

Nov. 6, 1962

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3,061,833

TWO-PISTON EXPLOSIVE ACTUATED FASTENER DRIVING TOOL

Filed Aug. 26, 1957

3 Sheets-Sheet 1

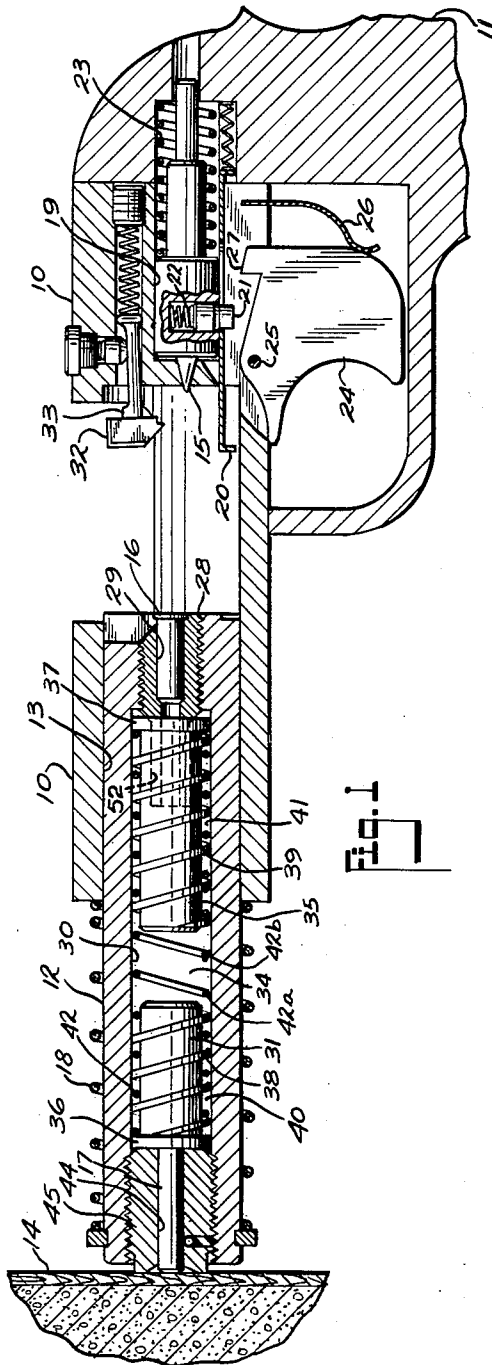


Fig. 1

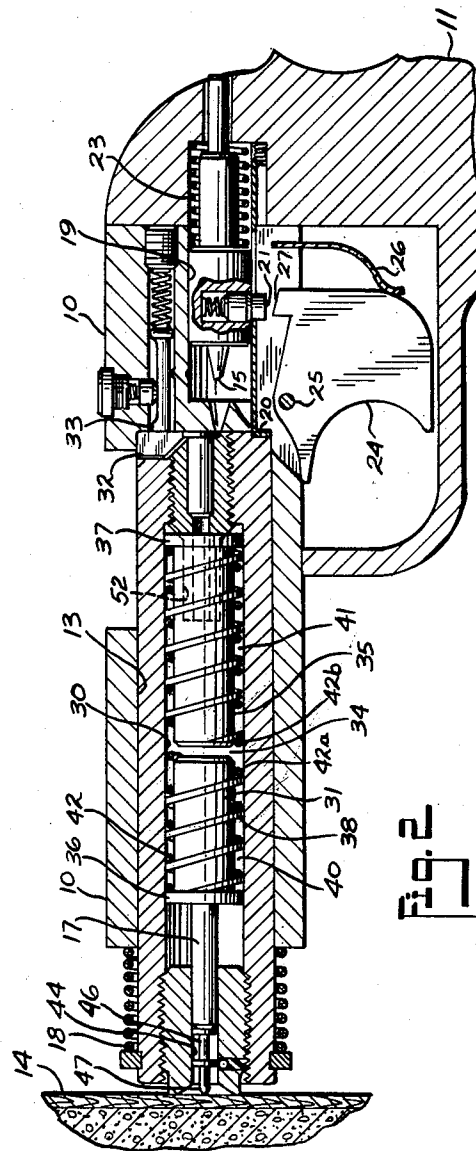


Fig. 2

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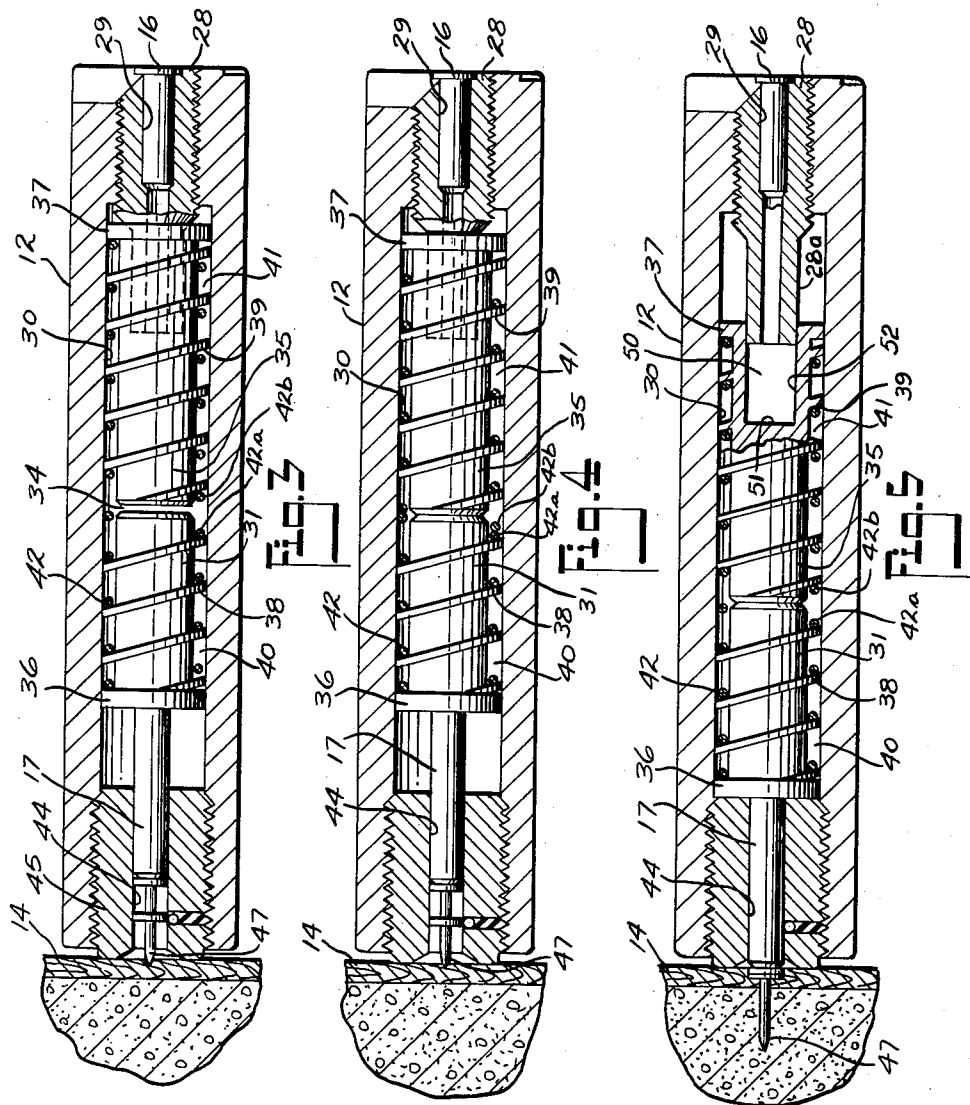
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3 Sheets-Sheet 3

