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Leonardo et al.

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[54] POWDER ACTUATED TOOL

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[52] **U.S. Cl.** **227/10**, 227/8

[51] **Int. Cl.** **B25c 1/14**

[58] **Field of Search** 227/8, 9, 10, 11

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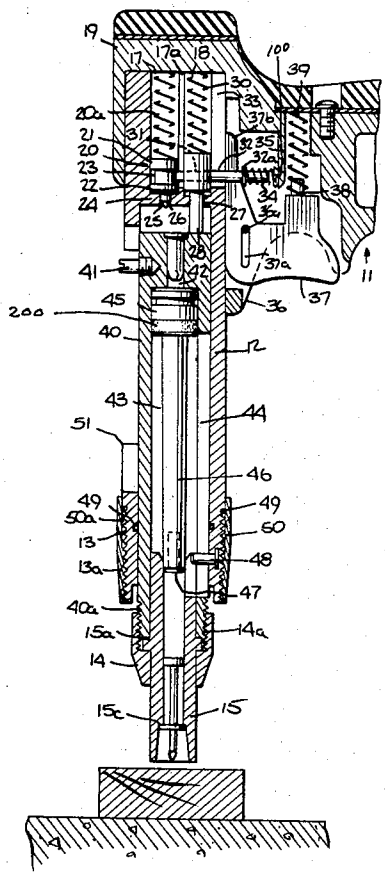
[57] **ABSTRACT**

A powder actuated tool including a barrel with a muzzle affixed to one end is disclosed. A cylinder is movable within the barrel and a piston having a piston rod extending through the muzzle is movable within the cylinder. Stop means are located in the cylinder and the guidepin is located on the barrel. Adjustable means are provided for varying the stroke length of the piston within the cylinder and means are provided for increasing the service life of the piston rod.

5 Claims, 12 Drawing Figures



PATENTED MAR 28 1972 3,652,003

Fig. 1.

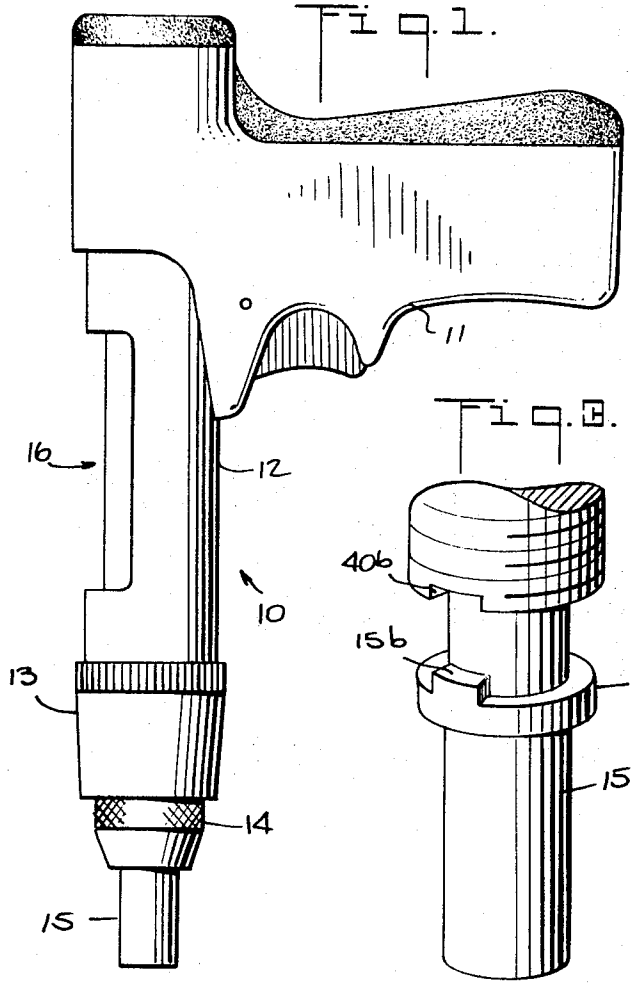


Fig. 2.

