assembly 36 includes a latch or detent element 72 having a tapered end 72a adapted to be received within a recess or notched portion 20b in the magnetic armature 20. The latch member 72 is slidably mounted at one end in an aperture in a depending wall on the member 50 and a U-shaped support 74 carried on the member 50. A compression spring 76 interposed between one end of the latch 72 and a projection 78a on a supporting bracket 78 mounted within the hollow handle 12 of the tool biases the latch 72 to the left (FIG. 1) into engagement with the notched portion 20b on the magnetic armature 20. The other end of the latch 72 is slidably mounted on two projecting portions 78b formed integral with the support 78.

The latch assembly 34 also includes means for selectively energizing the winding 16 in a timed relation to the release of the armature 20 for movement under the force of the biasing assembly 33. The control switch 38, which is mounted within the hollow handle portion 12 on the supporting bracket 78, forms a part of a control circuit for controlling the energization of the winding 16. The switch 38 can be connected to a control circuit remote from the tool 10 of the type disclosed in

the above-identified copending Doyle et al. application by means of a flexible connector. Alternatively, the control circuit for energizing the winding 16 can be carried within the hollow handle 12. The switch 38 includes a depending switch operator 38a which is disposed adjacent an inclined or cam surface 72b on the latch element 72. In the normal condition of the latching assembly 34 in which the end 72a of the latch element 72 engages the recess 20b, the switch operator 38a is disposed in its lowered position, and the switch 38 is not actuated. However, when the latch member 72 is moved to the right (FIG. 1) against the action of the bias spring 76 to move the point 72a out of interlocking engagement with the notched portion 20b so that the armature 20 is free to move downwardly, the cam surface 72b of the latch engages the operator element or stem 38a and moves it upwardly to actuate the switch 38. The actuation of the switch 38 controls the application of energy to the operating winding 16, and the energization of the winding 16 is synchronized with the downward movement of the magnetic armature 20 under the force of the biasing assembly 33.

The manual operating assembly 36 for controlling the operation of the latching assembly 34 includes means responsive to manual actuation of the assembly 36 for releasing the latching assembly 34 and operating the switch 38 and for permitting the assembly 38 to return to an effective position in which the armature 20 can be latched in its upper position without requiring the release of the assembly 36. More specifically, the assembly 36 includes a trigger element 80 pivotally mounted on the head portion 14 of the tool 10 by a pivot pin 82. The lower end of an operating plunger 84 rests on the trigger 80, and the upper end of this plunger is slidably mounted within a bushing 86 carried on the head portion 14. An enlarged or flanged head of the bushing 86 clamps a projecting arm on the bracket 78 against a wall of the housing to secure the bracket 78 in a desired position, and the outer end of the bushing 86 carries a nut 88 which secures the bushing 86 in position.

In the normal condition of the tool 10, a tapered upper end 84a on the operating plunger 84 is disposed adjacent an operating pawl 90 which is pivotally mounted on a stub shaft 92 (FIG. 3) and which is continuously biased in a counterclockwise direction to the normal position shown in FIG. 1 by a torsion spring 94. In this position, a projection 90a on the pawl 90 is disposed adjacent a transversely extending wall on an element 96 that is pivotally mounted on the latch member 72 by a stub shaft or pin 98. A torsion spring 100 bearing against the latch 72 at one end and a flange on the member 96 at its other end normally biases the element 96 to the position shown in FIG. 1 which is determined by the mutual engagement of stop surfaces on the latch 72 and the element 96.

When the tool 10 is to be operated, the nosepiece 26 is placed adjacent the workpiece, and the trigger 80 is pivoted in a counterclockwise direction about the pivot pin 82 so that the operating plunger 84 moves upwardly from the normal position shown in FIG. 1. During this movement, the tapered upper end 84a of the plunger 84 bears against the nose of the pawl 90 and pivots this pawl in a clockwise direction about the pivot pin 92 against the action of the torsion spring 94. During this movement, the projecting portion 90a bears against the transverse wall of the element 96 to shift the latch 72 to the right from the position shown in FIG. 1 to the position shown in FIG. 2. During this movement, the end 72a of the latch 72 moves out of engagement with the recess 20b on the armature 20, and this armature is forced downwardly by the piston 60 and the expanding compression spring 64. This movement is illustrated by the position of the armature 20 in FIG. 2 of the drawings. Thus, the initial actuation of the assembly 36 releases the latching assembly 34 and permits the arma-

ture 20 to move downwardly under the force provided by the biasing assembly 33.