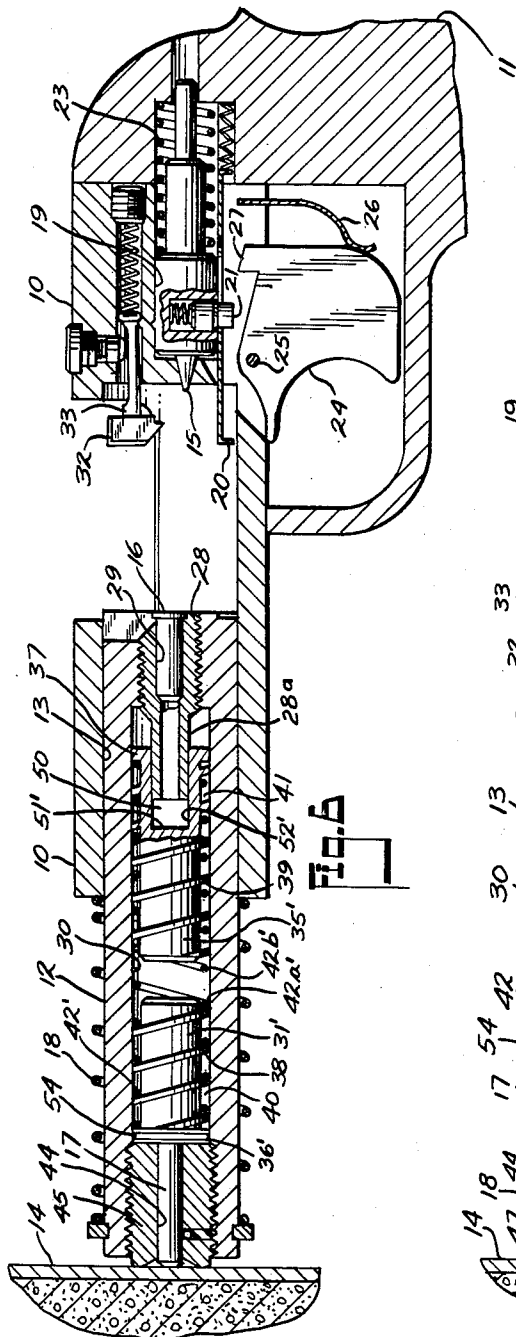


Fig. 6

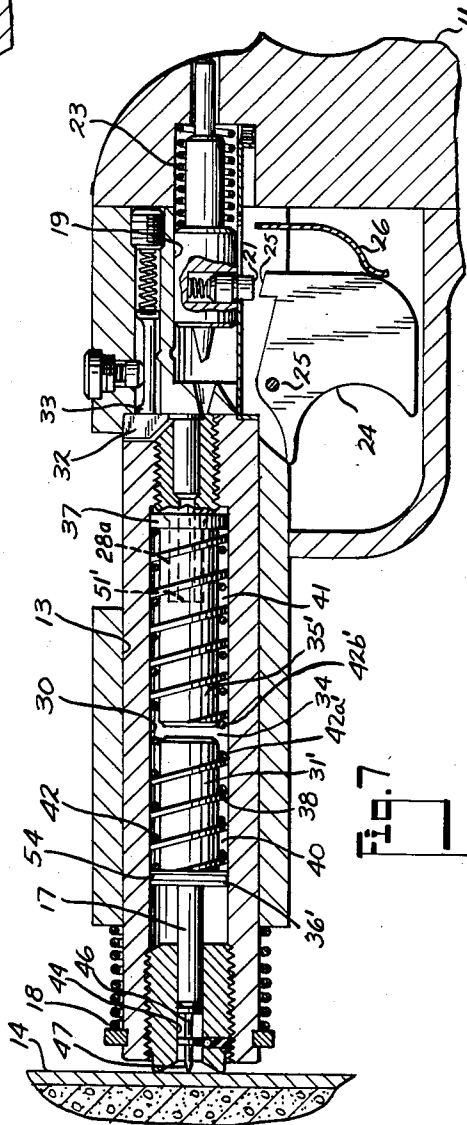


Fig. 7

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TWO-PISTON EXPLOSIVE ACTUATED FASTENER DRIVING TOOL

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Filed Aug. 26, 1957, Ser. No. 680,115

6 Claims. (Cl. 1—44.5)

This invention relates to improvements in explosively actuated power tools for driving fasteners into steel, concrete and the like, and more particularly to an explosively actuated tool having a two-piece fastener driving piston or ram therein.

A further object of the present invention is to provide a power tool employing an explosive charge, with novel two-piece fastener driving means and having resilient means integrally associated therewith for returning the piston toward the breech end of the barrel after discharge of the tool, thereby eliminating the requirement for a piston return mechanism.

Still another object of the present invention is to provide a novel power tool employing an explosive charge with a novel two-piece fastener driving piston wherein the front piston portion normally rests adjacent the discharge end of the barrel in a forward position, thus preventing free flight of the front piston portion and thereby eliminating the possibility of the small diameter driving rod (usually located at the forward or muzzle end of the piston) from breaking off due to inertia and going forward as a projectile in the absence of a fastener in the tool.

Still another object of the present invention is to provide a power tool employing a two-piece fastener driving piston wherein one-half of the piston is normally maintained at the breech end of the barrel and the other end of the piston is normally maintained at the muzzle end of the barrel in continuous contact with the fastener until the fastener is driven.

Still another object of the present invention is to provide a power tool employing an explosive charge with a novel two-piece fastener driving piston having means integrally associated therewith which resiliently bias the front piston portion toward the muzzle end of the tool and the rear piston portion toward the breech end of the tool at all times.

Still another object of the present invention is to provide a power tool employing an explosive charge with a novel two-piece fastener driving piston having means associated therewith, wherein the size of the explosive chamber in which the gases are exploded is automatically regulated in accordance with the length of the fastener to be driven. Thus, a short fastener would increase the size of the chamber, thereby creating less pressure and generating less velocity and consequently less energy while a longer fastener would reduce the size of the chamber, thereby creating more pressure and generating more velocity and consequently more energy for driving said longer fastener.

Another object of the present invention is to provide a power actuated tool comprising means for power driving a fastener, means forming a chamber in said tool, means on said tool for exploding a charge with the gas thereof expanding into said chamber and fastener driving means comprising a first driving member and a second driving member and resilient means operatively connected between said first and second driving members and biasing said members in opposite directions and normally maintaining said members a spaced distance apart. A discharge end of said tool is adapted to receive a fastener, and the first driving member is biased into contact with

