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ELECTRICALLY ACTUATED FASTENER DRIVING TOOL

Filed Oct. 5, 1964

3 Sheets-Sheet 1

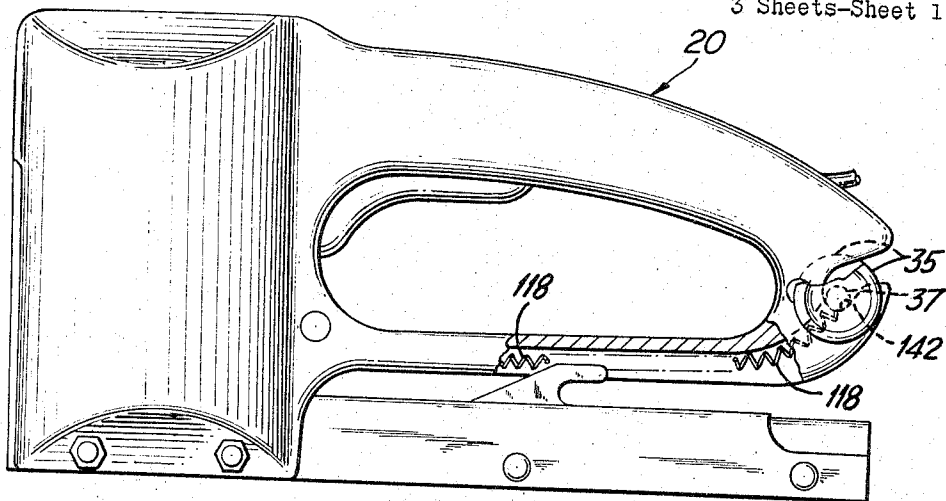


FIG. 1

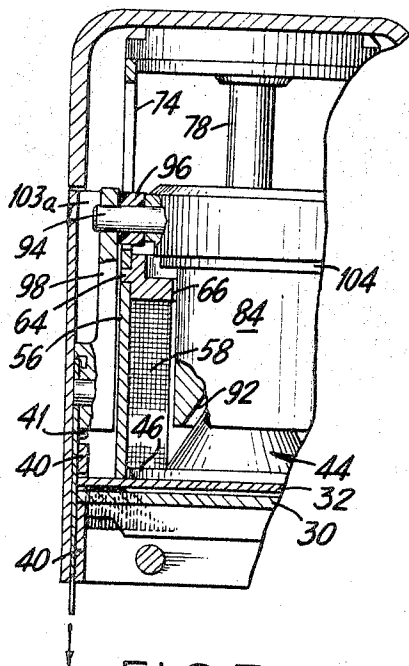


FIG. 7

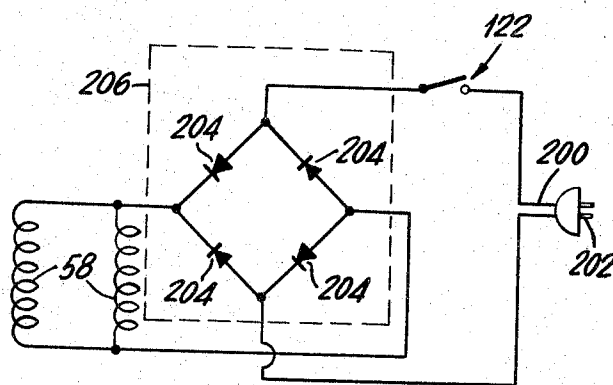


FIG. 8