Continuing upward movement of the operating plunger 84 pivots the pawl 90 further in a clockwise direction about the pivot pin 92 so that the projecting portion 90a bears against the element 96 to force the latch 72 further to the right to the position illustrated in FIG. 2. During this movement, the surface 72b on the element 72 cams against the lower end of the operating stem 38a to move this stem upwardly and operate the switch 38. When the switch 38 is operated, the winding 16 is energized, and the flux field developed thereby acts on the previously moving magnetic armature 20 to propel this armature and the connected fastener driving element 22 downwardly to engage and drive a fastener supplied to the drive track 24 by the magazine 28. The downward movement of the armature 20 is terminated by engagement with the resilient bumper 46.

The continuing upward movement of the plunger 84 from the position shown in FIG. 2 to the position shown in FIG. 3 pivots the pawl 90 a sufficient distance in a clockwise direction for the projection 90a to move beyond the element 96 carried on the latch 72. At this time, the compression spring 76 forces the latch 72 to the left from the position shown in FIG. 2 to the position shown in FIG. 3. When the latch 72 moves to the left, the pointed end 72a bears against the wall of the magnetic armature 20 but does not interfere with its downward movement. Further, this movement of the latch 72 shifts the cam surface 72b to the left to permit the operating stem 38a for the switch 38 to drop. The position of the cam surface 72b can be such that the switch 38 is either maintained in an operated condition or released when the latch 72 returns to this position intermediate between the position fully to the left shown in FIG. 1 in which the armature 20 is latched and the extreme right-hand position shown in FIG. 2 in which the latch 72 is displaced from contact from the armature 20.

By permitting the latch 72 to return to a position engaging the armature 20 while the trigger 80 is deflected and the plunger 84 elevated, it is possible to latch the armature 20 in its elevated position as soon as it is returned by the spring 30 independent of the position of the assembly 36. Thus, when the field provided by the winding 16 collapses and the return spring 30 elevates the armature 20, the flanged portion 20a again strikes the lower end of the piston 60 and compresses the spring 64 to condition the biasing assembly 33 for the next cycle of operation. When the armature 20 is elevated to its normal position shown in FIG. 1, the point 72a on the latch, which has been sliding in contact with the armature 20, moves into an interlocking relation with the recess 20b, and the latch retains the armature 20 in its normal position in condition for another cycle of operation.

When the trigger 80 is released, the trigger is pivoted in a clockwise direction, and the plunger 84 drops to its normal position shown in FIG. 1. The torsion spring 94 acts on the pawl 90 to pivot it in a counterclockwise direction about the pivot pin 92. Since the latch 72 is now in its normal position (FIG. 1), the leading edge of the projecting portion 90a on the pawl 90 strikes the lower wall of the element 96 and pivots this element in a clockwise direction about the pivot pin 98 against the action of the torsion spring 100. The relative positions of the pawl 90 and the element 96 during this return movement is illustrated in dot-and-dash outline in FIG. 3. When the pawl 90 has pivoted out of engagement with the element 96, the torsion spring 94 restores the pawl 90 to the normal position shown in FIG. 1, and the torsion spring 100 pivots the element 96 in a counterclockwise direction about the pin 98 to restore it to normal position shown in solid outline in FIGS. 1 and 3. Thus, the manual actuating assembly 36 includes a unidirectional motion transmitting means which permits the latch 72 to be released and the switch 38 to be operated in response to

actuation of the trigger 80 and which permits the latch element 72 to be restored to a position in which it is capable of latching the magnetic armature 20 regardless of the length of time that the manual control assembly 36 is held in an operated condition. It is desirable to do this because the tool 10 operates and restores the armature 20 in less time than the operator could respond.

FIGS. 4 and 5 of the drawings illustrate a modification of the tool 10 including an improved manual actuating or control assembly indicated generally as 102. The remaining components of the tool 10 are the same as those illustrated in detail in FIGS. 1-3 of the drawings and are indicated by the same reference numerals.

