Sept. 23, 1969 L. F. MULNO 3,468,465

POWER ACTUATED TOOL

Filed March 24, 1966 4 Sheets-Sheet 1

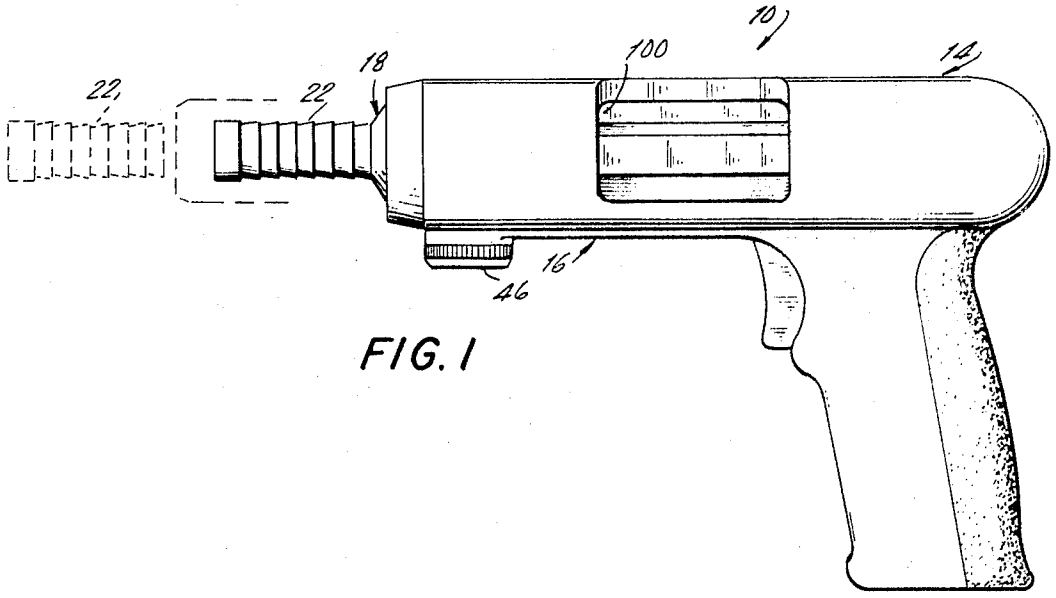

FIG. 1

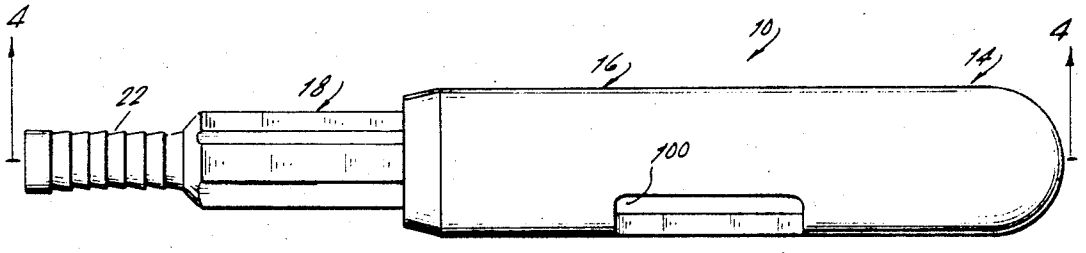

FIG. 2

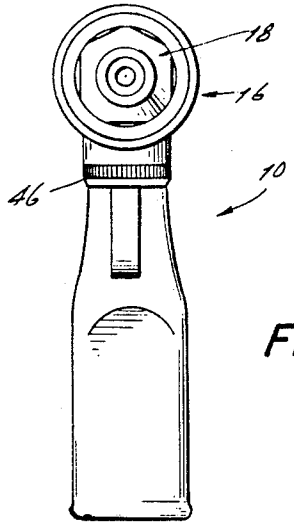

FIG. 3

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POWER ACTUATED TOOL