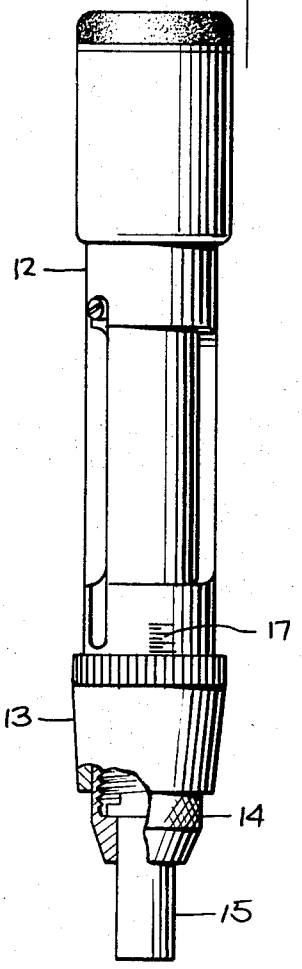
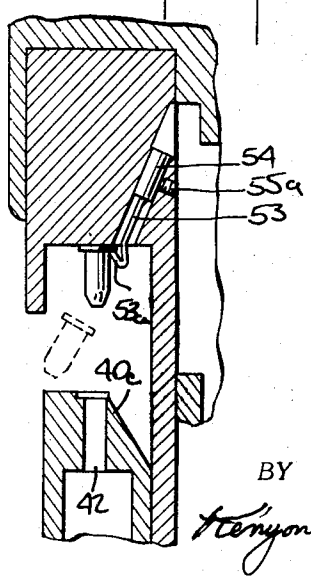


Fig. 3.

Fig. 10.



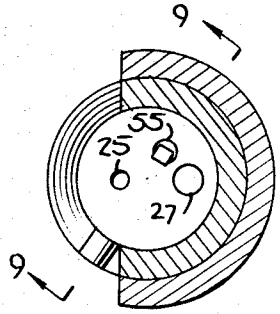


Fig. 8.

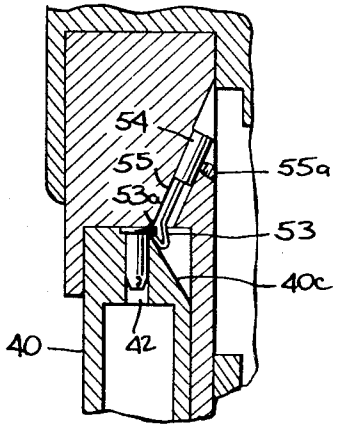


Fig. 9.

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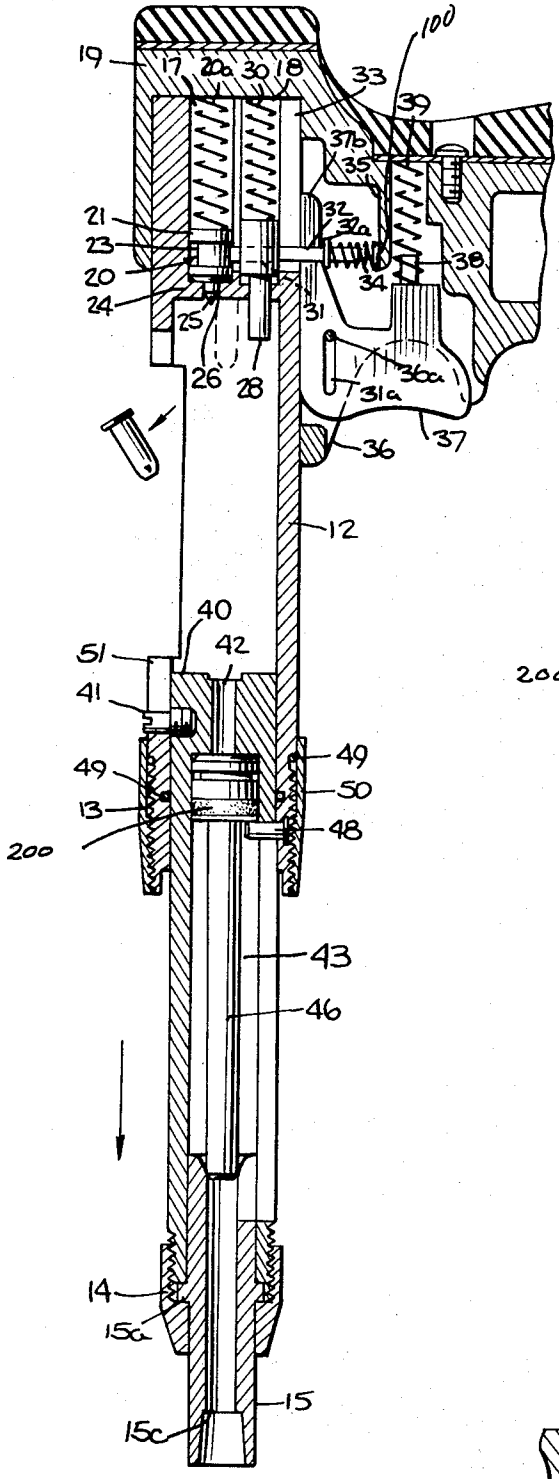

Fig. 4.

Fig. 5.