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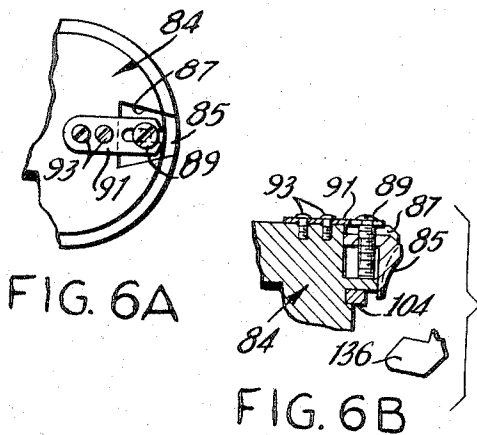
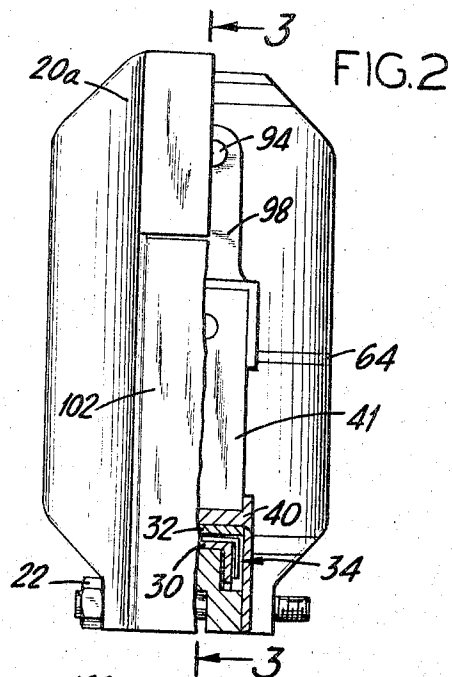
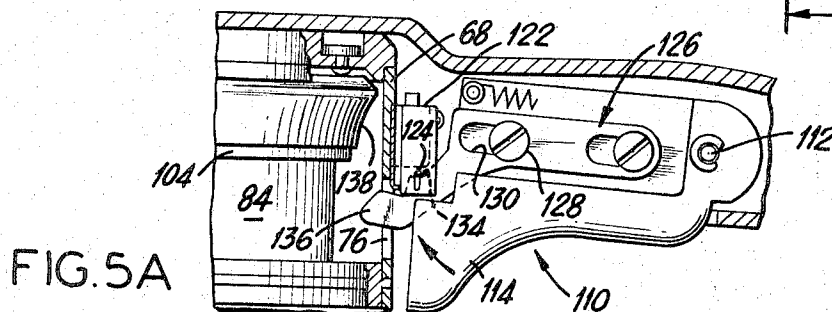
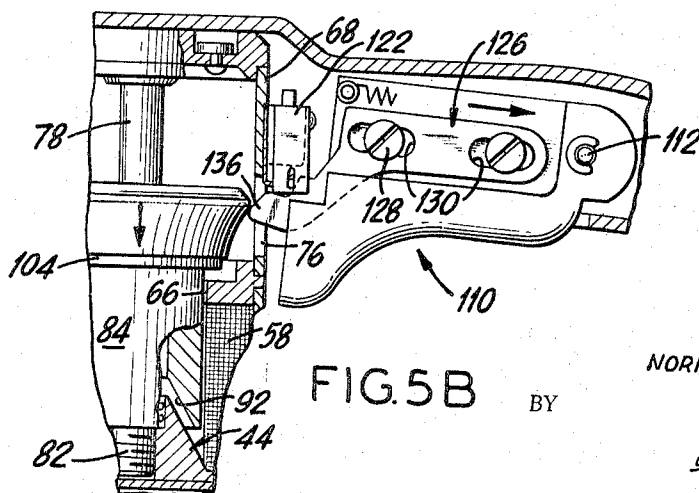
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3 Sheets-Sheet 2