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the fastener while at the same time the member is biasing said fastener against the workpiece as the discharge end of the tool is pushed against the workpiece. By this arrangement the fastener at the instant of explosion of said charge, is at rest relative to said tool. The second driving member serves as a movable member to be driven by said gas expanding into said chamber and the first driving member is adapted to be engaged and driven by said second driving member after limited free travel of said second driving member so as to press said fastener into the workpiece, and said resilient means automatically biases said second driving member toward the breech end of said tool after said fastener has been driven.

Another object of the present invention is to provide a power tool having a novel two-piece fastener driving piston characterized by its structural simplicity, the ease of assembly of its parts, its strong and sturdy nature and its low manufacturing cost. Other features of this invention reside in the arrangement and design of the parts for carrying out their appropriate functions.

Further objects of the present invention and certain practical advantages will be referred to in or will be evident from the following description of two embodiments of the invention, as illustrated in the accompanying drawings, in which:

FIG. 1 is a side elevational view of the power tool forming the present invention with the tool in a breech open position and the muzzle thereof in contact with a workpiece and showing the two-piece fastener driving piston means in a relaxed extended position.

FIG. 2 is a side elevational view of the tool held compressed against a workpiece in driving position with the breech closed, the firing pin cocked and having a fastener therein ready to be driven into the workpiece.

FIG. 3 is an enlarged fragmentary view of the barrel end of the tool showing the disposition of the two-piece fastener driving piston at the instant of exploding the powder charge.

FIG. 4 is a view sequential to FIG. 3, showing the disposition of the two-piece fastener driving piston and its associated spring means at the instant the rear piston portion contacts the front piston portion following the explosion of the powder charge.

FIG. 5 is a view sequential to FIG. 4 and showing the disposition of the two-piece fastener driving piston at the instant the front piston portion abuts against the muzzle end of the barrel and at the moment the fastener is completely driven and just prior to the rear piston portion returning toward the breech end of the barrel.

FIG. 6 is a side elevational view of still another embodiment of the invention which includes a two-piece fastener driving piston and spring associated therewith wherein the entire length of the two-piece piston and its associated spring, in a relaxed position as here shown, is less than the interior chamber length of the barrel of the tool.