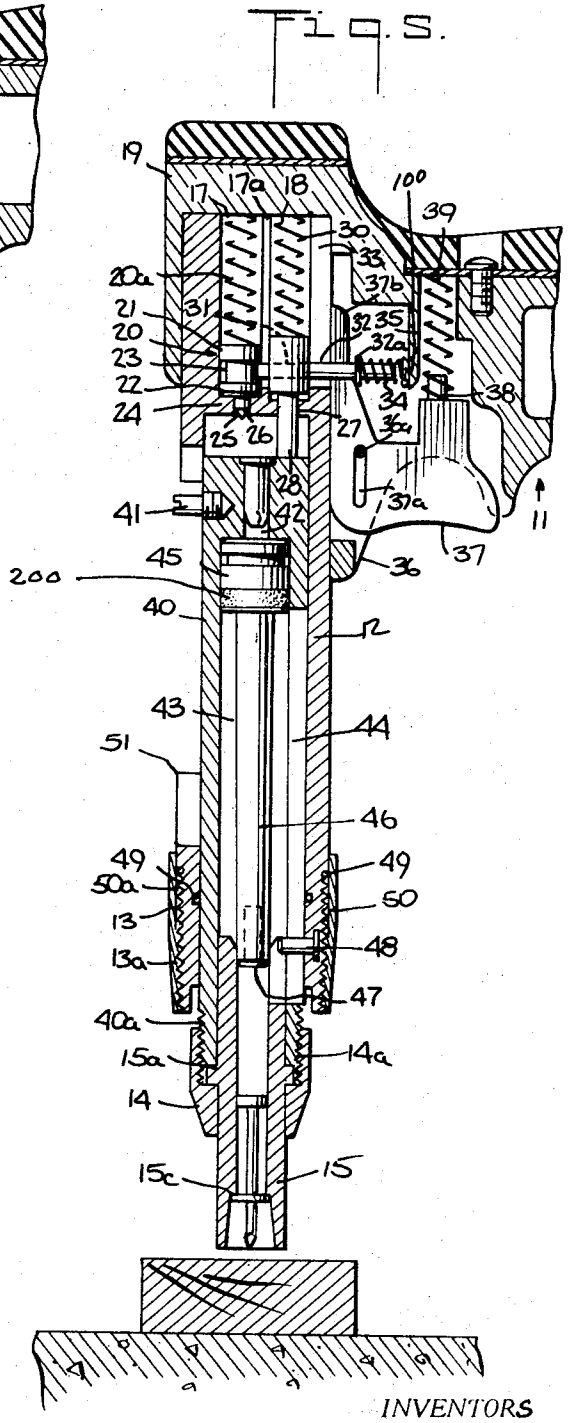

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Fig. 6.