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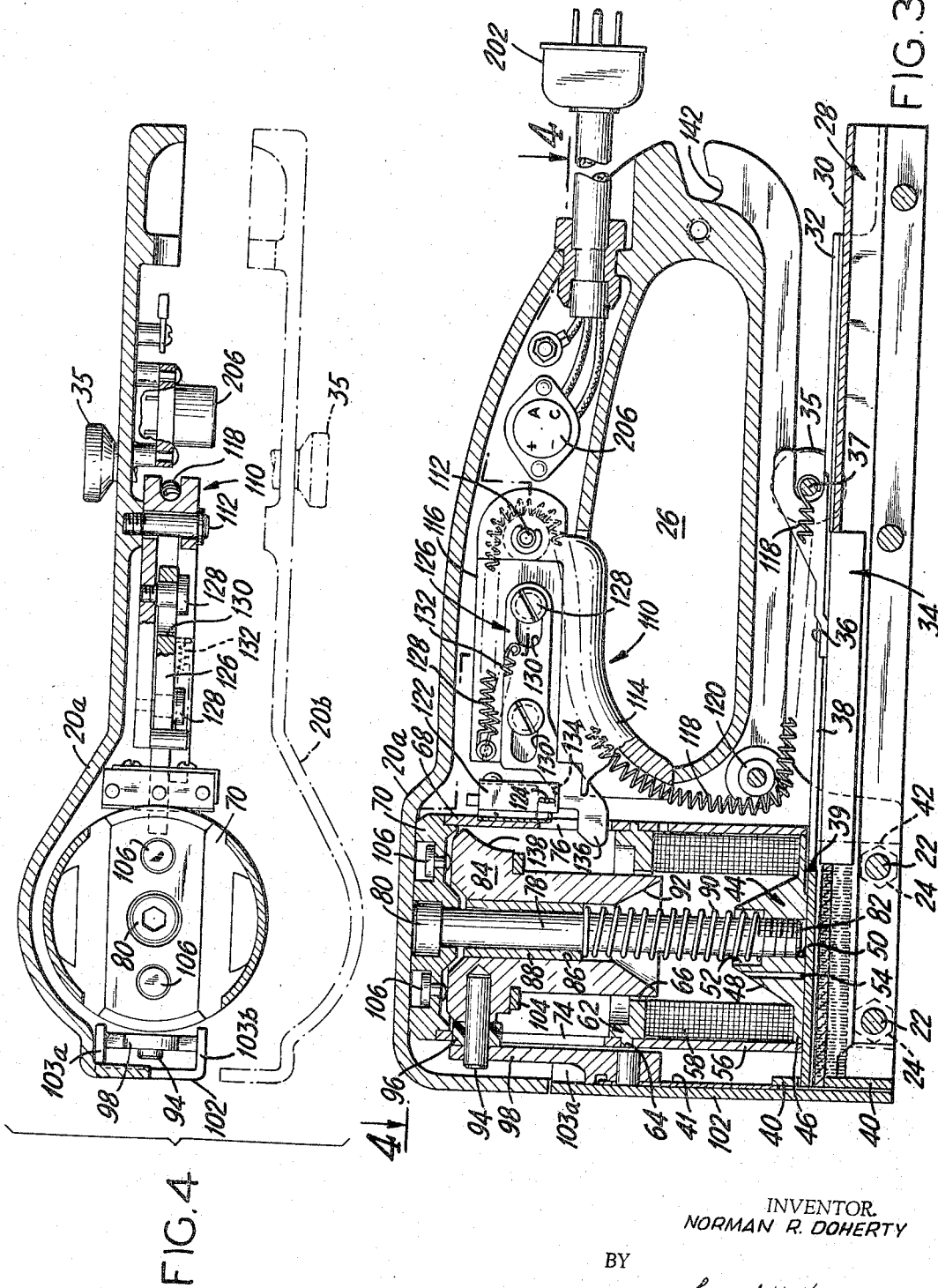
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ELECTRICALLY ACTUATED FASTENER DRIVING TOOL

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3 Sheets-Sheet 3



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ELECTRICALLY ACTUATED FASTENER DRIVING TOOL

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8 Claims. (Cl. 227-131)

This invention relates to an electrically operated fastener driving tool.

The present invention will be particularly described as applied to means for driving staples for tacking purposes but it is to be understood that the invention may be applied to stapling machines and devices for driving other types of fasteners such as nails, tacks, pins and the like.

A feature of the present invention is the use of a power actuated staple driving blade mounted parallel and in cantilevered fashion to a linearly movable solenoid armature. By positioning the blade in this manner, the tool, and particularly the staple driving blade, can be utilized in close proximity to a wall or similar obstruction. By way of contrast, electric staple tackers of the prior art generally positioned the driving blade coaxially with and on the longitudinal centerline of the driving means.

Whereas many of the prior art power operated fastener tools were large and awkward to handle, the instant design is lightweight and readily portable thereby greatly providing it with utility.

Many of the prior art devices commercially available are characterized by the generation of considerable heat during operation. In addition to the improved solenoid, the present invention includes a conveniently located, finger-actuated trigger in combination with novel switch cutout means. Overheating of the solenoid is thereby prevented and the tacker may be repetitively fired for long periods of time.