FIG. 7 is a view similar to FIG. 6 but showing the two-piece fastener driving piston in a position ready for firing with a fastener in place ready to be driven into a workpiece by the piston.

Before describing in detail the herein disclosed embodiments of the invention, it is to be understood that the present invention is not limited to the structural details or the particular arrangement of parts herein shown, as devices embodying the present invention may take other forms. It is also to be understood that the phraseology and terminology herein used are for purposes of description and not of limitation, as the scope of the present invention is denoted by the appended claims.

Those familiar with the present art will recognize that the instant invention may be applied in many ways, but it

has been chosen to illustrate the same in conjunction with a powder actuated tool.

Since both embodiments of the invention have the same basic parts and the same general mode of operation, a general description for those of FIGS. 1 to 5 inclusive, will serve for both embodiments of the invention. The basic parts of the tool include a housing member or breech closure member 10 having a handle 11 at one end for engagement by the hand of the operator and a sleeve-type piston guide member or barrel member 12 for guiding piston travel relative thereto between initial and final positions, and means operatively connecting said housing member 10 and said piston guide member 12 for axial relative movement, said means including a housing bore 13 in housing 10 and adapted to telescopically receive piston guide member 12. The basic purpose of the invention is to provide a power tool which actuates a piston by exploding the powder in a cartridge case for driving a fastener into a workpiece 14, with novel two-piece fastener driving piston means.

In order to facilitate a clear understanding of the invention, a brief description of the general mode of operation will follow. When the tool is in a relaxed position or in a breech open position, the component parts thereof are disposed, as shown in FIG. 1. The tool is then advanced toward the workpiece 14, with contact between the workpiece and the muzzle of the tool, until the housing member 10 moves into a breech closed or tool driving position as seen in FIG. 2. Telescopic movement of the housing member 10 with respect to the piston guide member 12 has the effect of cocking the firing pin 15, as shown in FIG. 2. From the position of FIG. 2, the trigger is pulled to release the firing pin 15 so that the piston means is driven downwardly by the exploding powder in cartridge case 16 with the driving rod 17 at the end of the piston driving a suitable fastener into the workpiece. The tool is then pulled away from the workpiece 14 by movement in the opposite direction and automatically returned to a withdrawn or breech open position by means of spring 18 which was compressed during movement toward the workpiece. The relative movement of the two-piece fastener driving piston means is shown sequentially in FIGS. 2 through 5.

Since a general introduction to both embodiments of the invention has been given, the form in FIGS. 1 to 5 inclusive will now be described in detail. The tool includes power means for driving the piston means from an initial position to a final position. In the present disclosure, the power means takes the form of the powder containing cartridge case 16 and a firing pin assembly for igniting this powder by striking the primer in said cartridge case. The firing pin 15, as seen in FIGS. 1 and 2, is telescopically mounted within the housing bore 19 for longitudinal movement for striking the cartridge case primer and exploding the powder therein. The firing pin is cocked when the tool is moved in a direction toward the workpiece from the breech open position, shown in FIG. 1, to the breech closed position of FIG. 2. A cocking rod 20 is telescopically carried by the housing and has its outer end thereof adapted to be engaged by the breech end of the piston guide member 12. As the housing member 10 telescopes over the piston guide member 12, the cocking rod 20 engages the firing pin pawl 21; said pawl projecting through an aperture provided in the cocking rod, so that the firing pin pawl 21 which is normally biased outwardly by a firing pin pawl spring 22 cocks the firing pin 15 against the firing pin spring 23 to the fully cocked position of FIG. 2. A trigger 24 is pivotally connected to the housing member 10 at pivot 25 and when pulled will revolve counterclockwise about the pivot against the force of the trigger spring 26, anchored at its upper end to the housing member 10, so that a trigger sear 27 will depress the firing pin pawl 21 with which it is aligned when the firing pin is in a cocked position, as shown in FIG. 2, and thereby release firing pin 15. Firing pin spring 23 will drive the firing pin 15 against the

primer of the cartridge case 16 to explode the powder charge therein.

It will be understood that the end of the piston guide member 12 adjacent the workpiece 14 is referred to as the muzzle end while the opposite end of the piston guide member is referred to as the breech end. Means is provided in the breech end of the piston guide member 12 for supporting the cartridge case 16. Said means takes the form of a cartridge chamber member 28 having a bore 29 therein and adapted to convey the exploding gases forwardly into the bore 30 of the piston guide or barrel member 12. The force of the explosion causes the two-piece fastener driving piston means to be moved forwardly in a manner as will be hereinafter more fully defined until the front piston portion 31 thereof abuts against a muzzle abutment sleeve 45, as shown in FIG. 1.

The tool is provided with a cartridge case extractor 32 supported on the end of an arm portion 33 and which engages the cartridge case head shoulder in such a manner that the cartridge case will be extracted from the cartridge chamber 29. The details of structure and the specific mode of operation of the extractor here shown is identical to that disclosed in copending application Serial No. 590,274, filed June 8, 1956.

The specific structure for driving the drivable fastener will now be explained in detail. As shown in FIGS. 1 to 5, bore 30 of piston guide or barrel member 12 provides an elongated barrel chamber 34. The cartridge receiving bore 29 in cartridge member 28 and a bore 44 (receiving a drivable fastening unit) provided in the muzzle abutment sleeve 45 are preferably concentric to and communicate with the barrel chamber 34.