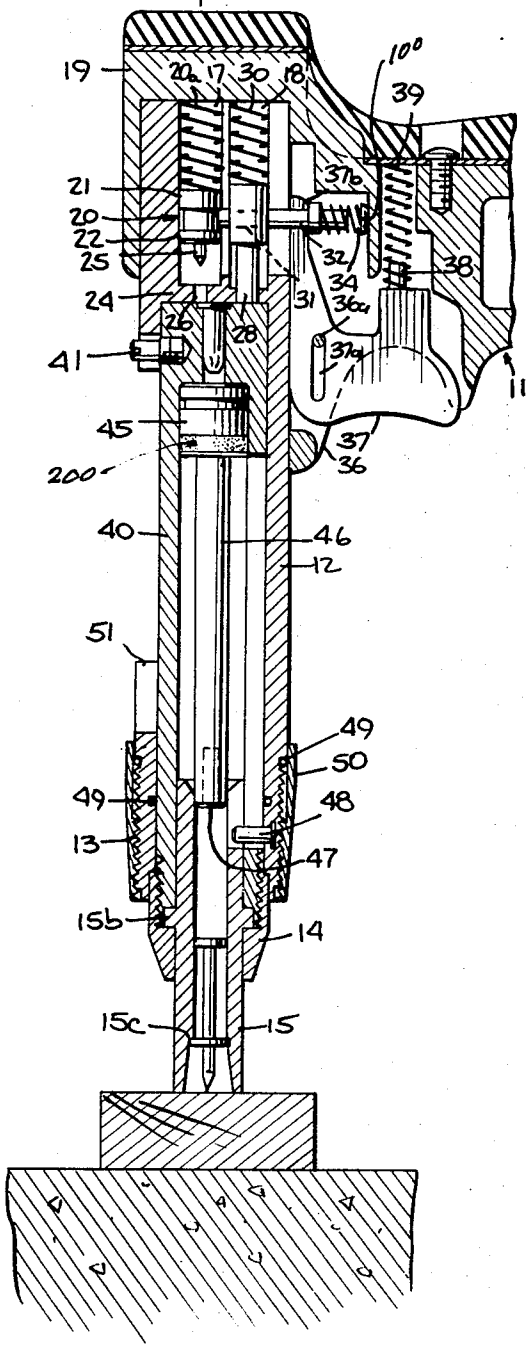
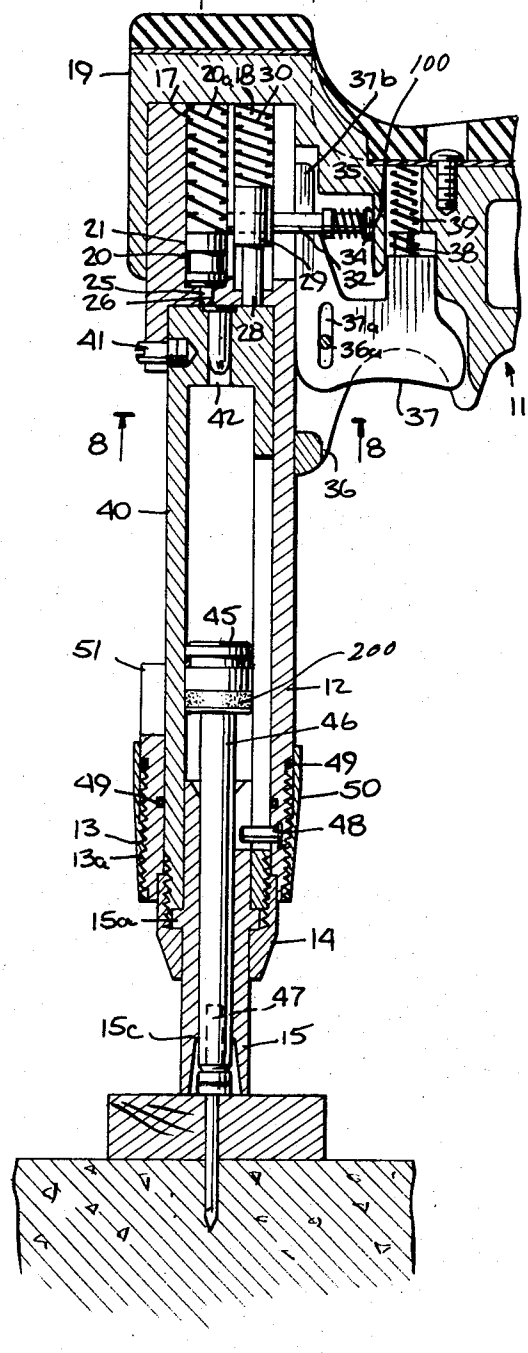


Fig. 7.



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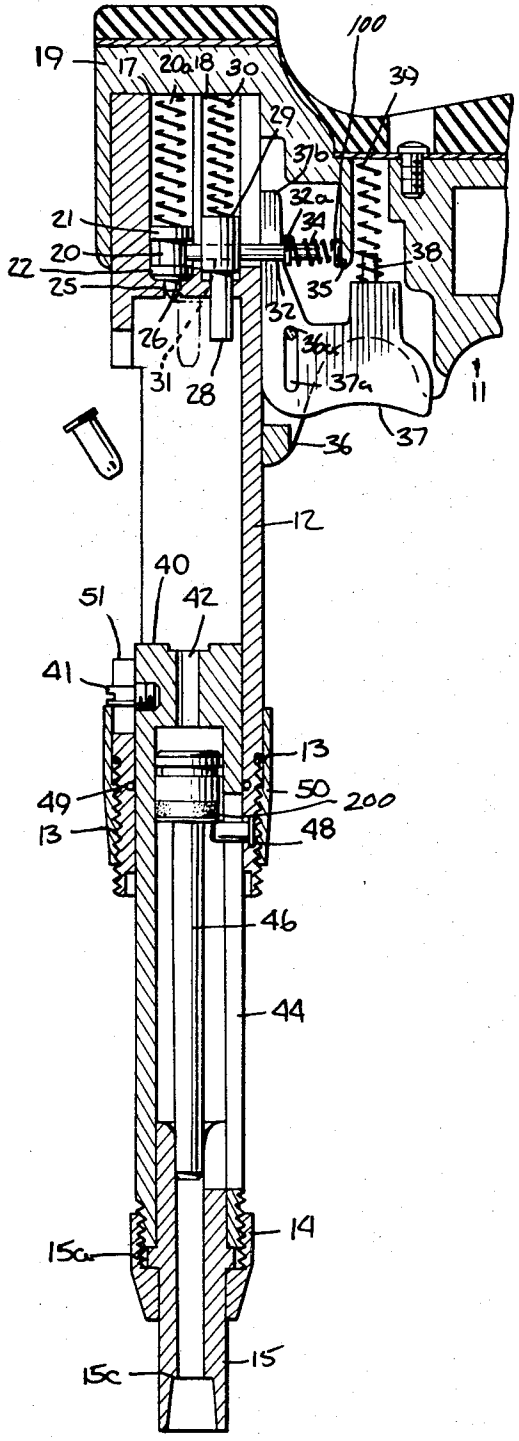

Fig. 11.