Additional utility is provided in the tacker of the present invention by including means to vary the power of the solenoid stroke. Thus only as much force is developed as is required to drive a particular size staple into a workpiece having particular hardness or density characteristics. Due to an acceleration effect, maximum power is achieved at the end of the solenoid stroke. This characteristic is used to advantage by incorporating an externally adjustable cam in the solenoid structure and by having the cam cooperate with the novel switch cutout means.

A spring loaded staple follower is provided to maintain the staples in their forward position proximate the driving blade. When reloading of staples is necessary, the follower block is retracted out of the staple track. Guide means are provided for directing the staple follower into a suitably positioned notch. The device may then be conveniently and safely loaded.

Accordingly, it is an objective of the present invention to provide an electric tacker having the staple driving blade positioned as close to the front of the housing as possible.

Another object is to provide a lightweight, hand held electric tacker.

An additional object is to provide an inherently safe-to-use electric tacker.

A still further object is to provide improved actuating means for the driving blade of an electric tacker.

A still further object is to mount the staple driving blade in a cantilevered relationship to the driving blade actuating means.

Still another object is to provide an improved solenoid for an electric tacker.

An additional object is to provide means for varying the power of the driving blade actuating means of an electric tacker.

Yet an additional object is to provide a conveniently

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located, finger-actuated trigger for operating an electric tacker.

It is a further object of the present invention to include novel switch cutout means that functions in cooperation with the trigger mechanism thereof.

A feature of this invention is the arrangement in an electrically actuated fastener, of a driving blade linked directly to a solenoid armature having an elongated internal bearing adapted to slide on a supporting shaft.

It is also an object of this invention to provide in an electrically actuated fastener driving tool an armature which is slidably mounted on a centrally positioned axial support.

A particular object is to provide in a tool of the type described a timing switch which is controlled by the movement of the driving system.

A further object is to provide in a device as described simple timing control means.

These and other features, objects and advantages of the invention will, in part, be pointed out with particularity and will, in part, become obvious from the following more detailed description of the invention taken in conjunction with the accompanying drawing which forms an integral part thereof.

In the various figures of the drawing like reference characters designate like parts.

In the drawing:

FIG. 1 is a fragmentary side elevational view showing the staple follower knobs in the retracted position;

FIG. 2 is a partially sectioned front elevational view of the present invention;

FIG. 3 is a longitudinal, cross sectional view in elevation taken along line 3-3 of FIG. 2;

FIG. 4 is a plan view taken along line 4-4 of FIG. 3 with a portion of the housing broken away and another portion of the housing shown exploded and in phantom outline;

FIG. 5A shows the trigger mechanism in the upward or "on" position.

FIG. 5B shows the switch actuator after it has been deflected to the right by the linearly movable solenoid armature;

FIG. 6A and FIG. 6B are fragmentary plan and sectional elevation views respectively of an alternative embodiment of the present invention having adjustable timing means for the fastener driving means;

FIG. 7 is a side elevation view in section illustrating the staple driving blade in the lower position; and

FIG. 8 is a circuit drawing illustrating the arrangement of the electrical components utilized in the present invention.

The construction of the device is shown in FIGS. 1-7.

The apparatus is contained in a housing 20 which may be conveniently formed in two halves 20a and 20b. It is presently preferred to employ aluminum die castings for this purpose although other metals or even synthetic resin materials may be utilized. The housing sections are conveniently secured to each other by means of transverse screws 22 and nuts 24. As may be seen particularly well in FIG. 3, the housing and integral handle are hollow. The driving mechanism is contained in the forward portion of the housing while the central and rearward portions thereof, in addition to housing other mechanical and electrical components, define a hand-gripping area. Enlarged opening 26 accommodates the user's fingers while his hand rests on the top surface of the central portion.