Energy transferring means is provided for transferring the explosive energy from the cartridge to the drivable fastener. Said means takes the form of a two-piece piston having front piston portion 31 and rear piston portion 35. The two piston portions 31 and 35 are mounted within the barrel chamber 34 for reciprocation therein. The front piston portion 31 has a main body portion which is generally cylindrical in shape and has a diameter somewhat less than that of bore 30. At the muzzle end of the cylindrical body portion 31 there is provided an enlarged circular flange 36 which snugly engages the inner surface of the bore 30. Projecting forwardly toward the muzzle end of the tool and concentric to the cylindrical body portion 31 is fastener driving rod 17 which is rigidly secured to the front circular flange 36. The rear piston portion 35 is also provided with a cylindrical body portion having substantially the same diameter as the front piston portion 31 and has its end adjacent the breech of the tool provided with an enlarged circular flange portion 37 which snugly but slidably engages the side walls of the bore 30. Both the front and rear piston portions 31 and 35 are provided with helical flanges 38 and 39 respectively; the flanges are preferably of similar pitch. As illustrated in the present embodiment of the invention, grooves 40 and 41 are provided between adjacent coils of the helical flanges 38 and 39 respectively. A coil spring 42, which has coils of a pitch about the same as said helical grooves and flanges but preferably formed of coils of a larger pitch than the helical flanges, is adapted to have its opposite ends engage the front and rear piston portions and normally maintains the front and rear piston portions at a spaced distance from each other. It will be understood that the convolutions of the compression spring 42 are threaded upon the helical grooves 40 and 41 provided on the cylindrical body portions of the front and rear piston portions 31 and 35 respectively.

As is best seen in FIGS. 1 and 5, the cartridge chamber member 28 is integrally provided on its front end with a cylindrical guide portion 28a which extends axially forwardly into the barrel chamber 34.

The piston part 35 is provided with a cylindrical bore 52 which, as is seen in FIG. 5, extends axially partially

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therethrough and opens to the rearward face of said piston part, being of such diameter as to slidably accommodate the aforesaid guide portion 28a of the cartridge chamber member 28.

In a relaxed position and in the absence of a fastener in the tool, as seen in FIG. 1, the two-piece piston assembly including the coil spring 42 substantially fills the chamber 34 in such a manner that the circular flange member 36 of the front piston portion 31 abuts the muzzle abutment sleeve 45 while the circular flange member 37 of the rear piston portion 35 abuts the breech end of the chamber 34. In this position, the aforesaid cylindrical guide portion 28a of the cartridge member 28 is substantially completely disposed within the rear piston part bore 52. In FIG. 2, a fastener element 46 has been inserted into the bore 44 in abutment sleeve 45 at the muzzle or discharge end of the tool and the tool pushed toward the workpiece 14 so that the fastener element 46 pushes against the driving rod 17 which causes the front piston portion 31 to move to the right, from the position of FIG. 1 to that of FIG. 2. Since the rear piston portion 35 remains stationary, the front piston portion in approaching the rear piston portion compresses the spring 42 between said front and rear piston portions. As shown in FIG. 1, there are preferably not more than a few free medial turns of the spring such as the two free coils 42a and 42b between the front and rear piston portions 31 and 35. As the front piston portion moves to the right, from the position of FIG. 1 to that of FIG. 2, the coils of spring 42 tend to move into engagement with the adjacent flanges while the free coils 42a and 42b between the front and rear piston portions are substantially compressed.

Spring 42 performs a plurality of functions. The spring 42 normally urges the front piston portion 31 into a forward position, or to the left, as viewed in FIGS. 1 and 2, against the abutment sleeve 45. Thus, if the cartridge 16 should be accidentally fired, there would be no free travel of the front piston portion 31 since it is held stationary against the abutment sleeve 45. In previously constructed tools, the single piston member was free to slide back and forth in the absence of a fastener and if a cartridge were accidentally discharged while the piston was located toward the rear of the barrel chamber, it would have ample opportunity for free flight. The danger present in free flight of the front piston portion exists in the tendency of the driving rod member due to its inertia to pull apart from the piston when the latter is being stopped and become a free projectile capable of doing severe damage upon leaving the tool. In the old type tool construction having the solid piston, the smaller diameter driving rod tended to breakoff by inertia and go forward as a projectile, whereas with the present tool the front piston portion 31 never attains the velocity attained by the previous type solid piston construction tools. Thus, the spring by preventing free flight in the front piston imparts safety to the tool when a fastener is not in place. The spring also insures that the front end of the driving rod 17 is always in contact with the fastener to be driven. Driving of the piercing portion 47 of the fastener can only occur when the tool is pushed against the workpiece. As the discharge end of the tool is pressed against the workpiece, the tip of the forwardly projecting piercing portion 47, in attempting to assume a flush position with the end of the tool, will cause the tool parts to be moved to the ready-to-drive position shown in FIG. 2 due to the effort of the tool operator in pushing the discharge end of the tool against the workpiece. The spring 42 biases the forward end of driving rod 17 against the fastener 46 which in turn is held against the workpiece in a ready-to-drive position so that for safety reasons the front piston portion 31 has zero velocity, relative to the tool, at the time of explosion of the cartridge 16. This construction has the effect of driving the fastener with a lower velocity; that is to say, the fastener is forced into

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the workpiece by pressure thereon instead of by the high velocity impact. In order to further facilitate this low velocity, the rear piston portion 35 is preferably constructed with greater weight than the front piston portion 31 so that upon explosion of the cartridge the heavier rear piston portion may have a relatively lower velocity than previously constructed lighter weight pistons while maintaining the same degree of kinetic energy so that upon striking the front piston portion 31, the fastener 46 is forced into the workpiece by pressure created by a heavy weight traveling at a lower velocity rather than a light weight traveling at a high velocity.