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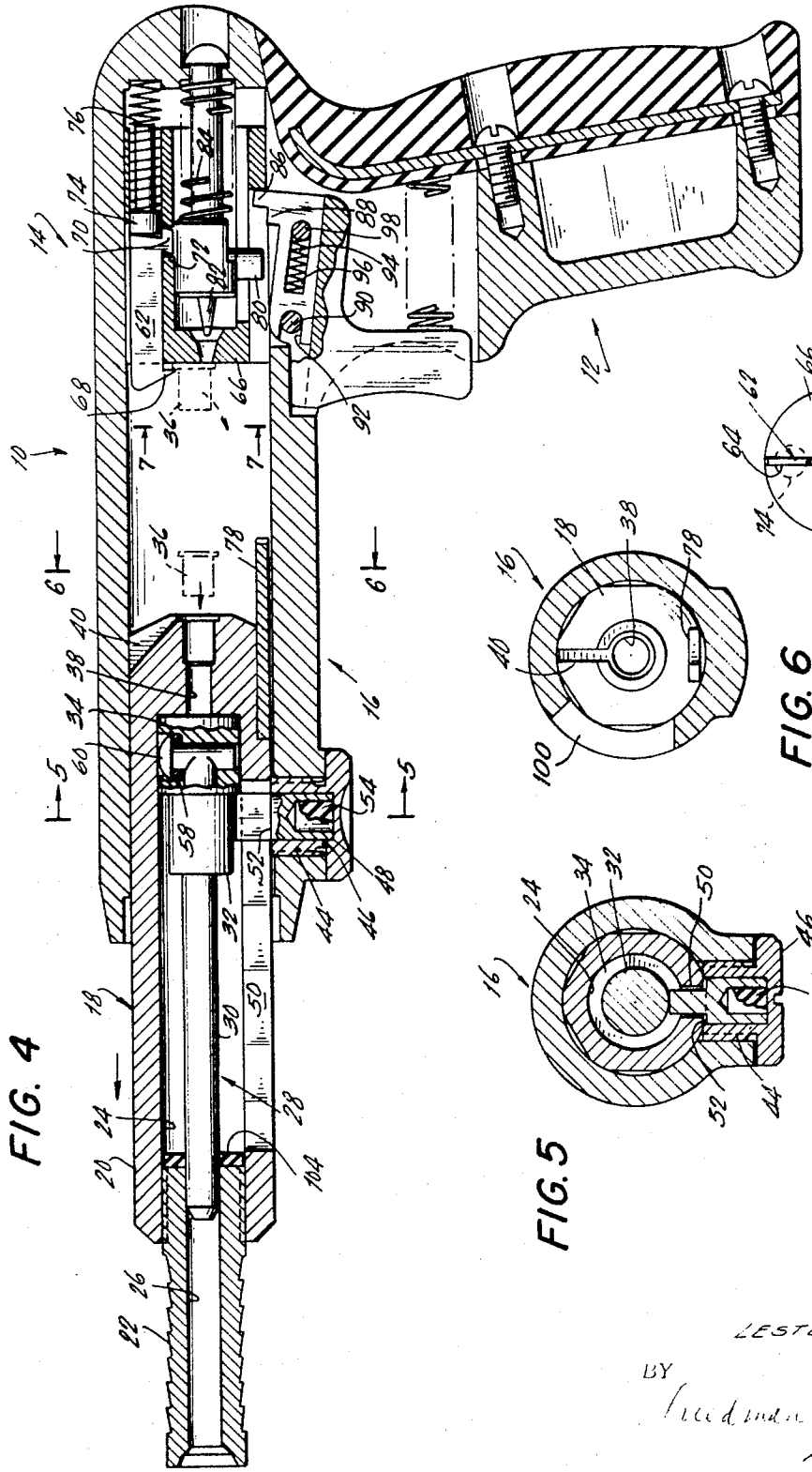

FIG. 4

FIG. 5

FIG. 6

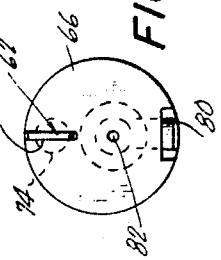

FIG. 7

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POWER ACTUATED TOOL

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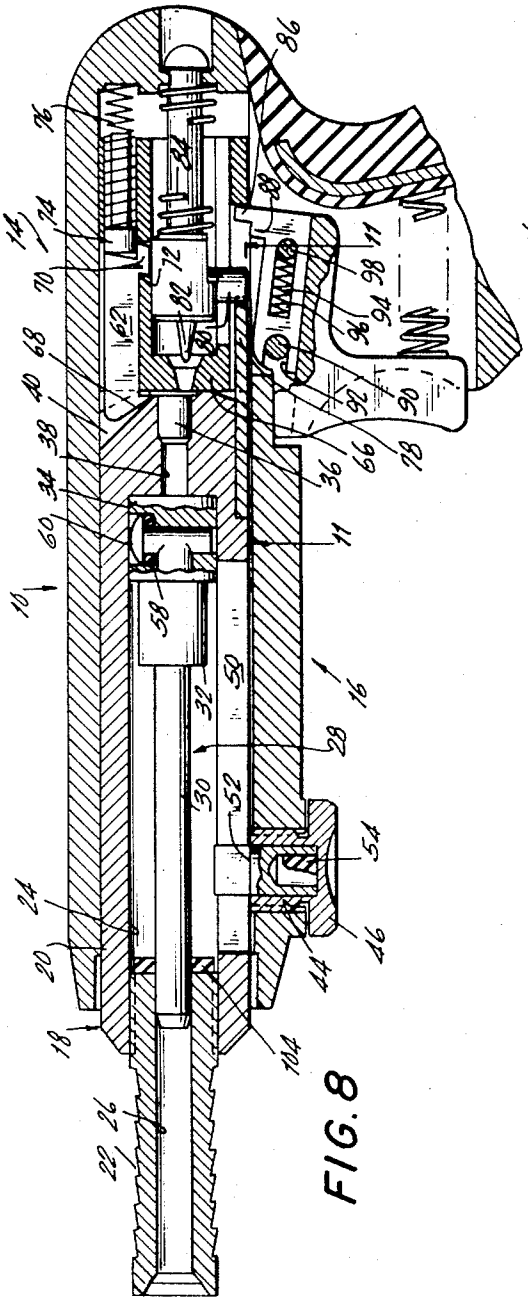