Staple track 28 is also secured to the housing by means of the transverse screws 22 and nuts 24. The staple track is comprised of a pair of nested, inverted U-shaped channel members 30 and 32, having a space therebetween along the confronting top surfaces and a portion of each

of the confronted side walls thereof. The track slidably receives a stick of conventional, adhesively bonded wire staples. Spring loaded staple feed bar 34, provided with a pair of outboard finger-gripping rollers 35, is also adapted to slide in the space between channel members 30 and 32 in order to continuously urge the staples into a forward position. Tab 36 formed on the top surface of feed bar 34 slides in cutout 38 provided in the top surface of member 32. Transverse end 39 of cutout 38 serves as a stop to arrest the forward progress of the feed bar when the supply of staples is exhausted. Die block 40 straddles the forward end of the staples and staple track and is provided with a recess spaced from the inside surface of the front wall of the housing. The recess slidably receives the staple driver blade 41 without any appreciable play.

The actuating means for driving the staples is comprised of a solenoid having a cantilevered driver and blade secured to the linearly movable armature thereof, as will be described hereinafter. The solenoid 58 seats on annular portion 46 of the solenoid core base section 44. In turn, downwardly extending flanges 42 straddle channel members 30 and 32 and are secured thereto by transverse screws 22 and nuts 24. The base section 44 is further comprised of an upwardly disposed conical central portion 48 having a threaded bore 50 and a spring seat 52. Conical portion 48 may also have one or more vent holes 54 to prevent a pressure build-up at the lower end of the solenoid stroke.

Lower solenoid case 56 is also seated on the upper surface of channel member 32 and encloses flange portion 46 of the solenoid base. In one embodiment of the invention, a wire coil 58 is seated on the top surface of flange portion 46 and is also enclosed by lower solenoid case 56. Ferromagnetic cover member 62 retains the coils in place and is provided with a circular flange portion 64 of substantially the same diameter as the outside of ferromagnetic solenoid case 56. Central bore 66 of ferromagnetic cover member 62 is fabricated with substantially the same diameter as that of the linearly movable solenoid armature 84 but with sufficient clearance so that it moves freely therethrough.

Upper ferromagnetic case 68 seats on the upper surface of the cover member flange portion 64. A cap member 70 is positioned on the top end of upper case 68 and is held in place when cover halves 20a and 20b are fastened by transverse screws 22 and nuts 24. Upper case 68 is provided with a pair of opposed, elongated slots 74 and 76 which cooperate with the linear movement of the solenoid armature in a manner to be more fully disclosed hereinafter. The construction of the upper case and cap is by way of illustration only, it being understood that the two aforementioned elements may be fabricated as a single, drawn piece.

Nonmagnetic shaft 78, having a head end 80 seated in cap 70 and a threaded lower end 82 secured in bore 50 of solenoid base 44, slidably supports solenoid armature 84. Central bore 86 of the armature is provided with sleeve bearing 88 to permit free linear movement of the armature with respect to shaft 78. Spring member 90 is disposed about the lower end of shaft 78 and extends between the bearing 88 and the spring seat 52 formed in solenoid base 44. Spring member 90 returns the solenoid armature to its upward starting position after each stroke. At its lower end, solenoid armature 84 is provided with a conical bore 92 contiguous with bore 86 and adapted to fit about conical portion 48 of the solenoid base. When the solenoid armature is in its lowest position relative to shaft 78, there will be a slight air gap between conical bore 86 and conical portion 48. A more detailed description of the mating cone configuration together with possible variations and advantages thereof will be given subsequently.

Depending outwardly from the upper end of solenoid armature 84 and substantially at a right angle thereto

is a drive pin 94. A nylon guide bushing 96 is fitted onto pin 94 which extends through elongated slot 74 formed in upper solenoid case 68. A driver block 98 is secured to the outboard end of pin 94 and a driver blade 41 is, in turn, affixed to the driver block. The driver block and the driver blade are in parallel planes to each other and move together with and parallel to the linearly movable solenoid armature. Driver blade 41 is positioned directly over the position of the forwardmost staple in the track and is accurately guided in its downward motion by die block 40. Housing head 102, having spaced outboard side flanges 103a and 103b, serves to guide driver block 98 in its downward travel. Transverse screws 22 and nuts 24 are also employed to retain housing head 102.

It will be seen then in FIG. 3 that the driver blade 41 is spaced from the outer forwardmost surface of the tool only by the wall thickness of housing head 102. The wall is in the order of $\frac{1}{32}$ " thick therefore permitting a staple to be driven almost flush against a wall or similar obstacle.