The space between the front and rear piston portions permits the rear piston to attain a velocity before it meets with a resistance upon striking the front piston portion. With the present construction, the escape velocity of the fasteners is less; however, sufficient kinetic energy is transmitted to the fastener by means of the heavier rear piston portion 35 traveling at a lower velocity but with greater mass and thereby has a tendency to reduce the recoil and lifting action that occurs in the tool when a solid high velocity piston is used. The initial action of the rear piston portion 35 is that of heavy impact instead of high velocity. There would be a strong recoil if the entire piston were moving but there is less mass (only rear piston portion moving to create impact) and therefore, less recoil.

The operation of the two-piece piston is as follows. With the fastener in place, as seen in FIGS. 2 and 3, the front piston portion 31 is moved to the right from the position of FIG. 1 to that as seen in FIGS. 2 and 3, by the tool being pushed against the workpiece whereby spring 42 becomes compressed. To ignite the cartridge 16, the operator pulls back on the trigger 24 thus pivoting the latter about pin 25 in a counterclockwise direction, as viewed in FIG. 2. The pawl 21 of the firing pin is depressed by said trigger sufficiently to permit said firing pin to be propelled by its spring 23 into rim engagement with the cartridge, thereby igniting said cartridge.

As a result, the explosive gases created by igniting said cartridge are expelled forwardly through the bore 29 in the cartridge member 28 and impinges upon the end wall 51 of the bore 52 in the rear piston portion 35. Said rear piston portion is thereby rapidly propelled through the barrel member chamber 34, sliding forwardly over the cylindrical guide portion 28a of the aforesaid cartridge member 28, and moves into engagement with the tail end of the front piston portion 31, as is seen in FIG. 4. Thereafter, the front and rear piston portions 31 and 35, respectively, move, in effect, as an integral unit forwardly through the aforesaid barrel member chamber 34 to thus drive the fastener 46 into the workpiece 14. As seen in FIG. 5, the aforesaid piston portions 31, 35 have completed their fastener driving stroke and the flange 36 on the piston portion 31 abuts against the rear face of the sleeve 45. At the instant of firing the cartridge 16, the gases generated thereby are expelled directly into a restrictive volume consisting substantially of the portion of the bore 29 defined between said cartridge and end wall 51 of the bore 52. As a result, the rear piston portion 35 is propelled forwardly through the bore 34 with a maximum velocity. With said piston movement, the volume into which said gases are expelled increases since a progressively increasing portion of the bore 52 connects directly with the bore 29. And, with the slidable relationship between the guide portion 28a of the cartridge member 28 and the bore 52, the explosive gases may also escape from said cavity between the relatively sliding surfaces of the latter and said guide portion, and thence into the rearward part of the bore 34. And as is well understood in the art, with the volume into which the gases are expelled being progressively increased, the pressure of said gases decreases. Likewise, with the aforesaid gases coming into direct contact with the metallic material comprising the above mentioned components of the

instant tool, the heat energy of said gases, which comprises a substantial portion of the total energy of the same, is rapidly drawn off and dissipated through said metallic material. As a combined result therefore, as will be understood, the pressure of said gases rapidly diminishes, and as is characteristic of the type of cartridge used in the industry, the pressure at the end of the fastener driving cycle has been reduced to substantially atmospheric pressure. At the instant of firing, it will also be understood that the rear piston portion 35 moves to the left from the position of FIGS. 2 and 3 to that of FIG. 4 and as it travels to the left, it immediately imparts its velocity to the portion of spring 42 contained on the rear piston portion 35 so that when the rear piston portion 35 makes contact with the front piston portion 31, as seen in FIG. 4, the tendency of the spring 42 on the rear piston portion is to surge forward into contact with the flange members 39 of the rear piston portion 35, as seen in FIG. 4. At the instant of impact between the front and rear piston portions, if it were not for the flanges 39 on the rear piston portion 35, the spring coils contained thereon would tend to surge forward and pack one upon the other to thus assume the form of a solid cylinder in which condition the coils of the spring have a tendency to break or attain a permanent set. Thus, it is extremely important to prevent the spring from attaining said solid configuration and for this reason, the helical flanges 38 and 39 are provided on the front and rear piston portions 31 and 35 respectively. After the rear piston portion 35 contacts the front piston portion 31, it causes the front piston portion 31 to move from the position of FIG. 4 to that of FIG. 5 and by so moving drive the fastener 46 into the workpiece 14, as seen in FIG. 5. Upon impact of the front and rear piston portions, as shown in FIG. 4, the front piston portion tends to move to the left, while the spring on the front portion remains stationary for an instant until the front piston portion imparts its movement thereon. The spring coils on the front piston portion, during this instant of lag, would very quickly tend to assume a solid cylindrical configuration in the manner as above described with the coils of the spring on the rear piston portion, as they move to the left from the position of FIG. 3 to that shown in FIG. 4 in the absence of the flanges 38 and 39. With the present construction, however, only the two free coils 42a and 42b actually contact each other and this is in no way destructive to the spring as a whole. A solid cylindrical form would again be attained in FIG. 5 when both the front and rear piston portions come to an abrupt halt, as the circular flange 36 abuts the abutment sleeve 45, wherein the tendency of the spring coils on both front and rear piston portions would be to continue their forward travel and thus assume a form of a solid cylinder. Formation of a solid cylindrical form in spring 42 is prevented by the helical flanges 38 and 39 on the front and rear piston portions. Perhaps at this point another word should be said about the spring tending to assume a solid or compacted cylindrical configuration. This effect is the same as if one end of a given spring were to receive a hard blow. The struck end of the spring would rapidly travel toward its opposite end, progressively compacting the coils of the same as it moves forward due to the energy which was imparted into it and would eventually assume the form of a cylinder wherein each coil collided and packed upon its adjacent coil. In this condition, it is no longer a true spring and would therefore have a tendency to break and/or attain a permanent set. The spring 42 in the present invention, however, picks up the load induced thereon sequentially from coil to coil and there can be no solid bottoming of the spring due to the helical flanges 38 and 39. The axial surging of each coil of the spring is limited to the spacing between adjacent flange coils. In other words, the spring coil surge is limited to a one-coil length rather than to the full spring length.

