

[54] FASTENER DRIVING TOOL
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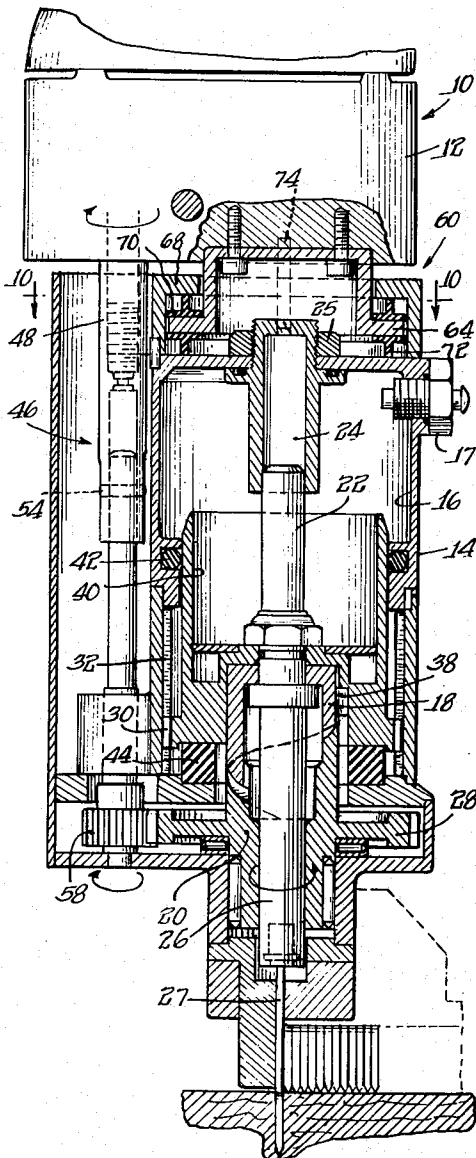
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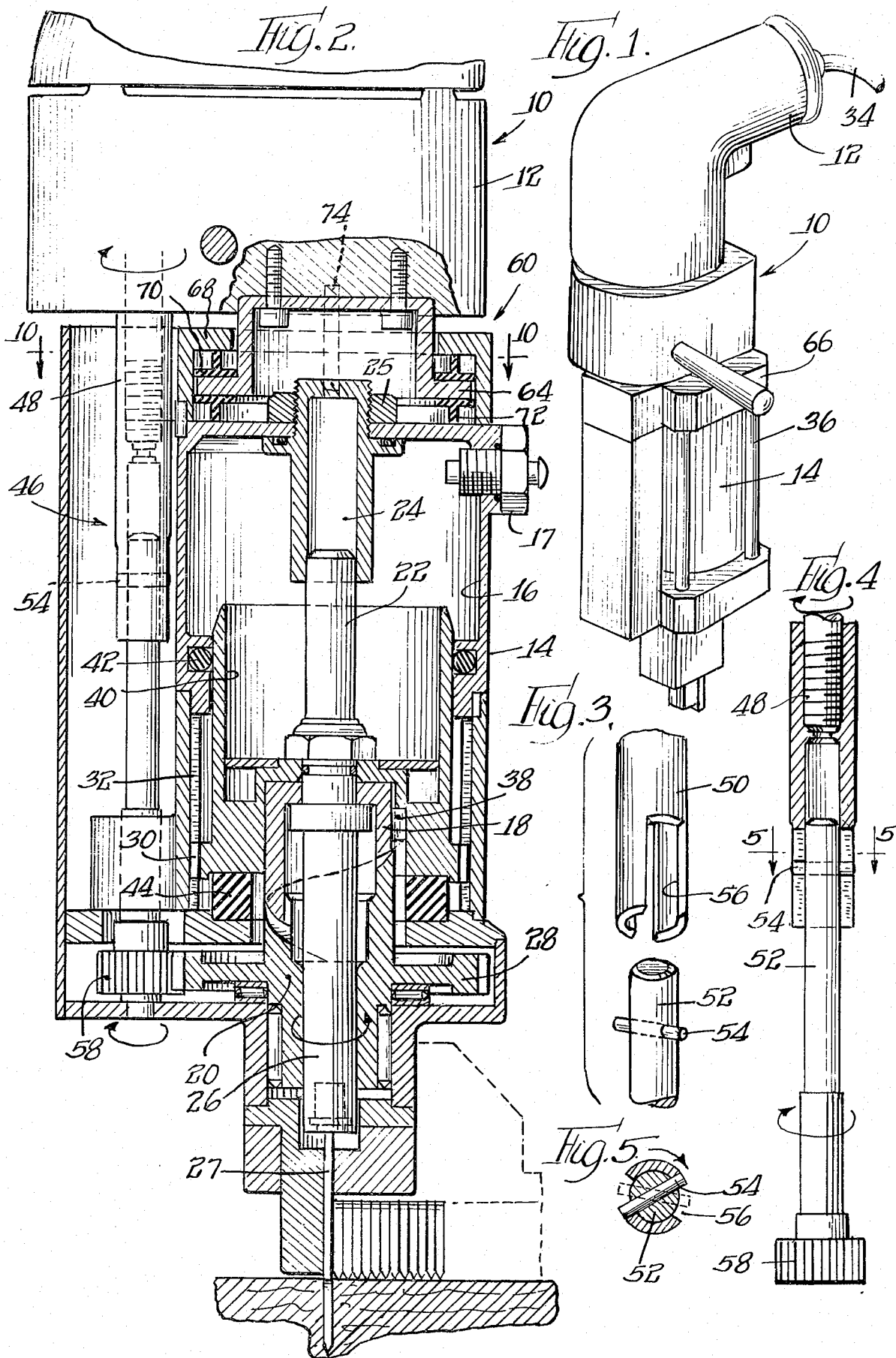
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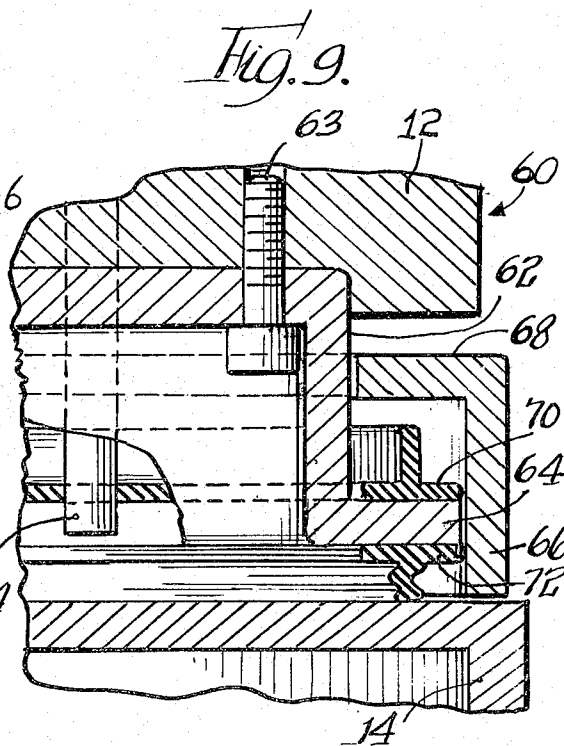