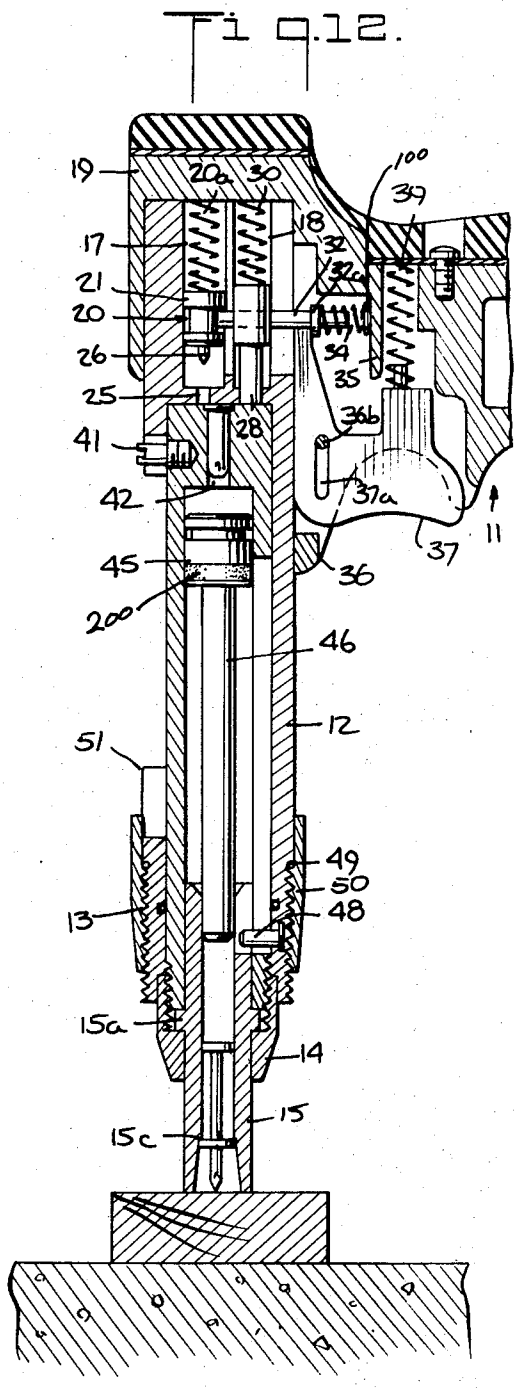

Fig. 12.

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POWDER ACTUATED TOOL

This invention relates to a powder actuated tool of the type utilizing an explosively actuated piston to drive fasteners into construction material. In particular, the present invention is for a powder actuated tool of the type herein described where the stroke of the piston and the explosive force imparted to the piston can be easily and simply varied and where the piston is designed to have a long service life.

It has been known in the prior art to use an explosive projectile to provide an actuating force for the piston of a powder actuated tool wherein the piston was used to impart force to a fastener such as a bolt or stud, etc. in order to drive the fastener into a material. In particular, it has been known to use such powder actuated tools in the construction trades where they have been used to drive nails and other fastening items into concrete and steel walls. Generally, this was done by using an explosive projectile to apply a force to one side of a piston having a piston rod and utilizing the free end of the piston rod to abut a nail or other fastener to drive a fastener into a construction material. While these prior art devices were generally successful in applying sufficient force for propelling the fastener through a material there were a number of disadvantages associated with these prior art tools which limited their use.

A first such disadvantage of these prior art powder tools was that it was extremely difficult in these tools to adjust the stroke of the piston and the amount of explosive force applied to the piston and hence the force applied to the fastener which the piston was to move. It is important to be able to control the force applied to the piston and hence the fastener which is moved thereby since if a sufficient amount of force is not applied to the fastener it will not be able to penetrate the material it is aimed at. Similarly if too much force is applied to the piston the fastener may crumble the material it is supposed to penetrate. One prior art device taught moving the piston rod relative to the piston to vary the stroke of the piston rod and the amount of force imparted to the fastener. Obviously, this was a time consuming and awkward technique.