After the front and rear piston portions have reached

the position of FIG. 5, and since the spring has not attained a permanent set, due to preventing it from assuming the form of a cylinder, the aforesaid spring will return to its normal relaxed position, or to that position shown in FIG. 1 which results from the spring extending to the right from the position of FIG. 5. The respective coils of the spring by engaging the flanges of the rear piston portion move it to the right from the position in FIG. 5 to that of FIG. 1. Thus, it is seen that the spring serves as an automatic return mechanism for the piston portion 35 by returning it to its position at the rear of the chamber and thereby eliminates the need for complex and expensive piston return mechanism oftentimes required in previous power tool constructions.

The spring 42 is preferably designed sufficiently strong to push the front piston portion 31 into a forward position, as seen in FIG. 1, whenever the tool is out of work-piece contact, to maintain the driving rod 17 in contact with the fastener 46 at all times, and further to perform the important function of returning the rear piston portion 35 automatically after discharging the tool thereby eliminating complex and expensive piston return mechanism.

An additional safety feature exists by having the spring between the two piston portions when driving the fastener into a mat or other material having insufficient resistance to penetration or one which the fastener would penetrate and project completely through the material and beyond. Due to the spring loading, the fastener would gradually penetrate the material having insufficient resistance to penetration as the tool was pressed against the workpiece and therefore there could be no chance of free flight of the fastener.

The second embodiment of the tool form, as shown in FIGS. 6 and 7 will next be described. In this form of the invention, all parts of the tool are identical to those shown in FIGS. 1 and 2 with the exception of the two-piece fastener driving piston. Identical parts will therefore be designated by the same reference characters as used in FIGS. 1 and 2. As shown in FIG. 6, the overall length of the instant form of two-piece piston and associated spring is somewhat less than the overall length of the chamber 34. The purpose of this construction is to permit varying the capacity of the explosion chamber 50 in accordance with the length of the fastener to be driven. It is the size of the chamber 50 formed between the inner end wall 51' of the bore 52' provided in the rear piston portion 35' and the rear face of the cartridge 16 which regulates the capacity of the explosion. Thus, moving the rear piston portion 35' to the left away from the cartridge 16 would increase the explosion chamber, in which the gases are expanded so that lower pressures are created and less power is developed, whereas by decreasing the size of explosion chamber 50 higher pressures are developed and produce more power. Thus if a long fastener, for example, were inserted into the muzzle of the tool, as seen in FIG. 7, the rear piston portion 35' would be moved to the right, from that shown in FIG. 6 to that of FIG. 7, due to the movement of the front piston portion 31' which would transmit its motion by spring 42 to the rear piston portion 35' to create a smaller explosion chamber thereby creating greater pressures and developing more power with which to drive the longer fastener. If a shorter fastener were used, the rear piston portion 35' would be moved to the right to a lesser extent than shown in FIG. 7 and would thereby create a larger chamber which would produce a lower pressure and develop less power. The circular flange 36' of the front piston portion 31' is provided with a groove adapted to receive an O-ring 54. The O-ring provides friction between the two-piece piston and the inner side walls of bore 30. The O-ring thereby prevents the two-piece piston assembly from moving to and fro within the chamber 34 in the absence of a fastener. Of course, it will be understood that after firing the tool, the front piston will be in the forward position, as shown in FIG. 6, and will be

retained in this forward position by means of the O-ring 54. The rear piston portion 35' will be returned to the right to the position as seen in FIG. 6.

In the absence of the O-ring 54, should the tool be aimed in an upward direction to be discharged, the tendency would be for both front and rear piston portions to fall to the rear of the chamber 34 and thereby decrease the explosion chamber 50 and therein increase the pressure of the explosion. This would impart free flight to the piston portions and create a substantial hazard to safety. Through the use of the retainer ring 54 safety is maintained whether driving in an upward or downward direction, since the two-piece piston is always retained at the front end of the tool where there can be no free flight and a large explosion chamber exists.

The sequence of operation of the embodiment shown in FIGS. 6 and 7 is identical to that shown in FIGS. 1 and 2, and heretofore disclosed in the sequential illustrations of FIGS. 3, 4 and 5.

In view of the foregoing description, taken in conjunction with the accompanying drawings, it is believed that a clear understanding of the construction, operation and advantages of the device will be quite apparent to those skilled in this art.