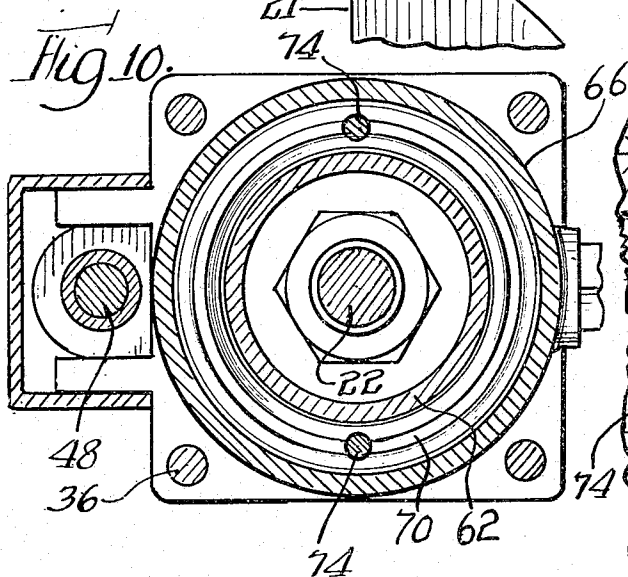
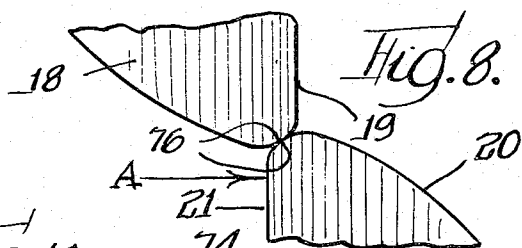
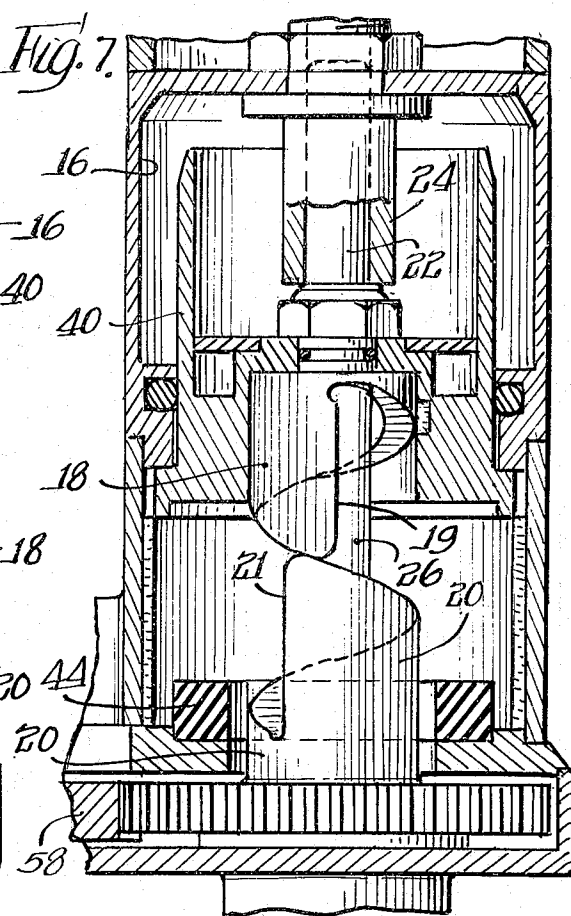
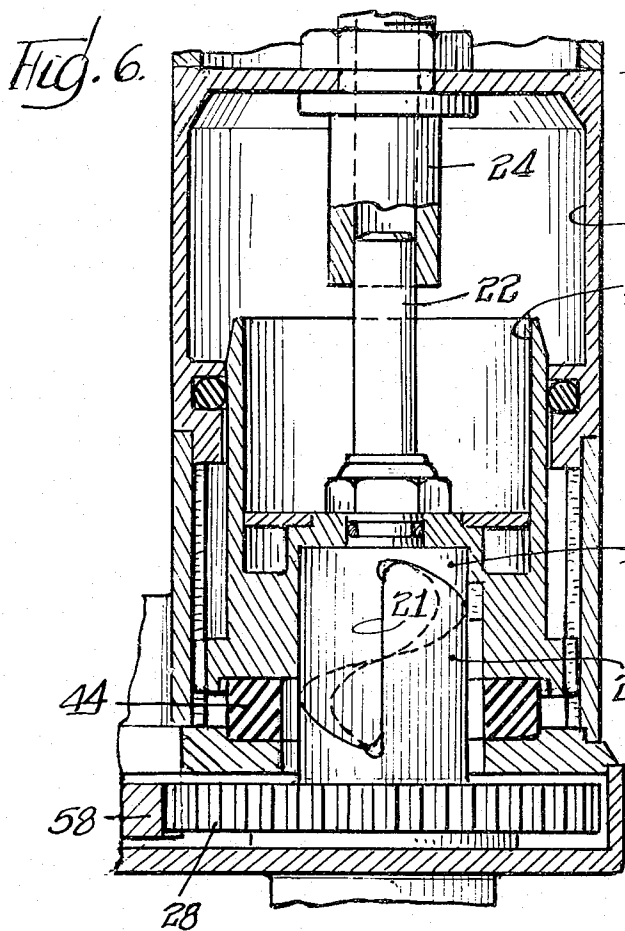
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[57] ABSTRACT
A driving tool utilizing an electric motor to periodically compress a spring means and utilizing energy stored in the springs as the driving force for a ram. The spring is compressed by coaxing helicoidal cams and a drive train from the electric motor to the cam includes a coupling allowing the driving cam to accelerate in rotation as the driven cam reaches the firing point.

