

[54] FASTENER DRIVING TOOL
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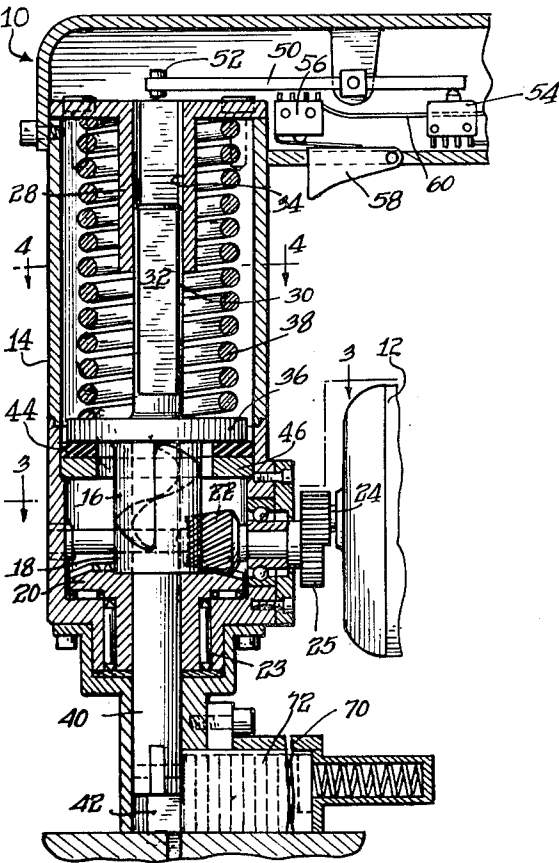
ABSTRACT

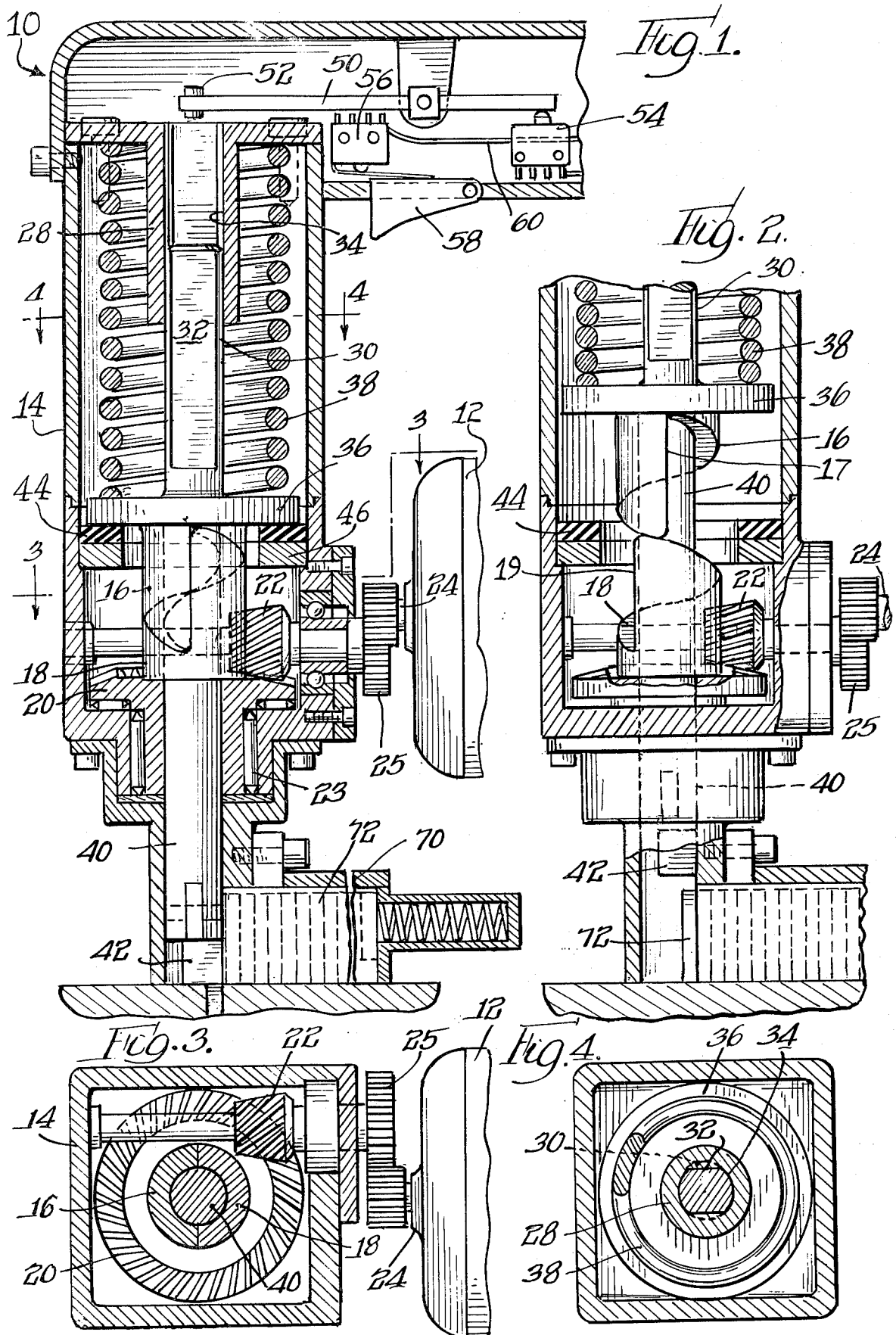
A driving tool utilizing an electric motor to periodically compress a spring and utilize the energy stored in the spring as the force provided for an impact stroke with a ram. The force allowing the ram to compress the spring is provided by mating helicoidal cams each having a generally helical path surrounding the ram axis followed by a sharp drop-off portion.