FIG. 8

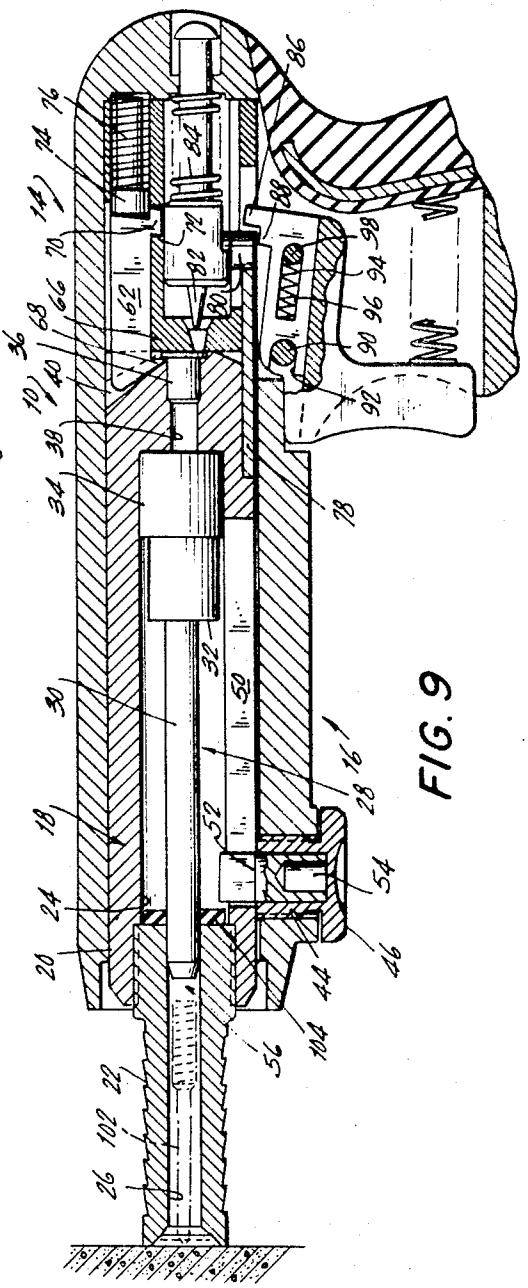

FIG. 9

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POWER ACTUATED TOOL

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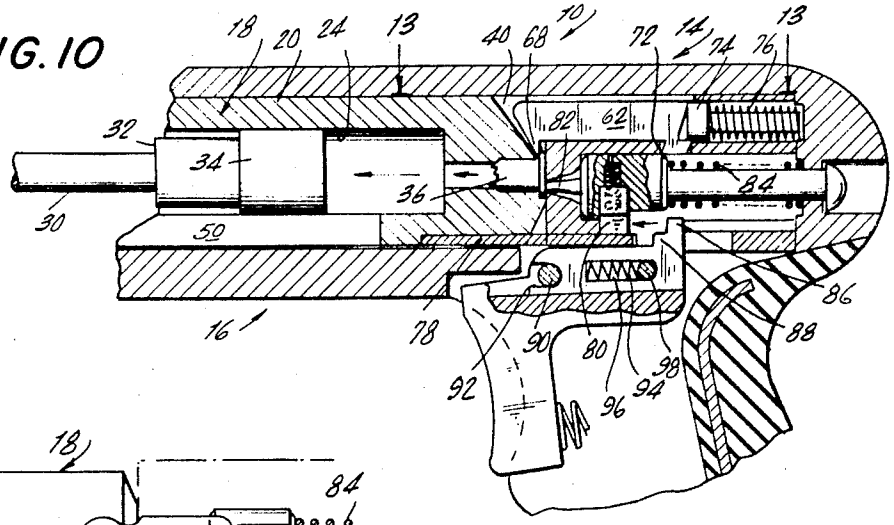
FIG. 10