12 Claims, 10 Drawing Figures







FASTENER DRIVING TOOL

BACKGROUND OF THE INVENTION

Tools for driving fasteners, such as nails, staples or the like, have been proposed and 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 compressors and air hoses which makes a tool undesirable for the various remote locations required on a construction site.

Cartridge activated devices provide a high energy source for a single shot tool but suffer from certain disadvantages, such as the noise and disposal of cartridges.

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 for use in a low power tool

SUMMARY OF THE INVENTION

The driving tool of the subject invention allows electric power to be fed into the tool continuously and utilizes the energy from the electric power to be stored in a spring means. The spring will provide the actual driving force to seat the fastener when it is suddenly allowed to release.

The spring is periodically and selectively compressed and released through the use of coacting helicoidal cam elements, one of which elements is rotated about the axis of a ram and adapted to allow the ram to pass through upon 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 the spring until the mating cam configuration allows the ram to be driven rapidly under the stored energy of the spring.

One aspect of the invention is the provision of a coupling device in the drive train between the electric motor and the rotatable cam so that the rotatable cam may be accelerated in rotation at the point when the tips of the helicoidal cam are coacting. Devices of the type utilizing helicoidal cams tend to needlessly dissipate driving energy by attempting to force the driving cam out of contact since there will be a vector of force in the lateral direction as well as in an axial direction. The tips of the cams cannot be accurately retained in a sharp point but will be somewhat rounded, thus, creating the condition where the ram starts to drive but is restrained from instantaneous reaction by the force vector in the lateral direction.

Other aspects of the invention include means to absorb impact shock between the motor casing and driving assembly. The invention provides a flexible mounting device between the driving housing and the electric motor casing to prohibit the shocks of either a free fire condition or a recoil from acting on the electric motor.

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

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective of the tool shown combining the electric motor casing with the driving housing.

FIG. 2 is a side elevational view in partial section of the tool of the present invention.

FIG. 3 is an exploded perspective view of the coupling aspects of the invention.

FIG. 4 is a side view in partial section of the coupling device in the drive train of the invention.

FIG. 5 is a sectional view taken along the lines 5—5 of FIG. 4.

FIG. 6 is an enlarged sectional view of the impact driving means of the invention.

FIG. 7 is a view similar to FIG. 6 showing the impact driving means approaching the cocked position.

FIG. 8 is an enlarged view showing the coacting cam elements in a position immediately prior to the release of the spring force.

FIG. 9 is an enlarged view of the flexible coupling aspect of the invention in partial section.

FIG. 10 is a cross-sectional view taken along lines 10—10 of FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The fastener driving tool 10 is shown in FIG. 1 as including an electric motor housing 12 and a driver housing 14. Upper and lower flange portions of the housing are interconnected by connection rods 36 which serve to clamp the entire housing together.