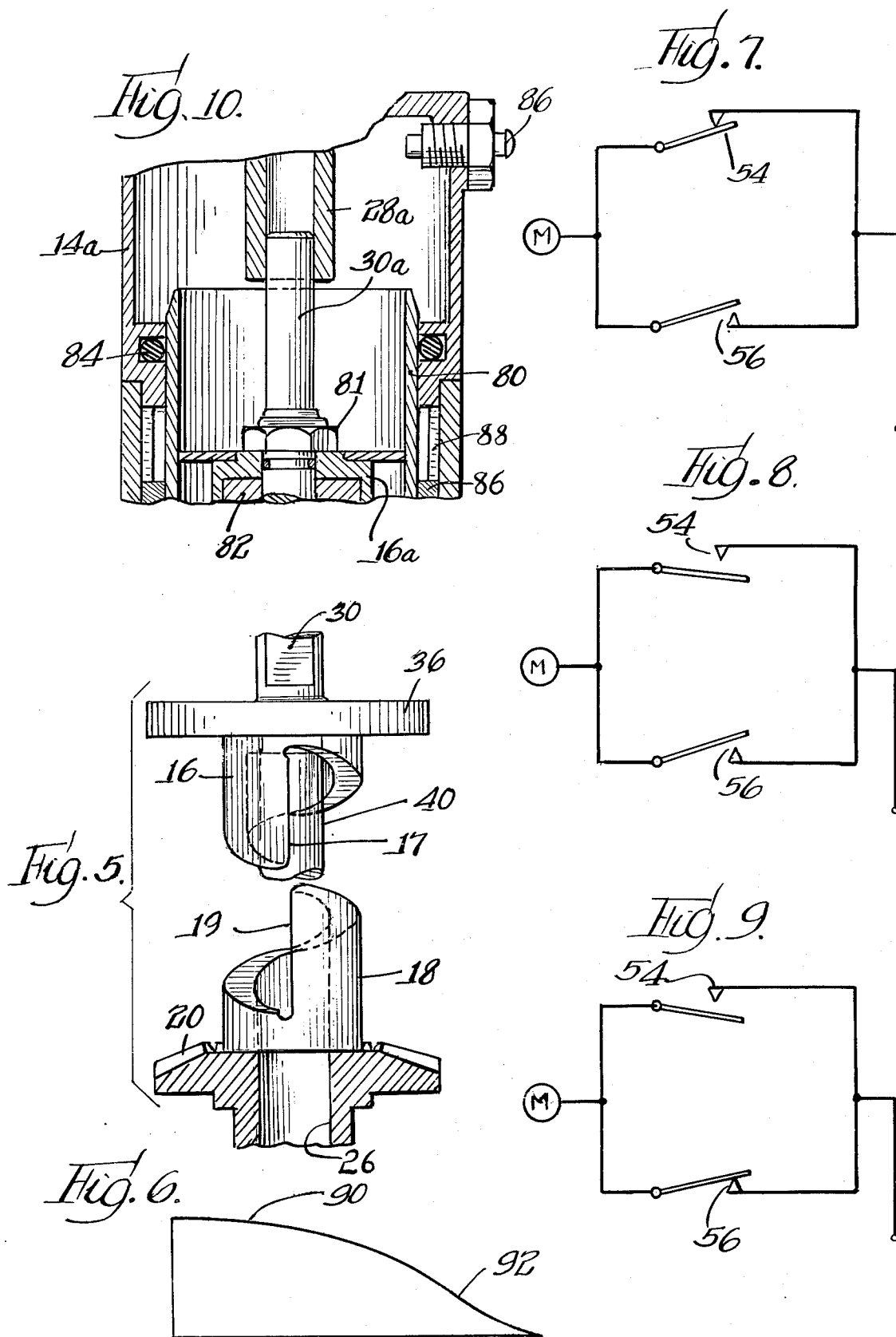
8 Claims, 10 Drawing Figures

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FASTENER DRIVING TOOL

BACKGROUND OF THE INVENTION

Tools for driving fasteners, such as nails, staples or the like, have been proposed which operate principally on a pneumatic power source or cartridge activated power source. Pneumatic devices are commonly used because such a device provides a lightweight, simple tool which delivers energy sufficient to drive fasteners. However, such a tool requires convenient sources of air pressure, such as compressors and air hoses. The use of such a tool on a construction site, for example, would be impractical.

Cartridge activated devices provide a high energy source for a single shot tool but suffer from certain disadvantages centering on the noise and cartridge disposal problems.

In addition to these prior art methods, electric operated tools have been utilized in which a solenoid directly drives a ram which in turn drives a fastener. This type of tool requires extremely high current to operate a low power tool.

SUMMARY OF THE INVENTION

The driving tool of the subject invention allows electric power to be fed into the tool more or less continuously and allows such energy to be stored in a spring means. The spring provides the actual driving force to seat a fastener when the spring is suddenly allowed to release.

The spring is periodically compressed and released through the use of coaxing helicoidal cam elements one of which elements is rotated about the axis of the ram and adapted to allow the ram to pass through upon the release of the stored energy. A second cam member is fixedly attached to the ram and restrained from rotary motion so that the rotation of the first helicoidal cam causes the ram to be forced in an axial direction compressing a spring until the mating cam configuration allows the ram to be driven rapidly under the stored energy of the spring through the rotatable cam.

Other aspects of the invention include the provision of a cushion to prevent the driving and driven cams from directly receiving the high shock loads as the ram is driven under the energy stored by the spring. Switching devices may also be included to de-energize the electric motor when the spring has approached its maximum compression. Additional switching means will then re-energize the motor to drive the ram instantaneously.