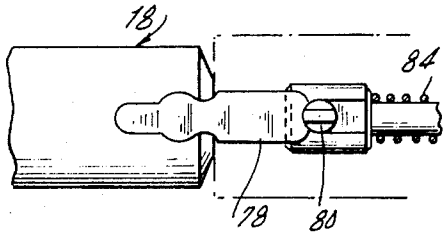


FIG. 11

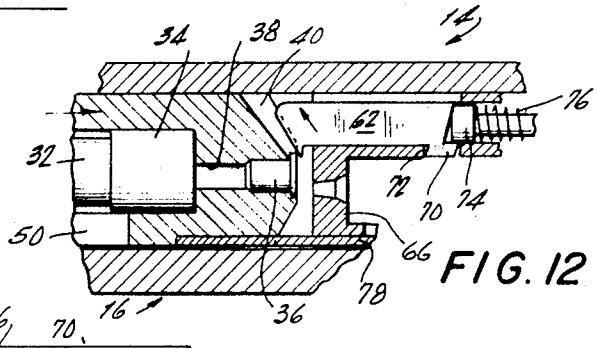


FIG. 12

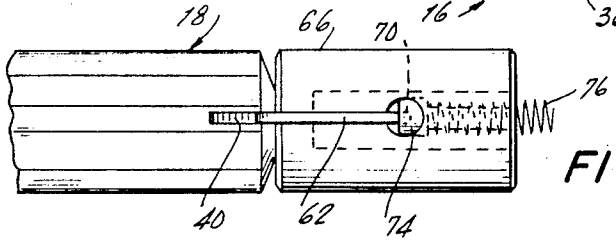


FIG. 13

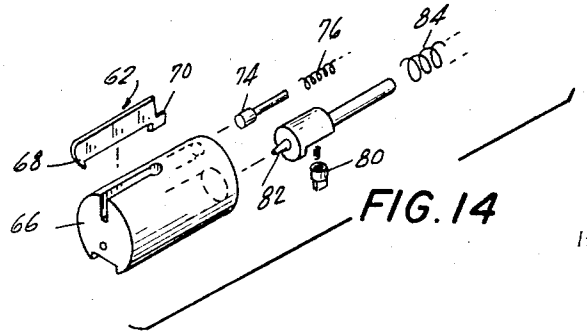


FIG. 14

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3,468,465

POWER ACTUATED TOOL

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Filed Mar. 24, 1966, Ser. No. 537,045
Int. Cl. B25c 1/16
U.S. Cl. 227—10 7 Claims

ABSTRACT OF THE DISCLOSURE

The invention is directed to an explosively-actuated power tool having a housing and a barrel axially movable relative to the housing, characterized by improved means for controlling the relative position of the barrel with respect to the housing; said barrel having an internal bore and a piston axially movable within said bore, characterized by improved means for controlling the relative position of the piston with respect to the barrel; said tool being further characterized by having improved means for extracting and ejecting spent cartridges therefrom and by an improved firing mechanism.

This invention relates to power actuated tools. More particularly, this invention relates to an explosive-actuated tool for driving fasteners and the like.

Explosive-actuated tools for driving fasteners are well-known in the art and are widely used. In general, such tools comprise a housing of pistol-like form comprising a grip with an associated trigger and a generally tubular forward portion, a barrel mounted within the tubular forward portion of the housing and adapted to move axially therein, and a piston contained within the barrel and adapted to move axially with respect to the barrel.

In the usual form of such tools, the breech end of the barrel is recessed to form a chamber for an explosive cartridge, the chamber communicating with the bore so that the gases generated by the explosive charge are transmitted to the face of the piston, and a more or less conventional firing mechanism including a firing pin is located in the housing.

In the operation of the tool, the barrel is moved forward with respect to the housing, and a cartridge is inserted in the chamber. A fastener or the like is positioned in the muzzle end of the barrel, forward of the piston. The barrel is then moved rearwardly with respect to the housing, bringing the chamber into proximity with the firing pin, and also, by way of suitable operating rods, cams, or the like, cocking the firing mechanism. As a safety feature, it is common to provide that the firing mechanism is cocked by moving the barrel rearwardly against a substantial spring bias, generated by pressing the muzzle of the tool against the surface into which the fastener is to be driven.

While the tools of this general type heretofore proposed have been effective and have obtained wide acceptance, they are nevertheless subject to certain disadvantages, or areas susceptible of improvement.