A driving apparatus is mounted within the housing 14 and includes a pair of coacting helicoidal cams 18 and 20.

The lower cam 20 will be rotatably mounted within the housing and serves as the driving cam. The upper cam 18 will be nonrotatably mounted in the housing and serves as the driven cam which in turn compresses a compressible gas in chamber 16.

As seen in Figs. 6 and 7 as well as Fig. 2, the cams are designed to have a generally helical path extending 360° about the axis of the cams and drop-off portions 19 and 21, which when axially aligned will permit the upper cam to be driven downwardly under the bias of the compressed gas.

The upper cam assembly 18 will include a ram 26 extending forwardly in the housing 14 and through a bore in the lower cam 20. The upper cam will also include a guide shaft 22 extending coaxially with the ram for telescopic association with a sleeve 24 mounted in the rearmost portion of the cylinder 16. A cup-like piston 40 is integrally connected to the cam and the piston is sealed within the chamber with an appropriate sealing means, such as 42, mounted in the wall of the housing. The upper cam assembly 18 is restrained from rotation by key and spline devices 30 and 32 so that rotation of the driving or actuating cam 20 will produce a purely axial rearwardly motion to the upper cam 18 and the associated ram 26.

The impact forces of the upper cam 18 are prevented from being absorbed directly by the lower cam surfaces through the use of a resilient cushion ring 44 which may be mounted between a radially extending flange of the piston 40 and a shoulder formed in the frontmost extremity of the housing 14.

As the electric motor 12 is energized, the drive shaft 48 will rotate in the direction indicated in FIG. 2. The

drive coupling device 46 will transmit this torque to a pinion gear 58 which in turn transmits the rotary motion to a ring gear 28 integral with the lower cam 20. The novel drive coupling 46 will now be described in relationship with the cam configuration shown in FIG. 8. As the lower cam 20 rotates slightly beyond the position shown in FIG. 7 to that of FIG. 8, it will be apparent that the radiused tips 76 of each cam will provide a vector of force in the direction A which is lateral of the intended axial direction of the ram 26. Thus, as the upper cam 18 approaches the point of drop-off where surfaces 19 and 21 are aligned, the compressive energy stored in the spring will tend to be slightly dissipated as a result of the force in direction A. Because of the radiused tips, the lower cam 20 should be capable of briefly accelerating in order to allow the upper cam 18 to drive without dissipating energy. The coupling device 46 provides such an acceleration capability without causing an undue load on the electric motor.

In FIGS. 4 and 5 the drive shaft 48 is shown to provide torque to the pinions 58 in the direction shown. Upper and lower coupling portions 50 and 52, respectively, allow pinion 58 to accelerate or rotate faster relative to the drive shaft 48. This is accomplished by a slot 56 formed at the extremity of the upper coupling portion 50 and generally along the center line thereof. The mating extremity of lower coupling portion 52 will include a pin 54 extending transversely of the axis thereof. The width of the slot 56 will be greater than the diameter of the pin 54 thus allowing the lower portion to rotate a predetermined limited arc of rotation relative to the upper portion. FIG. 5 shows the position of the pin 54 in normal driving arrangement wherein the upper portion 50 is transmitting torque to the lower cam 28 through the pin 54 in the coupling portion 52. However, when the cams 18 and 20 approach the configuration shown in FIG. 8, the force in direction A of FIG. 8 will be allowed to accelerate the rotation of the lower cam so that the pin 54 may rotate faster than the rotation of the drive shaft 48. This condition is shown in dotted lines in Fig. 5. Thus, the ram carrying cam is capable of quickly forcing the lower cam out of its driving path and allows the stored driving energy to be used almost entirely to drive an associated fastener.

It should be noted that the depth of the slot 56 is great enough to allow limited relative axial movement of the upper and lower coupling members as well as limited relative rotary motion.