The tool of the present invention will thus be capable of providing relatively high driving energies in a simple tool and at a high frequency and low electrical power requirement.

The above and other features and advantages will become apparent from the following description when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view in partial section of a tool forming one embodiment of the present invention.

FIG. 2 is a partial side elevational view similar to that of FIG. 1 showing the tool as the spring means is compressed.

FIG. 3 is a sectional view taken substantially along lines 3—3 of FIG. 1.

FIG. 4 is a sectional view taken along the lines 4—4 of FIG. 1.

FIG. 5 is an enlarged elevational view in partial section of the pair of coaxing helicoidal cams used in the present invention.

FIG. 6 is a graphical representation of the configuration of the cam surface in an alternate embodiment of the cam devices.

FIGS. 7-9 are various schematic representations of the switching mechanisms showing the various conditions capable as a result of the limit switch.

FIG. 10 is a partial side elevational view of another embodiment of the present invention showing an alternate spring mechanism.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings and particularly to FIG. 1, the fastener driving tool 10 will be seen to include an electric motor casing 12 and an actuator housing 14. Mounted axially within the housing are a pair of mating helicoidal cams 16 and 18. The cam 16 will include a radially extending flange 36 above the cam surfaces and a guide shaft 30 extending coaxially of the cam above the flange. Extending in the opposite axial direction through the cam surfaces is an elongate ram portion 40 adapted to drive sequentially fed fasteners in a manner which will be described in detail later herein. The lower cam portion 18 will be of a substantially identical helicoidal shape and positioned to mate with the helicoidal surfaces of the upper cam 16. Cam 18 will also include an integral ring gear 20 surrounding the axis of the cam. A bore 26 is formed through the axis of the cam and adapted to receive the driving ram 40. Attention is directed to FIG. 5 for the details of the coaxing cam 16 and 18.

The upper cam 16 is continuously biased downwardly to the position shown in FIG. 1. The coil spring 38 is interposed between the upper portions of the housing and the flange 36 for this biasing purpose.