An object of this invention, therefore, is to provide an improved explosively-actuated power tool.

Another object is to provide an explosively-actuated power tool having a housing and a barrel axially movable relative to said housing, characterized by improved means for controlling the relative position of said barrel with respect to said housing.

Another object is to provide an explosively-actuated power tool having a barrel with an internal bore and a piston axially movable within said bore, characterized by improved means for controlling the relative position of said piston with respect to said barrel.

Still another object is to provide a tool actuated by an explosive cartridge, characterized by improved means for extracting and ejecting spent cartridges therefrom.

A further object is to provide a tool of the type described, characterized by an improved firing mechanism.

A feature of the invention is the provision of a piston having an enlarged shoulder, and a key mounted on the housing and extending through an aperture in the barrel, said key cooperating with said enlarged shoulder to prevent escape of said barrel from said housing.

Another feature is the provision of a resilient frictional member interposed between the housing and the barrel to frictionally restrain the barrel against random motions with respect to the housing, as well as the provision of a resilient frictional member interposed between the piston and the barrel to frictionally restrain the piston against random motions with respect to the barrel.

A further feature is the provision of an extractor mounted for pivotal motion but devoid of a pivot pin.

Another feature is the provision of a breech block adapted for axial movement in a housing which is located and retained in said housing by a trigger projection in a predetermined axial and radial orientation.

Yet another feature is the provision of a resilient trigger mount effective to minimize or eliminate accidental damage to the firing mechanism by dropping the tool.

Other objects, features and advantages will become apparent from the following more complete description and claims, and the accompanying drawings.

In one particularly desirable embodiment, this invention contemplates an explosive-actuated power tool comprising in combination a housing having a breech portion and a generally tubular forward portion, a barrel mounted in said tubular forward portion and axially movable therein, said barrel having a breech end and a muzzle end, a piston mounted in said barrel and axially movable therein, said piston having a portion of relatively larger diameter nearer the breech end of said barrel and a portion of relatively smaller diameter nearer the muzzle end of said barrel, said larger diameter portion and said smaller diameter portion cooperating to define a shoulder facing toward the muzzle end of said barrel, said barrel being apertured to define an axially elongated slot, and a key connected to said forward portion of said housing and extending through said slot in position to intercept said shoulder of said piston, thereby limiting the distance to which said piston can move forwardly relative to said housing.

In another particularly desirable aspect, this invention contemplates an explosive-actuated power tool comprising in combination a housing having a breech portion and a generally tubular forward portion, a barrel mounted in said tubular forward portion and axially movable therein, a piston contained in said barrel and axially movable therein and resilient friction means for yieldingly resisting relative motion of said piston with respect to said barrel.

In another important aspect, this invention contemplates an explosive-actuated power tool comprising a chamber for the reception of an explosive cartridge, a breech block, and an extractor for removing said cartridge from said chamber after the firing thereof, said extractor comprising in combination an extractor hook plate having an inwardly projecting tooth at its forward end and being provided at its rearward end with an offset lug depending from the radially innermost edge of said rearward end, said breech block being grooved to provide a slot for the reception of said extractor hook plate, permitting radial movement of said plate but restraining the same against circumferential movement, said groove being deeper in the region occupied by said

offset lug and providing a rearwardly-facing shoulder in position to serve as an abutment for the forward portion of said depending lug, and resilient means for yieldingly biasing the upper portion of the rearward end of said extractor hook plate to a forward position.

This invention also contemplates a firing mechanism comprising a breech block having an axial movement in the housing and including an axial recess within which a two-part firing pin is located. The firing pin is comprised of a front part which extends rearwardly through an aperture in the housing, and a rear screw part which creates a shoulder and interlocks the firing pin and the housing. A predetermined axial relationship is thus maintained between the firing pin and the housing, the firing pin being additionally provided with a radial recess for a sear, and the firing pin including spring means for urging said firing pin to a forward position, a sear located in said radial recess and projecting radially outwardly therefrom, sear spring means for urging said sear to a radially outward position, to contact cocking means for forcing said firing pin rearwardly against the bias of said firing pin spring means by axial pressure exerted against said sear, trigger means including a sear-lifting shoulder for lifting said sear free of said cocking means and thereby permitting said firing pin to spring forward to fire the tool.

Referring now to the drawings:

FIGURE 1 is a side elevation of an explosive-actuated power tool according to the invention.

FIGURE 2 is a top view of the tool of FIGURE 1.

FIGURE 3 is a front or muzzle-end view of the tool of FIGURES 1 and 2.

FIGURE 4 is a longitudinal cross-section of the tool, taken along line 4—4 of FIGURE 2, showing the tool in "loading" condition.