The manual control assembly 102 is actuated by the trigger 80 which is pivotally mounted on the head portion 14 of the housing. A plunger 104 slidably mounted within a bushing 106 carried on the housing 14 includes an enlarged or rounded lower end resting on the trigger element 80. The bushing 106 is formed with a flanged upper end 106a which rests on a projecting portion of the bracket 78 and includes a lower threaded portion on which a nut 108 is received so that the bushing 106 clamps the bracket 78 in position on the housing 14. A compression spring 110 is interposed between the enlarged head of the plunger 104 and the upper wall of an annular recess 112 in the bushing to provide means for normally biasing the operating plunger 104 and the trigger 80 to the position illustrated in FIG. 4 of the drawings.

To provide means for releasing the latching assembly 34 and operating the control switch 38 in a timed relation while yet permitting these assemblies to be restored to a normal position independent of the operated or released condition of the operating plunger 104, the upper end of this plunger is provided with a notched or hooked portion 104a having an inclined surface. The notched portion 104a cooperates with a pawl 114 that is pivotally mounted upon the latch element 72 by a pivot pin 116. A torsion spring 118 normally biases the pawl 114 about the pivot pin 116 in a clockwise direction so that an upstanding and transversely extending wall 114a on the pawl 114 engages a wall on the latch 72 to limit this clockwise movement.

When the tool is operated by pivoting the trigger 80 in a counterclockwise direction about the pivot pin 82, the plunger 104 moves upwardly against the bias of the spring 110, and the inclined surface on the notched portion 104a of this plunger bears against a similarly inclined wall on the pawl 114. This shifts the link 72 to the right against the action of the compression spring 76 so that the point 72a moves out of engagement with the recess 20b on the armature 20. This permits the armature 20 to move downwardly under the force supplied by the biasing assembly 33. The movement to the right of the link 72 from the position shown in solid outline in FIG. 4 to the position shown in dot-and-dash outline in FIG. 4 forces the cam surface 72b on the latch element 72 against the operating stem 38a so that the switch 38 is operated to control the timed energization of the operating winding 16.

As the inclined surface on the notched portion 104a of the operating plunger 104 moves beyond the inclined surface on the pawl 114, the plunger 104 and the pawl 114 occupy the relative positions shown in dashed outline in FIG. 4 and in solid line in FIG. 5. This is true because the biasing spring 76 forces the latch 72 to the left as soon as the notched portion 104a clears the pawl 114. This movement to the left of the latch 72 releases the switch 78 and biases the point 72a against the outer surface of the armature 20 to condition the latching assembly 34 for securing the armature 20 in its elevated position at the termination of the power stroke in the manner described above. When the armature 20 is returned to its normal position, the latch 72 moves slightly further to the left as the point 72a moves into interlocking engagement with the recess 20b on the armature 20.

The manual control assembly 102 remains in this position (FIG. 5) until this assembly is released by removing the deflecting force from the trigger 80. At this time, the compression spring 110 pivots the trigger 80 in a clockwise direction about the pivot pin 82 and moves the plunger 104 downwardly from the position shown in solid line in FIG. 5 to the position shown in dashed line in FIG. 5 and in solid outline in FIG. 4. In moving downwardly, the lower surface of the notched portion 104a on the plunger 104 moves into engagement with the transversely extending wall on the pawl 114. This pivots the pawl in a counterclockwise direction about the pivot pin 116 against the action of the torsion spring 118 and moves the wall portion 114a out of engagement with the adjacent wall portion on the latch 72. As soon as the pawl 114 is moved to the position shown in dashed outline in FIG. 5 in which the notched portion 104a moves out of interlocking engagement with the pawl, the pawl is pivoted in a clockwise direction about the pin 116 to its normal position determined by engagement of the wall 114a with the adjacent wall on the latch 72. Thus, the release of the manual control assembly 104 and its subsequent restoration to its normal condition does not cause the release of the latching assembly 34 or the actuation of the control switch 38.