Reference is again made to FIG. 5 as well as FIGS. 1 and 2 for a general description of the operation of the tool. Each cam element 16 and 18 will include a generally helical surface extending approximately 360° about the central axis of the element with the upper and lower extremities of the helical surface being connected by sharp drop-off portions 17 and 19, respectively. The drop-off portions will extend parallel to the central axis of the cams and thus to the axis of the driving ram 40. As lower cam 18 is rotated, and upper cam 16 restrained from rotation, the helical mating surfaces on the cams will operate to force the upper cam 16 rearwardly of the housing compressing the spring 38. The latter stage of this compression and relative positions at the cams is shown clearly in FIG. 2. Further rotation of the lower cam from that shown in FIG. 2 will allow the drop-off portions 17 and 19 to become coplanar and at that instant the ram and upper cam will be driven forcefully downwardly under the bias of the compressed spring 38. Since the ram 40 extends through a bore in the lower cam 18, it will contact a fastener member 72 fed beneath the striker 42 on the extremity of the ram.

Since an important aspect in the operation of the tool is the restraint from rotation of upper cam 16, the guide shaft 30 may be provided with flats, such as 32, for mating telescopic association with a complementary bore 34 in guide sleeve 28. Attention is directed to FIGS. 1

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and 4 for this relationship. The interaction of the guide shaft 30 and guide sleeve 28 will allow the forces acting on the upper cam to be essentially along the center line of the ram and eliminate any possibility of cocking as the spring is compressed or released.

The source of power to compress the spring in the housing may conveniently be provided by a conventional electric motor within the casing 12. The output shaft 24 of the motor is connected to a pinion 22 through a gear set 25. Upon actuation of the motor, rotary power will be imparted to the lower cam 18 through the interaction of the pinion 22 and the ring gear 20, which is integrally connected to the cam. Cam portion 18 will also include a sleeve portion extending axially forwardly for reception in a cavity at the forward end of the housing 14. Suitable bearings 23 are interposed between this sleeve and the housing to permit free rotation thereof.

Actuation of the electric motor 12 is initiated through a trigger 58 which in turn operates a switch 56. One of the features of the invention is a switching arrangement which allows the ram 40 to be retained in a cocked position for essentially instantaneous driving upon the actuation of the trigger 58 by the operator. For this purpose, attention is directed to FIGS. 1 and 7-9.

A pivot arm lever 50 is mounted adjacent the rear of the housing 14 with a terminal contact portion 52 aligned axially with the guide shaft 30. The extremity of the pivot arm 50 opposite the contact point 52 is adapted to contact a switch 54 which is normally closed.

FIG. 7 represents the switch configuration during the portion of the compression cycle immediately following impact stroke after the actuation of the electric motor by the trigger 58 and switch 56. The instantaneous position of the elements can be represented by the condition shown in FIG. 1.

As the driving ram and associated camming surface reapproach the condition of maximum compression of the spring rearwardly in the housing, the upper extremity of the guide shaft 30 will open limit switch 54 through the interaction of the pivot arm 50. This switching condition is represented by FIG. 8 in which the circuit is now completely open and electric motor thus de-energized. The relative positions of the cams in this position can be represented by that shown in FIG. 2. The switching condition of FIG. 8 and the cam position of FIG. 2 now present a tool which is cocked under the compression of the spring for essentially instantaneous driving upon direction of the operator through trigger 58.

FIG. 9 shows switch 56 closed upon the actuation of trigger 58 and indicates an instantaneous condition of the circuit after the trigger has started the motor to slightly rotate the lower cam 20 from the position shown in FIG. 2 until the drop-off portions of the cam are aligned. The immediate switch condition following the condition shown in FIG. 9 would be that shown in FIG. 7 assuming the operator releases the trigger. It should be understood that the operator can affect continuous operation of the device by continued activation of the trigger device 58.

The impact shock of the driving ram is prevented from being absorbed by the camming surfaces themselves by a resilient annular ring cushion 44 positioned beneath the flange 36 and a shoulder 46 mounted in the housing.

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FIG. 10 shows an alternate embodiment of the power driving tool which utilizes a compressible gas, such as air or the like, as the spring means. The rearmost extremity of the housing 14a provides the chamber for such a compressible gas. A cup-like piston 80 is fixedly mounted to the upper cam 16a. The gas chamber is sealed by suitable seal means 84 between the inner walls of the housing 14a and the outer side walls of the piston 80. The piston may be fixedly retained to the cam and guide shaft 30a by threaded fastener means, such as 81 and 82. A valve 86 is provided for selectively charging the chamber with the appropriate compressible gas. This embodiment will thus allow the compressibility of the spring to be conveniently varied. The upper cam portion may be restrained from rotation through mating key and slot devices 86 and 88.