In conjunction with the coupling device described above, attention is directed to the details shown in FIG. 9 of the interconnection of the motor housing 12 with the driver housing 14. A flexible mounting device is provided which enables the motor housing and driver housing to move a limited axial distance relative to one another so that shocks imparted to the tool as a result of either free firing or actually impacting a tool as a result of either free firing or actually impacting a fastener with the resulting recoil forces will not be absorbed by the motor itself.

For this purpose a shock connection 60 includes an upper cup member 62 fixedly attached to the motor housing 12 with a conventional bolt means 63. A lower cup-like portion 66 is likewise fixedly attached to the driver housing 14. This attachment may be in the form of the connection rods 36. Upper portion 62 will include a radially outwardly extending flange portion 64 spaced axially from the base portion which is attached

to the housing 12. The lower attachment portion 66 will include radially inwardly extending flange portions 68 spaced axially from the point of attachment of the cup portion 66 with the housing 14. The flange 68 will form an aperture of a size sufficient to allow the base and wall portions of the upper cup 62 to pass therethrough. However, the flanges 64 and 68 will overlies one another to prohibit total axial separation of the housing 12 from the housing 14. A T-shaped cushion ring 70 is positioned on the flange 64 so as to provide a cushioning means between flange 68 and flange 64 and absorb forces such as recoil forces. Likewise, a similar T-shaped resilient ring 72 is positioned on the lower surface of the flange 64 so as to be interposed between the flange 64 and the housing 14 thus absorbing forces such as free firing forces from acting on the electric motor. Dowel pins 74 are provided to pass through the cup portions and the rings and serve as a means to locate the housing 14 on the electric motor housing 12.

The shock connection 60 in cooperation with the coupling 46 will enable the electric motor to be essentially protected from any shock forces that may arise during the actuation of the ram 26, by allowing cushioned limited axial movement between the two housings.

It is apparent now that there has been provided in accordance with the invention an electric motor driven fastener tool in which the motor is protected from various deleterious forces normally encountered during driving under the compression of a spring means. 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 drive mechanism housing, a ram mounted for nonrotating axial movement in the housing, spring means in the housing adapted to urge the ram forwardly in the housing, a ram actuating means mounted for rotation about the axis of the ram, the ram and ram actuating means including first and second cam means respectively fixedly mounted thereto, the first cam means being disposed rearwardly of the second cam means in housing, each cam means including a rising surface and drop-off surface wherein rotation of the actuating means forces the ram rearwardly in the housing against the spring bias and then allows the ram to be driven forwardly under the spring bias, an electric motor means operatively connected to the housing and including a rotary drive shaft extending therefrom, a drive train connecting the drive shaft to the ram actuating means for providing rotary motion to the ram actuating means and second cam means, coupling means in the drive train for allowing the actuating means to accelerate in rotational movement relative to the drive shaft.

2. A driving tool in accordance with claim 1, wherein the electric motor means is mounted to the housing with means allowing flexible movement between the housing and motor to dampen the shock forces between the motor and housing when the ram is driven.

3. A fastener driving tool in accordance with claim 1, wherein the motor means includes a housing, the drive

mechanism housing and the motor housing being connected through a flexible joint, the joint including a first attachment member fixedly attached to one housing and a second attachment member fixedly attached to the other housing, the first and second attachment members coupled together for limited telescoping relative movement.

4. A fastener driving tool in accordance with claim 3, wherein the first attachment member is generally cup-shaped with a base, side walls and flange means extending radially from the side walls, the base being secured to the one housing, the flange means and at least portions of the side walls mounted for movement within the second attachment member, the second attachment member including a lip interposed between the flange means and the one housing, resilient cushion means mounted between the lip and one side of the flange and the opposite side of the flange and said other housing.

5. A fastener driving tool in accordance with claim 4, wherein the resilient cushion means comprise a urethane ring with a generally T-shaped cross-sectional configuration.