FIG. 6 of the drawings illustrates another modification in the control system for timing the release of the magnetic armature 20 and actuating the control switch 38. The latching construction shown in FIG. 6 is substantially the same in its general arrangement as that shown in FIGS. 1-3 of the drawings except that the armature 20 includes a longitudinally extending slot 20c aligned with the detent notch 20b. The manual actuating assembly used in the construction shown in FIG. 6 is substantially identical to the assembly 102 shown in FIGS. 4-5 of the drawings. However, the construction of the latching assembly has been modified to permit the switch 38 to be actuated by resilient means rather than under the control of the manual actuation of the trigger 80.

More specifically, the construction shown in FIG. 6 includes a latch member or element 122 having a pointed end portion 122a similar to the portion 72a on the latch 72 that is normally received within the recessed area 20b on the armature 20 to retain this armature 20 in its elevated position. The portion of the latch element 122 disposed adjacent the point 122a is slidably mounted on the housing of the tool in the same manner as the latch member 72. However, the right-hand end of the latch member 122 is provided with an elongated opening 124 in which a headed fastener 126 is slidably mounted to provide means for slidably supporting the other end of the latch. An intermediate portion of the latch member 122 carries the pawl 114 which is pivotally mounted thereon by the shaft 116 and which is biased to the normal position shown in solid line in FIG. 6 by the torsion spring 118.

To provide means for operating the actuating stem 38a of the switch 38, the latch member 122 is provided with an inclined surface or cam portion 122b that faces in an opposite direction from the surface 72b on the latch element 72. The switch 38 is carried on a bracket 128 that is substantially the same as the bracket 78 except that a rearwardly extending portion 128a is provided within an internally threaded boss in which a lead screw 130 is threadedly mounted. The inner end of the lead screw 130 is provided with a reduced diameter portion on which is seated one end of a compression spring 132, the other end of which bears against the right-hand portion of the latch element 122. Thus, the spring 132 normally biases the latch element 122 to a position engaging the magnetic armature 20 and in a direction for actuating the stem 38a of the switch 38. Adjustment of the lead screw 130 varies the biasing force applied to the latch member 122.

In operation, the depression of the trigger 80 moves the plunger 104 upwardly to cam the latch 122 to the

right in the same manner as the control assembly 102 (FIGS. 4 and 5). When the latch 122 moves to the right (FIG. 6), the armature 20 is released and is moved downwardly by the biasing assembly 33. When the notched upper end portion 104a of the plunger passes beyond the pawl 114, the compression spring 132 biases the latch element 122 to the left. In view of the elongated slot 20c formed in the armature 20, the latch member 122 is free to move to the left beyond its normal latching position to a position in which the point 122a is disposed within the slot 20c. During this movement to the left, the surface 122b on the latch member 122 engages the operator stem 38a and actuates the switch 38 so that the winding 16 is energized. Thus, the energization of the winding 16 is dependent on the release of the magnet 20. The slot 20c prevents the latch 122 from interfering with movement of the armature 20.

At the end of the driving stroke and with a control circuit of the type providing only a single pulse of energy regardless of the length of time that the switch 38 is closed, the armature 20 is elevated by the return spring 30 to the normal position shown in FIG. 1. As the armature 20 approaches this position, the edge of the slot 20c cams against the point structure 122a and shifts the latch 122 to the right against the bias of the spring 132. When the armature 20 reaches its normal position, the latch member 122 returns to the position in which the point 122a engages the recessed portion 20b. When the latch member 122 is returned to the right by camming engagement with the armature 20, the switch 38 is released, and the operating stem 38a is restored to its normal position. The operating stem 104 is restored to its normal position by the compression spring 110 when the trigger 80 is released, this return movement causing pivotal movement of the pawl 114 carried on the latch member 122 in the same manner as described above in conjunction with the construction shown in FIGS. 4 and 5.

Although the present invention has been described with reference to several illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. In an electrically operated tool, an operating winding have an axial opening, armature means movable through the axial opening, resilient means, latching means securing the armature means in a given position stressing the resilient means, so that the resilient means biases the armature means for movement in a predetermined direction, the armature means being disposed relative to the winding means in said given position to move in said predetermined direction when the winding means is energized, and control means for releasing the latching means and energizing the winding so that both the winding means and the resilient means cause movement of the armature means in said predetermined direction.