Circular bumper or shock absorber 104 is interposed between the head end of armature 84, just beneath drive pin 94, and cover member 62, to absorb some of the force produced by the solenoid at the bottom of the armature stroke. A plurality of resilient bumpers 106 also extend downwardly through cover member 62 to absorb a portion of the force resulting from the upward stroke of the solenoid armature.

Trigger assembly 110 is pivotally mounted on transverse stud 112. As shown best in FIG. 4, stud 112 is fixed in the hand-gripping area of the housing central portion. The tool may therefore be grasped by hand and the fingers comfortably curled around the trigger assembly.

The trigger assembly is comprised of an arcuate, U-shaped portion 114 and a wall portion 116 upstanding from one of the sides of the U. An extensible coil spring 118 is disposed in the U-shaped portion of the trigger assembly and is also trained about stud 112 and idler roller 120. The spring terminates at one end in the forward portion of wall 116 and at the other end in between grippers 35 of staple feed bar 34. Thus it will be seen that spring 118 serves a dual purpose. First, spring 118 urges the staples forward so that as long as a supply of staples remain, they are in position for driving. Second, spring 118 normally biases the trigger assembly in a counterclockwise direction about stud 112 so that upward finger pressure or squeezing action is required to depress and actuate the trigger in order to drive a staple.

Switch means 122, having a pivoted contact making and breaking lever 124 is fastened to the outside upper end of upper solenoid case 68 proximate the trigger assembly which also includes a switch cutout bar 126. Threaded studs 128 support the cutout bar so that it may pivot together with the remainder of the trigger assembly. The cutout bar is also provided with a pair of elongated slots 130 through which the studs project. By this means, as may be seen in FIG. 3 and FIG. 5, the cutout bar may also move horizontally to the right, the cutout bar being returned to its original position by spring biasing means 132 extending between wall portion 116 and the rearward portion of cutout bar 126.

Switch means 122 is mounted directly over cutout bar 126 with lever 124 transverse the plane thereof. Stepped portion 134 of bar 126 is positioned such that it engages lever 124 after a very small arcuate travel of the trigger assembly. In the embodiment illustrated, the gap between lever 124 and stepped portion 134 is in the order of only $\frac{1}{32}$ inch. Squeezing the trigger will thereby produce substantially instantaneous actuation of the switch means.

The outer end 136 of cutout bar 126 is in the form of a cam surface which projects through slot 76 provided in the side of upper solenoid case 68. When the trigger assembly is squeezed and the switch activated, as described hereinabove, the solenoid armature will be

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driven downwardly through coils 58 and a concave cam 138 formed integrally in the upper end of solenoid armature 84 will engage cam surface 136. Continued downward travel of the armature will therefore slide cut-out bar 126 to the right (FIG. 3) against the urging of spring 132. When bar 126 has moved sufficiently to the right (FIG. 3) stepped portion 134 will move out from under lever 124 and the switch will return to its original condition. The novel cutout feature is of value in the electrical circuitry of the tool, as will subsequently be described.

Simple means to adjust the length of armature travel with respect to the cam surface 136 of trigger assembly 110 is illustrated by the alternative embodiment of FIG. 6A and FIG. 6B. With this arrangement for rendering the timing adjustable, the operator can vary the cycle to determine the depth of penetration or to accommodate staples of various size. For example, in some applications it may be desirable to drive the staple with a 1/4 inch leg; for other applications using a staple of the same width and thickness, it may be desired to drive a staple of a 5/8 inch leg.

The upper end of armature 84 is provided with an externally adjustable cam 85. Wedge shaped slot 87 guides the similarly shaped cam member to prevent it from turning when it is vertically displaced by screw 89. It will be seen in FIG. 6B that screw 89 is held captive by retainer member 91 which is, in turn, secured to the top surface of the armature by screws 93.

In the embodiment having the aforementioned adjustability, three equally spaced resilient bumpers would be provided similar to those designated by reference character 106. An access hole would be provided on the upper surface of the housing thereby exposing the head of screw 89. Rotation of the screw would cause cam member 85 to be moved either up or down. It will therefore be seen that for short staples or those applications requiring less penetration of the staples it would be advantageous to cut off the power quickly. For other applications, power cut off is made later. While simple yet effective means to accomplish this have been illustrated, it should be appreciated that other arrangements are available to those skilled in the art without departing from the spirit of the invention.