6. A fastener driving tool in accordance with claim 1, wherein the electric motor means includes a housing, means joining the housings for limited movement relative to one another, the drive train also including means to permit relative axial motion between the drive shaft and the rotary actuating means whereby shock loads will not be imparted directly to the electric motor means.

7. In a fastener driving tool, a drive mechanism housing, a ram mounted for nonrotating axial movement in the housing, spring means in the housing adapted to urge the ram forwardly in the housing, ram actuating means mounted for rotation about the axis of the ram, the ram and ram actuating means including first and second cam means respectively fixedly mounted thereto, each cam means including a rising surface and drop-off surface wherein rotation of the actuating means forces the ram rearwardly in the housing against the spring bias and then allows the ram to be driven forwardly under the spring bias, an electric motor means operatively connected to the housing and including a rotary drive shaft extending therefrom, a drive train connecting the drive shaft to the rotary actuating means, said motor means including a housing, the drive mechanism housing and the motor means housing being connected through a flexible joint, the joint including a first attachment member which is generally cup shaped and including a base, side walls and flange means extending radially from the side walls the base being secured to one of the housings, a second attachment member including a lip interposed between the flange means and said one housing, said second attachment member being fixedly attached to the other housing, resilient cushion means mounted between the lip and one side of the flange and the opposite side of the flange and said other housing.

8. A fastener driving tool in accordance with claim 7, wherein the resilient cushion means comprise a urethane ring with a generally T-shaped cross-sectional configuration.

9. In a fastener driving tool, a drive mechanism hous-

ing, a ram mounted for nonrotating axial movement in the housing, spring means in the housing adapted to urge the ram forwardly in the housing, a ram actuating means mounted for rotation about the axis of the ram, the ram and ram actuating means including first and second cam means respectively fixedly mounted thereto, the ram actuating means including a ring gear fixedly attached thereto surrounding the axis of the cam means, each cam means including a rising surface and drop-off surface wherein rotation of the actuating means forces the ram rearwardly in the housing against the spring bias and then allows the ram to be driven forwardly under the spring bias, an electric motor means operatively connected to the housing and including a rotary drive shaft extending therefrom, a drive train connecting the drive shaft to the ram actuating means for providing rotary motion to the ram actuating means and second cam means, coupling means in the drive train for allowing the actuating means to accelerate in rotational movement relative to the drive shaft.

10. In a fastener driving tool, a drive mechanism housing, a ram mounted for nonrotating axial movement in the housing, spring means in the housing adapted to urge the ram forwardly in the housing, a ram actuating means mounted for rotation about the axis of the ram, the ram and ram actuating means including first and second cam means respectively fixedly mounted thereto, each cam means including a rising surface and drop-off surface wherein rotation of the actuating means forces the ram rearwardly in the housing against the spring bias and then allows the ram to be driven forwardly under the spring bias, an electric motor means operatively connected to the housing and including a rotary drive shaft extending therefrom, a drive train connecting the drive shaft to the ram actuating means for providing rotary motion to the ram actuating means and second cam means, the drive train comprising a pinion gear mounted on a shaft extending parallel to the axis of the ram to rotatively drive a ring gear means fixedly mounted to the ram actuating means, the drive shaft extending coaxially with the pinion shaft, the drive shaft and pinion shaft being interconnected by means for transmitting torque from the drive shaft to the pinion shaft, the means including interengageable slot means and radial protuberance means, the slot being of greater width than the width of the radial protuberance to permit limited rotation of the pinion shaft relative to the drive shaft and thus allow the ram actuating means to accelerate in rotational movement relative to the drive shaft.

11. A driving tool in accordance with claim 10, wherein the slot extends axially at the terminal extremity of one member and the protuberance on the other member comprises a pin extending transverse the axis of said other member and is received in the slot in such a manner as to be capable of transmitting torque from one member to the other member.

12. A driving tool in accordance with claim 10, wherein the slot means extends axially of the associated interconnected member to permit the interconnected members to move axially relative to each other.

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