A further disadvantage of prior art powder tools was that very often the free end of the piston rod which was used to supply an impact force to a fastener would fracture or otherwise fail after a relatively limited period of use. This required the use of a new piston rod after each such failure. This of course detracted from the value of the powder actuated tool since the replacing of the defective piston rod and piston with a new piston and piston rod was time consuming and expensive while otherwise slowing up the job for which the tool was being used.

It is thus apparent that if a powder actuated tool could be devised in which the force applied by the tool to a fastener could be varied so as to be able to efficiently drive a fastener into materials of different hardnesses it would find widespread use. If the powder actuated tool could also be designed so that the piston rod which is attached to the piston and used to supply an impact force to the fastening device would have a long service life and not fracture or otherwise fail after a limited number of uses it would add to the desirability of the tool.

It is therefore an object of the present invention to provide an improved powder tool of the type wherein an explosive projectile is utilized to provide the force for driving a fastener into a material.

A further object of the present invention is to provide an improved powder actuated tool of the type utilizing an explosive projectile to supply the force required to drive a fastener into a material wherein the force that is supplied by the explosive projectile to the fastener can be varied.

Another object of the present invention is to provide an improved powder actuated tool of the type utilizing an explosive projectile to provide the force required to drive a fastener wherein the length of travel of the fastener during which a positive force is applied to the fastener can be simply and accurately controlled.

Still another object of the present invention is to provide an explosively actuated powder tool that utilizes a driven member to drive a fastener wherein the driven member has a long service life and will not fail after a relatively limited number of uses.

Still a further object of the present invention is to provide an explosively actuated powder tool of the type herein described wherein the powder actuated tool will be economical to make, reliable in operation and simple to use.

Briefly, in accordance with the present invention, the foregoing and other objects are accomplished by a powder actuated tool having a barrel with a muzzle affixed to one end thereof. A firing mechanism is fixed relative to the barrel housing at one end of the barrel with a trigger provided to actuate the firing mechanism. The barrel is movable within the barrel housing and a piston having a piston rod extending through the muzzle is movable within the barrel. Stop means are located on the barrel and a guide pin is located on the barrel housing.

When it is desired to fire the tool a fastener is placed in the open end of the muzzle and a cartridge is placed in a cartridge receiving opening in the barrel. The tool is cocked by urging the muzzle against the material the fastener is to be projected into and as a result of this urging moving the barrel, and hence the piston along therewith, to the rear of the barrel housing so as to cock the firing mechanism in the tool. Upon actuation of the trigger the cartridge is exploded supplying an impact to the piston and piston rod forcing the fastener in the muzzle into the material the muzzle is pressed against. The barrel is then thrown open to extract the cartridge with the stop pin limiting movement of the barrel relative to the barrel housing by abutting a portion of the barrel housing. The guide pin in turn limits movement of the piston relative to the barrel.

An adjusting nut is located on the barrel housing and movable relative thereto for varying the travel of the barrel relative to the barrel housing when the cylinder is thrown open by changing the location of the barrel housing on which the stop pin abuts. By varying the movement of the cylinder relative to the barrel when the cylinder is opened the guide pin varies the position of the piston relative to the barrel as the barrel is opened since the piston moves with the barrel when it is opened. Due to the friction between the piston and barrel the piston does not move relative to the barrel as the barrel is moved in the barrel housing to cock the tool and thus the position of the piston in the cocked tool is determined by the adjusting nut setting.

The position of the piston in the barrel determines the force applied to the piston by the cartridge since the position of these two elements relative to each other determines the volume in which the explosive force directed to the piston is dispersed in. The larger this volume the greater the dissipation of this force and thus a corresponding decrease in the force applied to the piston and vice versa.

Other objects, aspects and feature of the present invention will be apparent from the following specification and drawings in which:

FIG. 1 is a side elevational view of a powder tool in accordance with the present invention with the tool in the breach closed position;

FIG. 2 is a top plan view of the tool illustrated in FIG. 1;

FIG. 3 is an exploded view which illustrates the portions of the barrel housing and barrel of the present invention that prevent the barrel housing and barrel from rotating relative to each other;

FIG. 4 is an opened side elevational view of the powder actuated tool of the present invention in a breach opened position with the cartridge that is used to actuate the tool being ejected from the open breech of the tool and the tool set to impart maximum force to a fastener;

FIG. 5 is an opened side elevational view of the tool of the present invention in a breech closed, fully loaded uncocked condition wherein the tool is set to impart maximum force to a fastener;

FIG. 6 is an opened side elevational view of the tool of the present invention as shown in FIG. 5 in a loaded breech closed cocked condition;

FIG. 7 is an opened side elevational view of the tool of the present invention illustrated in FIG. 6 subsequent to the cartridge therein being fired;