2. In an electrically operated tool, an operating winding having an axial opening, armature means movable through the axial opening, resilient means, latching means for securing the armature means in a position stressing the resilient means, and control means for releasing the latching means to permit the armature to move under the influence of the resilient means and for then energizing the winding to impart additional kinetic energy to the moving armature.

3. An electrically operated tool comprising an operating winding having an axial opening, magnetic armature means movable in the opening, latch means for retaining the armature means in a predetermined position, switch means for controlling the energization of the winding means and including switch operator means, and mov-

ably mounted means for releasing the latch means and actuating the switch operator means.

4. The tool set forth in claim 3 including resilient means for biasing the latch means, and cam means formed on the latch and disposed adjacent the operator means, said resilient means moving the cam means to actuate the switch operator means when the latch means is released.

5. The tool set forth in claim 3 including cam means on the latch means disposed adjacent the switch operator means, said movably mounted means moving the latch means to release the armature means and to move the cam means relative to the switch operator means to actuate the switch means.

6. In an electrically operated tool, winding means having an opening, magnetic armature means movable in the opening, resilient means acting on said armature means to bias said armature means for movement, latch means for retaining said armature against movement, power means for energizing the winding, and control means for releasing the latch means to permit movement of the armature means by the resilient means and for then rendering the power means effective to energize the winding means so that the field produced by the winding means is applied to the moving armature means.

7. In an electrically operated tool, winding means having an axial opening, armature means movable in the opening, biasing means acting on the armature means and tending to move the armature means through the axial opening, latching means including a latch element engaging the armature means to prevent movement of the armature means by the biasing means, means including switch means for energizing the winding means to cause movement of the armature means through the axial opening, and control means operable to release the latching means and to actuate the switch means so that the armature is moved by the biasing means and the winding means is energized.

8. The tool set forth in claim 7 in which the switch means includes an operator means and in which the latching element includes cam means movable relative to the operator means for actuating the operator means and the switch means.

9. In a fastener driving tool, a reciprocally mounted fastener driving means, a power means for driving the fastener driving means through a driving stroke, return means for restoring the fastener driving means to a normal position following a driving stroke, resilient means for biasing the fastener driving means, detent means securing the fastener driving means in the normal position against the bias of the resilient means, and control means for releasing the detent means and operating the power means in sequence to apply energy to the faster driving means during the operating stroke from the resilient means and the power means in sequence.

10. In a fastener driving tool, a reciprocally mounted fastener driving means, a power means for driving the fastener driving means through a driving stroke, return means for restoring the faster driving means to a normal position following a driving stroke, resilient means for biasing the fastener driving means, detent means securing the fastener driving means in the normal position against the bias of the resilient means, first control means for controlling the operation of the power means, and second control means for operating the first control means and releasing the detent means in sequence so that the fastener driving means receives energy from both the power means and the resilient means.

11. In an electrically operated tool, winding means having an axial opening, armature means movable in the opening, biasing means acting on the armature means and tending to move the armature means through the axial opening, latching means including a latch element, resilient means biasing the latch element into a locking posi-

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tion to latch the armature means against movement, means including switch means for energizing the winding means, said switch means including operator means, and linkage means operable to move the latch element against the resilient bias to release the armature means and operable to actuate the operator means to energize the winding means.

12. The tool set forth in claim 11 in which the linkage means includes both a slidably mounted member and means responsive to movement of the member in only one direction for moving the latch element.

13. An electrically operated tool comprising an operating winding having an axial opening, armature means movable in the opening, a movably mounted latch means for holding the armature means in a given position, means including switch means for energizing the winding means, said switch means including an operator means, said latch means including a control surface for actuating the switch operator means, and means for shifting the position of the latch means to release the armature means and to render the control surface effective to actuate the switch operator means.

14. The tool set forth in claim 13 including a trigger mechanism, and a unidirectional motion transmitting

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means interposed between the trigger mechanism and the latch means.

15. An electrically operated tool comprising an operating winding having an axial opening, armature means movable in the opening, a movably mounted latch means for holding the armature means in a given position, means including switch means for energizing the winding means, said switch means including an operator means, said latch means including a control surface for actuating the switch operator means, actuating means for operating the latch means to release the armature means and to actuate the switch operator means, and means interposed between the actuating means and the latch means to permit the latch means to return to a position latching the armature means independent of the release of the actuating means.

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