FIGURE 5 is a transverse cross-section of the tool, taken along line 5—5 of FIGURE 4.

FIGURE 6 is a transverse cross-section of the tool, taken along line 6—6 of FIGURE 4.

FIGURE 7 is a transverse cross-section taken along line 7—7 of FIGURE 4.

FIGURE 8 is a fragmentary cross-section similar to FIGURE 4, showing the tool in "ready" condition.

FIGURE 9 is a fragmentary cross-section similar to FIGURE 8, showing the tool in "cocked" condition.

FIGURE 10 is a fragmentary cross-section, similar to FIGURES 8 and 9, but showing the condition of the tool just after firing of the explosive charge.

FIGURE 11 is a fragmentary sectional bottom view, taken on line 11—11 of FIGURE 8.

FIGURE 12 is a fragmentary cross-section, similar to FIGURES 8–10, showing the condition of parts of the tool just before reaching the "ready" condition.

FIGURE 13 is a fragmentary top view, taken on line 13—13 of FIGURE 10.

FIGURE 14 is an exploded birdseye perspective view of the brech block, firing pin, sear, and extractor assembly.

Referring now more particularly to FIGURE 4, the tool as there illustrated comprises a housing, indicated generally at 10, comprising a pistol grip 12, a breech section 14 and a generally tubular forward section 16. Housed in the forward section 16 is a barrel 18, which is free to move axially within the housing, as indicated by the arrow. In the illustrated form of the invention, the barrel is made in two sections, namely a main section 20 and a muzzle section 22.

The main section 20 is provided with a central axial bore 24, and a muzzle piece 22 with a somewhat narrower bore 26.

Within barrel 18 is housed a piston 28 having three cylindrical portions 30, 32 and 34, of relatively increasing diameter in the order named. The diameter of piston section 30 is sized to fit closely, but slidably, within the bore 26 of the muzzle piece, and that of piston section 34 is sized to form a sliding, but substantially gas-tight fit in the bore 24 of main barrel section 20.

The breech end of barrel main section 20 is chambered to accommodate an explosive cartridge 36, and bored to provide a gas passage 38 communicating with bore 24. The breech end is also provided with a slot 40.

Projecting axially and rearwardly from the breech end of barrel main section 20 is a cocking rod 78.

Near the forward end of housing forward portion 16 is a threaded aperture 44, adapted to receive a threaded plug 46. Plug 46 is recessed to receive the cylindrical base of a key 48. The rectangular upper portion of key 48 projects upwardly into bore 24, through an axial slot 50 provided for the purpose in barrel main section 20.

The juncture between the lower cylindrical portion and the upper rectangular portion of key 48 provides a pair of segment-shaped shoulders 52, positioned to bear against the surface of barrel main section 20. The lower cylindrical portion of key 48 is recessed to receive a compressible member such as a plug 54 of rubber or the like. The head of plug 46 is preferably slotted or knurled or both, and the pressure with which shoulders 52 bear against the barrel is adjusted by turning down the plug, thereby increasing the compression of resilient member 54, which compression is transmitted to key 48.

The upper, rectangular portion of key 48 projects into bore 24 sufficiently far to intercept the maximum diameter portion 34 of the piston, but not so far as to intercept the intermediate-diameter portion 32.

The function of the frictional force exerted by shoulders 52 on main barrel section 20 is to yieldingly restrain the barrel against movement relative to the housing. This helps to avoid unnecessary wear, and facilitates handling and operation of the tool, because the barrel tends to remain in whatever position the operator has placed it, while other operations are performed, such as loading, etc.

The function of the upper, rectangular portion of key 48 is threefold. First, as the barrel is moved forward relative to the housing, for example, to the forward or loading position illustrated in FIGURES 2 and 4, the upper portion of key 48 intercepts maximum diameter section 34 of the piston, as shown in FIGURE 4, and prevents the piston from going forward with the barrel. Thus, as the barrel moves forward and the piston remains stationary relative to the housing, the piston is moved all the way to the rear of bore 24, in proper position for firing. The same motion clears bore 26 in the muzzle piece for the insertion of a fastener to be driven, as best shown in FIGURE 9. As also shown in FIGURE 9, the fact that the piston is positioned by the key, rather than by pushing a fastener into the muzzle, provides a small head space 56, between the impact face of the piston and the head of the fastener. This is important, because it allows the piston to gather momentum before striking the fastener, so that the fastener is initially subjected to a sharp impact, rather than to the gradually increasing pressure of the expanding gases.