FIG. 8 is a view along lines 8—8 of FIG. 7 showing the geometrical relationship between the firing pin hole, the firing pin plunger hole and the receptacle for the cartridge ejector mechanism of the present invention;

FIG. 9 is an enlarged open view along lines 9—9 of FIG. 8 showing the ejector mechanism of the present invention with a cartridge in the tool and the barrel in a position to cock the firing pin;

FIG. 10 is an enlarged open view taken along lines 9—9 of FIG. 8 showing the ejector mechanism of the present invention ejecting a cartridge after it has been spent and while the barrel is being moved relative to the barrel housing;

FIG. 11 is an enlarged open view of the piston, barrel and barrel housing of the present invention with the barrel housing open and the tool set to impart less than the maximum force it is capable of imparting to a fastener; and

FIG. 12 is an enlarged open sectional view of the tool of the present invention as seen in FIG. 11 in a loaded barrel closed cocked condition.

Referring now to the drawings and FIG. 1 in particular wherein a powder tool **10** according to the present invention is seen to include a handle portion **11** and a barrel housing **12** rigidly secured thereto. Located about barrel housing **12** is a threaded adjusting nut **13** which, as will soon be apparent, serves to adjust the stroke length of the firing piston of tool **10** and the explosive force applied thereby. Located at the lowermost portion of the tool, as viewed in FIG. **1**, is a muzzle cap **14** and a muzzle **15**. Barrel housing **12** at its leftmost portion, as viewed in FIG. **1**, includes a U-shaped slot **16** with a series of marked indicating lines **17** located on the outer surface of the barrel housing (FIG. **2**) and to the left of slot **16**. A slotted extension **51** is located at the bottommost portion of slot **16**. The function of threaded adjusting nut **13** and indicating lines **17** in controlling the amount of explosive force imparted to a fastener which is to be driven by tool **10** and the length of travel of the fastener can be controlled extremely accurately by the cooperation of adjusting nut **13** and indicating lines **17** as will hereinafter be explained.

Referring now to FIG. **5** which is an opened side elevational view of the present invention where barrel housing **12** is seen to include at its uppermost portion firing pin chamber **17** and firing pin plunger chamber **18**. As can be seen from FIG. **5**, the firing pin chamber **17** is to the left of the firing pin plunger chamber **18** with tool **10** held in the position shown in this figure. A closure member **19** flanks the uppermost portion of barrel housing **12** as viewed in FIG. **5** and defines the uppermost extremity of firing pin chamber **17** and firing pin plunger chamber **18**, while breech block **24** defines the lowermost extremity of these chambers.

Firing pin chamber **17** is a circular chamber having a slot **17a** at its rightmost portion extending for the length of the chamber for a purpose soon to be explained. Housed within firing chamber **17** is a firing pin **20** which includes lands **21** and **22** separated by post **23** with the lands slideable within firing pin chamber **17**. A firing pin hole **25** is located in breech block **24** and a firing pin **26** projects from land **22** and is adapted to project through the firing pin hole when firing pin **20** is in the position illustrated in FIG. **5**. A spring **20***a* housed in firing pin chamber **17** biases the firing pin to the position seen in FIG. **5**.

Located in firing pin plunger chamber **18** is a firing plunger **29** which has a post **28** at its lowermost extremity as viewed in FIG. **5**. Post **28** is adapted to project through a firing post hole **27** in breech block **24** when the firing plunger is in the position shown in FIG. **5** under the bias of a spring **30** in firing plunger chamber **18**. Plunger **29** includes a sear pin hole **31** which is perpendicular to the major axis of the plunger. A slot **33** extends along the length of firing plunger chamber **18** and a sear pin **32** projects through slot **33**, sear pin hole **31** and slot **17***a* so that its free end rests between lands **21** and **22**. A flanged cam follower **32***a* is located in sear pin **32** with a spring **34** wrapped around the bottom of the sear pin and resting against flanged cam follower portion **32***a* thereof. The bottom of spring **34** rests against disc **100** which in turn rests on ledge **35**, the ledge being integral with closure member **19**.

A trigger mounting **36** is affixed to the right portion of barrel housing **12** and includes a post **36***a*. A trigger **37** includes a slot **37***a* through which post **36***a* projects with the left portion of the trigger flat and slideable along the right portion of barrel housing **12**. The upper most portion of trigger **37** includes a cam surface **37***b* which cooperates with flanged cam follower **32***a* in a manner to be hereinafter described. Trigger **37** includes a trigger spring post **38** with a spring **39** biasing the trigger in a downward direction as viewed in FIG. **5** so that post **36***a* is in the uppermost portion of slot **37***a*.