In order to load staples into the tool, gripper rollers 35 are pulled to the back and upward along the inclined spring member until the shaft 37 extending between rollers 35 falls into notch 142.

The electrical circuit of the apparatus is characterized by simplicity and reliability. Power cord 200 is attached at one end to the apparatus and at the other end to a conventional grounded male plug 202 which permits plugging of the cord into any conventional nominal 120 v. A.C. source. The apparatus may be modified by a technician familiar with the art to operate at other voltages. In series with one line, there is provided switch 122. It has been found that by placing the switch in the A.C. portion of the circuit rather than the D.C. portion, to be described hereinafter, an advantage is derived in that there is substantially no arcing across the switch contacts. Power is applied across a full wave rectifier employing silicon epitaxial diodes in a conventional full wave bridge circuit 206. The output of the bridge is applied directly to parallel solenoid coils 58.

It has been found that a very compact and efficient apparatus may be made if a plurality of coils are employed in parallel rather than one large coil. It has been found desirable to fashion the solenoid coil as two separate windings connected in parallel.

For operation from 120 v. a pair of coils each comprising 3000 turns of No. 32 A.W.S. wire may be employed.

The armature-core magnetic path surrounding the coil disclosed provides an extremely safe device. If a bare hand is held a few inches from the apparatus in the line of fire, no harm will result from sharp staples fired at and hitting the hand.

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Thus there has been disclosed a compact and efficient lightweight, safe, electrically operated fastener driver tool which may be used for driving staples and with appropriate feed means, nails, tacks, pins and the like. The apparatus employs a simplified direct drive means avoiding the use of complex linkages which result in mechanical inefficiencies. This simple timing mechanism is inexpensive, sturdy and accurate. A device, as described, weighing but 3/4 pound has been used to successfully drive 3/16 inch long by 1/2 inch wide 0.05 inch diameter wire staples into soft pine. Similar staples, 1/4 inch wide, were successfully driven into 0.04 inch thick aluminum sheet.

There has been disclosed heretofore the best embodiments of the invention presently contemplated and it is to be understood that various changes and modifications may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. An improved, electrically operated drive means for fasteners comprising:

- (a) a rigidly mounted, nonmovable shaft;
- (b) a magnetizable armature mounted coaxially about said shaft and arranged to slide on said shaft;
- (c) a tubular solenoid coil mounted coaxially about said shaft proximate one end thereof, said coil having an inner opening radially spaced from said shaft and dimensioned so as to receive said armature therein when said coil is electrically energized;
- (d) a magnetizable core member surrounding said coil, said core member comprising a coaxial sleeve member and upper and lower flux path members extending radially inward therefrom into proximity with said armature and shaft respectively;
- (e) means connected to said solenoid coil for energizing said solenoid with a current pulse of timed duration;
- (f) a driving blade mounted in cantilevered fashion, to said armature for parallel movement therewith; and
- (g) feed means to successively advance individual fasteners from a supply of the fasteners into the path of the driver blade.

2. An improved electric driver for penetrating fasteners comprising:

- (a) a slotted housing;
- (b) a solenoid having a linearly movable armature, said solenoid being disposed in said housing and energizable by an external power source;
- (b) a solenoid having a linearly movable armature, said solenoid being disposed in said housing and energizable by an external power source;
- (c) a fastener driving blade secured to the armature of said solenoid in spaced, cantilevered relationship thereto, said blade being disposed proximate the inside surface of the forward wall of said housing and being arranged to move through the slot in said housing;
- (d) a track secured to said housing, said track being adapted to slidably support a supply of fasteners;
- (e) means to urge the fasteners towards the forward end of said track whereby the first fastener is in the path of the linearly movable driving blade;
- (f) switch means interposed between said solenoid and the external source of power, said switch means being arranged to selectively energize said solenoid;
- (g) internal means to supply a direct current to said solenoid from the external alternating current power source; and
- (h) a trigger arranged to control said switch, said trigger comprising a cam integral with the upper end of said armature, said cam being linearly movable with said armature in a path that intersects the plane of an actuable portion of said switch.