What I claim is:

1. A power actuated tool for power driving a fastener into a workpiece, comprising means forming a chamber in said tool and having means at one end thereof for receiving an explosive cartridge, a fastener driving piston means disposed in said chamber forwardly of said cartridge, said piston means comprising a front piston portion and a rear piston portion, said front piston portion and said rear piston portion being spaced from each other, said front and rear piston portions having a helical flange provided on their outer surfaces defining helical grooves thereon, a helical spring having one end thereof threaded into the groove formed between adjacent turns of said flange of said front piston portion and the other end thereof threaded into the groove formed between adjacent turns of said flange of said rear piston portion, said helical spring having coils of substantially the same pitch of said grooves, adjacent turns of said helical flanges being spaced a distance greater than the thickness of said spring thereby permitting limited axial movement of the individual coils of said spring in said groove between adjacent flanges, said spring having free coil portions between said front and rear piston portions, said spring overlying both said piston portions to resiliently urge said front piston portion toward one end of said chamber and said rear piston portion toward the opposite end of said chamber toward said cartridge, means on said tool for igniting said cartridge for driving said rear piston portion through said chamber, said front piston portion being engaged and driven by said rear piston portion after limited free travel of said rear piston portion, said spring receiving the load induced thereon by movement of said front and rear piston portions sequentially from coil to coil whereby the movement of each coil of said spring is limited to the width of its associated groove formed between adjacent flanges thereby preventing the major part of said spring from assuming the form of a cylinder and said spring automatically returning said rear piston portion to said opposite end of said chamber in operable proximity with said cartridge.

2. A power actuated tool for power driving a fastener into a workpiece, comprising means forming a chamber in said tool and having means at one end thereof for receiving an explosive cartridge, a fastener driving piston means disposed in said chamber forwardly of said cartridge, said piston means comprising a front piston portion and a rear piston portion, a spring in said chamber having coils adjacent the front end thereof engaging said front piston portion and coils adjacent the rear end thereof engaging said rear piston portion, coil separating means on said front and rear piston portions for holding most of said

coils in said engagement while keeping them out of engagement with each other for limiting axial movement of adjacent coils of said spring with respect to both said front and rear piston portions, said spring having free intermediate coil portions extending between said coils across front and rear piston portions, said spring normally resiliently biasing said front piston portion and said rear piston portion in opposite directions within said chamber, means on said tool for igniting said cartridge for driving said rear piston portion through said chamber, and into engagement with said front piston portion thereby to drive said fastener into said workpiece.

3. A power actuated tool for power driving a fastener, comprising means forming a chamber in said tool having a discharge end and a breech end at opposite ends thereof, said breech end having means therein for receiving an explosive cartridge, a fastener driving piston means in said chamber comprising a front piston portion and a rear piston portion disposed for sliding movement in said chamber, said front and rear piston portions having helical grooves, a helical spring being of a thickness less than the width of said grooves having one end thereof threaded into a groove of said front piston portion and the other end thereof threaded into a groove of said rear piston portion so as to dispose not more than one spring thickness in each of said grooves, said spring and said two-piece piston portion having a total length less than the length of said chamber, means for igniting said cartridge to drive said rear piston portion toward said front piston portion, said front piston portion being driven forwardly through said chamber by said rear piston portion after limited free travel of said rear piston portion, said spring receiving the load induced thereon by travel of said front and rear piston portions sequentially from coil to coil whereby the surging of each coil of said spring is limited to the width of its associated groove thereby preventing said spring from forming a solid height of spring whereby the kinetic energy of said rear piston portion upon contacting said front piston portion presses the fastener into the workpiece, and means operatively connected with said fastener driving piston means for retaining said front piston portion adjacent the discharge end of said chamber after each fastener driving operation.

4. A power actuated tool for power driving a fastener, comprising means forming a chamber in said tool having a discharge end and a breech end at opposite ends thereof, said breech end having means therein for receiving an explosive cartridge, a fastener driving piston means comprising a front piston portion and a rear piston portion, said front piston portion and said rear piston portion being disposed for sliding movement within said chamber, said front and rear piston portions each having a helical groove, said grooves being of substantially similar pitch, a helical spring being of thickness less than the width of said grooves having one end thereof threaded into the groove of said front piston portion and the other end thereof threaded into the groove of said rear piston portion so as to dispose not more than one spring thickness in each of said grooves, said spring having a pitch larger than that of said groove, said piston means and spring in assembly having a total length less than the length of said chamber, means for igniting said cartridge to drive said rear piston portion toward said front piston portion, said front piston portion being driven forwardly through said chamber by said rear piston portion after limited free travel of said rear piston portion, said spring receiving the load induced thereon by travel of said front and rear piston portions sequentially from coil to coil whereby the surging of each coil of said spring is limited to the width of its associated groove thereby preventing said spring from forming, assuming the form of a solid cylinder and said spring automatically biasing said rear piston portion toward the breech end of said chamber.

5. The tool of claim 4 including means on the front piston portion to impact a fastener and also including

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means to retain said front piston portion in said chamber yieldably with respect to said driven rear piston portion and with respect to said fastener being received.

6. A power actuated tool comprising guide means whereby a rapidly expanding fluid actuates fastener driving means along said guide means toward the discharge end thereof, said tool being adapted at said end to receive said fastener, said driving means comprising in assembly a first movable driving member, a resilient means and a second driving member, said assembly occupying less than the length of said guide means, said resilient means operatively connecting said first and second driving members biasing them apart in opposite directions with said first member thereby adapted for contiguity with said received fastener, said second member being movable in said guide means to be driven therein by said fluid toward said end, said first driving member being adapted to be engaged and driven by said second member after limited

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free flight of said second member to thereby press said received fastener into a workpiece, and means on said fastener driving means for yieldably retaining said driving means adjacent the discharge end of said tool subsequent to discharge thereof to condition the tool for said contiguity and to permit movement of said first member with respect to said second member being driven and with respect to said fastener being received.

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