The second function of the rectangular portion of key 48 is to limit the forward motion of the barrel. When the barrel reaches the position shown in FIGURE 4, further forward motion of the piston is prevented by abutment of maximum diameter piston section 34 against the key, and further forward motion of the barrel is prevented by abutment of the rear end of bore 24 against the rear face of piston section 34. In the illustrated form of the invention, if key 48 were not present, the barrel would be free to move completely out of the housing; and the tool is, in fact, disassembled for cleaning and servicing by removing plug 46 and key 48, allowing the barrel to be removed. The third function of the rectangular portion of key 48 is to limit the rotation of the barrel.

Turning to another feature of the invention, the piston is provided with a radial recess bored in maximum diameter section 34 thereof, the bore having a section of wider diameter near the outer end thereof, forming a circular

shoulder. A resilient member such as O-ring **58** rests on the shoulder, and a friction member **60** of the general form of a round-head bolt is positioned in the recess, with the underside of the head thereof resting on the O-ring. The parts are so dimensioned that when the O-ring is relaxed, the center of the head of friction member **60** protrudes slightly outwardly from the surface of piston section **34**, so that when the piston is in position in bore **24**, the O-ring is compressed, causing friction member **60** to be urged against the wall of the bore.

The purpose of friction member **60** is to yieldingly restrain the piston from movement relative to the barrel. In addition to preventing unnecessary wear, this performs the more important function of maintaining the piston in proper firing position at the breech end of bore **20**, once it has been placed there by moving the barrel forward to the position shown in FIGURE 4.

Another novel feature of the invention resides in the extractor assembly. As also shown in FIGURE 4, the assembly includes an extractor hook plate **62** accommodated in a suitable radial slot **64** in breech block **66**. At the forward end of extractor hook plate is an extractor hook **68** of generally conventional form. At the rear end of the extractor hook plate is a depending lug **70**, the forward end of which bears against a suitable abutment **72** formed by the shape of the slot **64** in breech block **66**. A resilient assembly comprising a plunger **74** and a plunger spring **76** exerts a yielding forward bias against the upper portion of the rear end of extractor hook plate **62**.

Referring to FIGURE 12, as the barrel is brought back into "ready" position (as more fully illustrated in FIGURE 8) the rim of the cartridge forces the extractor hook upwardly, as indicated by the arrow, against the bias of spring **76**. Once the cartridge rim has cleared the hook, the hook drops back into place, as shown in FIGURE 8, for example. The hook remains in this position during cocking and firing. When the barrel is subsequently moved forward to "load" position, the cartridge is held back by the hook and thereby removed from the chamber. Once free of the chamber, the cartridge falls free of the hook and can be ejected from the tool by simply shaking it out through a suitable opening in the housing. It should be noted that this arrangement provides the necessary pivotal motion required to enable the extractor hook to be deflected by the rearwardly-moving rim of the cartridge, and then drop back to hook the rim, without requiring a pivot pin. This is a distinct advantage, inasmuch as the pivot pin in conventional extractor mechanisms is subjected to severe shocks and is prone to failure.

To overcome the possibility of damage from these eventualities, the trigger is mounted in a resilient fashion, as shown in FIGURE 4 and other figures, comprising a conventional trigger pivot pin **90** passing through the trigger and journalled into the housing at either side of the trigger. The corresponding aperture **92** in the trigger, instead of being circular and closed in accordance with conventional practice, is U-shaped and open as illustrated, thus providing for rearward motion of the trigger as a whole to absorb the shock of the sear on its return travel, for example. This rearward motion of the trigger is resisted by the bias of a compression spring **94**, which bears at one end against a portion of the trigger such as the front end of a slot **96**, and at the other against a pin **98**. Pin **98** is restrained against rearward motion in any suitable manner, for example by seating the ends thereof in arcuate slots (not shown) in the housing, concentric with trigger pivot pin **90**.

The operation of the tool is as follows: The barrel is first moved forward manually, or by "throwing" the tool to create a forward centrifugal force, to the position shown in FIGURE 4. This moves the piston to the rear of the barrel, by the action of key **48**, as described above. The tool is inverted, if necessary, sufficiently to drop the spent cartridge out through loading aperture **100** in the housing (FIGURES 1 and 2). A fresh cartridge **36** is inserted, through loading aperture **100**, into the chamber provided in the breech end of barrel **18**, and the barrel is returned manually, or by pushing it against a suitable surface, to the "ready" position shown in FIGURE 8. Because of the action of friction member **60**, as previously described, the piston remains in its rearward position relative to the barrel, as the barrel is moved back.