3. The apparatus of claim 2 including means to adjust the position of said cam with respect to the upper end of the said armature.

4. The apparatus of claim 2 wherein said solenoid is comprised of:

- (a) an elongated magnetizable case having an open end and a closed end;
- (b) a magnetizable closure member positioned in the open end of said case, said closure member comprising a raised frustoconical central portion and a radial, outwardly extending flange portion;
- (c) a pair of wire wound coils seated in tandem on said flange portion of said closure member, said coils being electrically connected to each other in parallel, and phased to provide coacting fields when energized, said coils having a common central bore parallel with the longitudinal axis of said case;
- (d) a magnetizable cover member disposed within said case on the top surface of the upper one of said coils, said cover member having a central bore contiguous with the bore of said coils; and
- (e) an armature having a central bore coaxially disposed and slidably movable relative to said coil members, said armature having a conical recess in the lower end thereof, said armature having a range of linear motion extending between the closed end of said case and a point slightly spaced from said conical central portion of said closure member, said armature having a longitudinal body portion adapted to freely pass through the central bore of said cover member and said coils.

5. The apparatus of claim 4 including a fixed non-movable central shaft having one end captured in the closed end of said case, the opposite end of said central shaft being secured in the central portion of said closure member and an elongated bearing disposed within the central bore of said armature, extending substantially the entire length thereof, said bearing having a close, running fit with said shaft whereby said armature moves in close concentric relationship to said shaft.

6. The apparatus of claim 4 wherein said conical, confronting face of the recess in said armature and said frustoconical central portion of said closure member are each formed at an included angle between 10° and 20°.

7. An improved electric tacker for driving wire staples into a workpiece, said tacker comprising:

- (a) an elongated housing adapted to be handheld and having an enlarged opening proximate one end thereof to accommodate the user's fingers, said housing being further provided with a transverse slot on the underside forward end thereof;
- (b) a staple track secured parallel to and in spaced relationship to the underside of said tacker, said track being adapted to slidably support a supply of staples;
- (c) a staple follower arranged to slide on said staple track and urge the supply of staples towards the forward end of said housing whereby the forwardmost staple is directly beneath the slot in said housing;
- (d) a solenoid having a linearly movable armature disposed in the forward end of said housing and secured to the forward end of said track;
- (e) a drive pin secured to the armature of said solenoid and extending outwardly at substantially a right angle thereto, said pin being movable with said armature;

- (f) a staple driving blade secured to said drive pin for movement therewith, said blade being disposed proximate the inside surface of forward wall of said housing and directly over the position of the forwardmost staple in the supply;
 - (g) switch means secured within said housing, said switch means having external means for actuating the contacts thereof;
 - (h) a trigger assembly mounted in said housing and extending into the enlarged opening provided therein, said trigger assembly comprising:
 - (1) a trigger bracket pivotally mounted in said housing,
 - (2) an elongated cutout bar slidably mounted on said trigger bracket between predetermined forward and rearward limits and pivotal together with said trigger bracket, one end of said cutout bar being disposed in close proximity to the switch contact actuating means,
 - (3) a cam follower formed on the forward projecting end of said cutout bar, and
 - (4) spring biasing means extending between said cutout bar and said trigger bracket whereby said cutout bar is continuously urged into position defined by its predetermined forward limit;
 - (i) a cam formed on the outside surface of the armature of said solenoid and arranged for linear movement therewith whereby the cam is brought into engagement with and travels past said cam follower during a portion of the armature stroke to thereby cause said cutout bar to move out of engagement with said switch means;
 - (j) extensible biasing means extending between said trigger bracket and said staple follower in a serpentine path about an idler roller and the pivot point of said trigger bracket, said biasing means normally urging the staple supply forward to a dispensing position and normally urging said cutout bar away from said switch means;
 - (k) rectifier means connected to said solenoid to supply direct current to said solenoid from an alternating current source; and
 - (l) means connecting the switch contacts in series with said rectifier means and the alternating current power source for controlling the energization of the said rectifier means.
8. The apparatus of claim 7 wherein said armature is surrounded by a plurality of coils having their terminal leads connected such that said coils are in parallel and when energized they generate magnetic fields coacting in the same direction.

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