While the camming surfaces have been shown as true helices, it may be advisable in certain conditions to provide a helical surface which has a variable rise from the starting point of the helical path to the termination point on the helical surface at the top of the cam. FIG. 6 shows, in a graphical form, how such a cam may be provided with a somewhat flattened surface 90 at the upper extremities of the cam and a conventional rising portion 92 at the beginning portions of the cam. Such a cam structure will enable the torque required to compress the spring to be essentially constant as the upper cam 16 reaches the point of maximum compression of the spring. This will enable the power requirement from the electric motor to remain substantially constant during all stages of compression and will keep the maximum amperage required of the tool to a minimum.

Thus, it is apparent that there has been provided, in accordance with the invention, a power driving tool which operates with electric power that satisfied the advantages set forth above. While the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications and variations as fall within the spirit and broad scope of the appended claims.

I claim:

1. In a fastener driving tool, a housing, driving means mounted for axial reciprocating movement therein, the driving means including an elongate ram, guide shaft and a cup-shaped piston opening rearwardly of the housing and the ram including a base portion extending radially outwardly of both the guide shaft and the ram and further including upstanding wall portions extending longitudinally of the housing from the base portion, said piston being located between the ram and guide shaft, seal means positioned between the upstanding wall portion of the piston and the associated inner periphery of the housing, a first helicoidal cam means fixedly attached to the driving means so that the ram extends coaxially through the cam means, a rotatable means for actuating the driving means including a second helicoidal cam means fixedly attached to a gear for rotation about the axis of the ram, a bore extending through the actuating means and second helicoidal cam to allow the ram to pass therethrough and create an impact force on a fastener positioned beneath the cams, compressible spring means in the housing to urge the driving means forwardly in the housing toward the second cam means, the spring means comprising a chamber at the rearmost extremity of the housing, a prede-

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terminated volume of gas stored in the chamber, valve means in the chamber to selectively vary the bias of the gas spring means on the cup-shaped piston, a sleeve mounted in the chamber and extending forwardly therein, coaxial with the guide shaft to receive the guide shaft during the reciprocation of the driving means in the housing, the housing also including shoulder means to support the cup-shaped piston when the driving means is in its forward position in the housing, resilient cushion means positioned between the piston and the shoulder means to absorb the impact shock of the driving means and thus prevent abutting cam surfaces to impact each other, a drive shaft driven by a source of rotary power located adjacent the housing, gear means operatively connecting the drive shaft to the gear attached to the second helicoidal cam means to transmit rotary motion to the actuating means, the helicoidal cams including sharp drop-off portions which allow the spring means to periodically drive the ram forwardly to drive a fastener.

2. The driving tool in accordance with claim 1, wherein each helicoidal cam means includes a helical surface extending approximately 360° about the axis of the ram, the sharp drop-off portion of each cam means comprising a surface extending generally parallel to the axis of the ram whereby the tool will provide one driving stroke per revolution of the second helicoidal cam.

3. The driving tool in accordance with claim 1, wherein the helicoidal cam means include helical-like surfaces wherein the slope of these surfaces decreases adjacent the drop-off portions of the cam so that the

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axial displacement of the driving means decreases as the spring approaches its maximum compression.

4. The driving tool in accordance with claim 1, wherein the source of rotary power comprises an electric motor.

5. The driving tool in accordance with claim 4, wherein switch means are interposed between the driving means and the source of rotary power to cock the driving means in a position adjacent the rearwardmost position of the driving means when the spring means is near its maximum compression.

6. The driving tool in accordance with claim 5, wherein the switch means comprises a pair of switches, a first switch being actuated by means to open the electric circuit and stop the motor as the guide shaft approaches its rearwardmost position in the housing, a second switch operative to close the electric circuit and allow the ram to be driven from a cocked position.

7. A driving tool in accordance with claim 1, wherein the internal surfaces of the sleeve and the guide shaft form telescoping noncircular cross-sectional configurations to prevent the driving means from rotating about its axis as the actuating means forces it rearwardly against the bias of the compressible spring means.

8. A driving tool in accordance with claim 1, wherein the driving means and housing include cooperating keys and slots to prevent the driving means from rotating as the actuating means forces the driving means rearwardly against the bias of the compressible spring means.

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