A fastener **102** is inserted in the muzzle piece, and the action is cocked by pushing the muzzle piece forcibly against the surface into which the fastener is to be driven, thus causing cocking rod **78** to push sear **80** and the firing pin back against the bias of firing pin spring **84**, in the manner described above. The trigger is squeezed, lifting sear **80** off cocking rod **78** by means of a sear-lifting shoulder **88** projecting, inwardly, integrally and at right angles from rear portion **86** of the trigger, and allowing the firing pin to spring forward and fire the cartridge. Expanding gases from the cartridge pass through gas passage **38** and drive the piston forward, as indicated in FIGURE 10, driving the fastener before it into the wall or other surface into which it is to be driven.

If the fastener overpenetrates, the forward motion of the piston is arrested by the striking of the intermediate diameter portion **32** of the piston against the front end of bore **24**, or preferably against a resilient member **104** located therein. The relative sizes of the parts are so selected with reference to the fastener that impingement of piston section **32** against resilient member **104** prevents overdriving the fastener. The tool is then taken away from the wall; the barrel moved forward to the "load" position; and the cycle is repeated for the next fastener.

While this invention has been described with reference to certain preferred embodiments and illustrated by way of certain drawings, these are illustrative only, as many alternatives and equivalents will readily occur to those skilled in the art, without departing from the spirit or proper scope of the invention. The invention is therefore not to be construed as limited, except as set forth in the appended claims.

I claim:

1. An explosive-actuated power tool comprising in combination a housing having a breech portion and a generally tubular forward portion, a barrel mounted in said tubular forward portion and axially movable therein, said barrel having a breech end and a muzzle end, a piston mounted in said barrel and axially movable therein, said piston having a portion of relatively larger diameter nearer the breech end of said barrel, and a portion of relatively smaller diameter nearer the muzzle end of said barrel, said large diameter portion and said smaller diameter portion cooperating to define a shoulder facing toward the muzzle end of said barrel, said barrel being apertued to define an axially elongated slot, and a key connected to said forward portion of said housing and extending through said slot in position to intercept said shoulder of said piston, thereby limiting the distance to which said piston can move forwardly relative to said housing and wherein said key comprises a generally cylindrical portion and a generally rectangular portion, said generally rectangular portion extending through said slot in said barrel into the interior thereof, said generally cylindrical and said generally rectangular portion cooperating to define, at their juncture, a pair of segment-shaped shoulders adapted to bear frictionally against the surface of said barrel adjacent said slot.

2. A tool according to claim **1**, further comprising adjustable resilient compression means for controlling the frictional force exerted by said shoulders against said barrel.

3. An explosive-actuated power tool comprising in combination a housing having a breech portion and a generally tubular forward portion, a barrel mounted in

said tubular forward portion and axially movable therein, a piston contained in said barrel and axially movable therein, and resilient friction means for yielding resisting relative motion of said piston with respect to said barrel, said friction means further comprising a friction member having an enlarged head, said friction member being seated in a shouldered, radial recess in said piston, and resilient means interposed between said shoulder and said enlarged head.

4. An explosive-actuated power tool comprising a chamber for the reception of an explosive cartridge, a breech block, and an extractor for removing said cartridge from said chamber after the firing thereof, said extractor comprising in combination an extractor hook plate having an inwardly-projecting tooth at its forward end and being provided at its rearward end with an offset lug depending from the radially innermost edge of said rearward end, said breech block being grooved to provide a slot for said extractor hook plate, permitting radial movement of said plate but restraining the same against circumferential movement, said groove being deeper in the region occupied by said offset lug and providing a rearwardly-facing shoulder in position to serve as an abutment for the forward portion of said depending lug, and resilient means for yieldingly biasing the upper portion of the rearward end of said extractor hook plate to a forward position.

5. A tool according to claim 4, wherein said resilient means for yieldingly biasing the upper portion of the rearward end of said extractor hook plate to a forward position comprises a spring-biased plunger bearing against said upper portion.

6. A firing mechanism for an explosive-actuated instrument, comprising in combination a breech block having an axial recess, a firing pin located in said axial recess, said firing pin having a radial recess, firing pin spring means for urging said firing pin to a forward position, a sear located in said radial recess and projecting radially outwardly therefrom, sear spring means for urging said sear to a radially outward position, cocking means for forcing said firing pin rearwardly against the bias of said firing pin spring means by axial pressure exerted against said sear, trigger means including a sear-lifting shoulder for lifting said sear free of said cocking means and thereby permitting said firing pin to spring forward, said trigger means being resiliently mounted to permit limited rearward motion of said trigger means as a whole.

7. A firing mechanism according to claim 6, wherein said resilient mounting of said trigger means comprises a pivot pin, an open-ended, forwardly-facing, U-shaped aperture in said trigger surrounding said pivot pin, and resilient means urging said aperture into engagement with said pivot pin.

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