A barrel **40** is slidably positioned within barrel housing **12** and has attached thereto a stop pin **41** which projects through the slot **16** in the at the top of barrel housing **12**. The uppermost portion of barrel **40** includes a cartridge receiving opening **42** which is adapted to receive a blank firing cartridge. Cartridge receiving opening **42** extends to a piston chamber **43** which is located within cylinder **40**. The rightmost portion of cylinder **40** includes an opened slot **44** for a reason soon to be apparent. Located within the chamber **43** is a piston **45** having an elongated piston rod **46** attached thereto with a bumper guard **200** located on the piston rod adjacent the piston. The lowermost portion of elongated piston rod **46** includes a hollow impact port **47** which is an important aspect of the present invention. A guide pin **48** is rigidly secured to barrel housing **12** and projects through slot **44** so as to abut piston **45** when the piston moves downwardly as seen in FIG. **5**.

The lowermost portion of barrel **40** includes threads **40***a* which mesh with threads **14***a* on muzzle cap **14**. The adjusting nut **13** surrounds the lower portion of barrel housing **12** and is threadedly mounted thereto. Threaded portion **13a** of adjusting nut **13** is in mesh with the threads **50***a* on barrel housing **12** for a reason soon to be apparent. An O-ring **49** is located between adjusting nut **13** and barrel housing **12** as well as between barrel housing **12** and barrel **40**.

Muzzle **15** includes a flanged portion **15***a* which has a stop **15***b* on it (FIG. **3**) which is adapted to be recessed in a slot receiving opening **40***b* on the threaded portion of barrel **40**. By having stop **15***b* of muzzle **15** project into opening **40***b* on cylinder **40** relative rotation between the muzzle and cylinder is prevented. The lowermost portion of the interior of muzzle **15** as viewed in FIG. **5** includes a stop portion **15***c*, the purpose of which will soon be apparent.

As seen in FIGS. **9** and **10** an ejector mechanism is provided for ejecting a cartridge from the tool subsequent to the tool being fired when the breech is opened and the barrel is moved to the downwardly relative to the barrel housing. The ejector mechanism includes an ejector spring rod **53** which has a curled finger portion **53***a* at one end that projects into the uppermost interior of the enclosed volume defined by breech block **24** and the uppermost portion of barrel **40**. Ejector rod **53** is secured to an ejector collar **54** which is fixed within an ejector plunger cylinder **55**, the relation between ejector collar cylinder **55**, firing pin hole **25** and firing plunger hole **27** being readily apparent from FIG. **8**.

As can be seen in FIGS. **9** and **10** the upper rightmost portion of barrel **40** includes a cutaway chamfered slot **40***c*. The cross-section of cutaway slot **40***c* forms an acute angle with a line extending axially through the rightmost portion of barrel housing **12**.

In normal operation a fastener such as a nail, etc. will be placed in the open end of muzzle **15** with a flanged portion of the fastener resting on stop portion **15***c* of muzzle **15** and with another portion of the fastener projecting further into the muzzle. Barrel **40** will be moved downwardly in barrel housing **12** as viewed in FIG. **4** or to a breech open position by throw-

ing the barrel in a rapid downward motion until stop pin **41** abuts nut **50**. Guide pin **48** will limit the travel of piston **45** in barrel **40**. The spent cartridge in the barrel will be ejected as the breech is opened as hereinafter described. A blank cartridge is then placed in cartridge receiving opening **42** and the barrel is moved upwardly relative to barrel housing **12** until it is in the position seen in FIG. **5**. As there is a great deal of friction between piston **45** and barrel **40**, piston **45** will stay in the position seen in FIG. **4** relative to barrel **40** as the barrel is moved to the right relative to the barrel housing. Movement of barrel **40** upward relative to barrel housing **12** will cause ejector finger **53***a* to be moved by the rim of the cartridge thereby clamping the inside rim of the cartridge in cartridge receiving opening **42** in the manner illustrated in FIG. **9**. The free end of muzzle **15** is now urged against the surface into which the fastener is to be fired as illustrated in FIG. **6**. This causes the barrel to move in an abutting relationship with breech block **24** of barrel housing **12** pushing firing pin post **28** and firing pin plunger **29** to the right against the bias of spring **30** as illustrated in FIG. **6**. Movement of the firing pin plunger to the right in chamber **18** will move sear pin **32** and hence firing pin **20** upward and to the cocked position illustrated in FIG. **6**. At this point trigger **37** can be depressed causing cam follower **32***a* on sear pin **32** to slide along cam portion **37***b* of the trigger depressing the sear pin and removing it from between lands **21** and **22**. With the sear pin **32** no longer holding the firing pin in the cocked position spring **17** moves the firing pin to the position seen in FIG. **7** so that the firing pin will abut the rim of the cartridge in the cartridge receiving chamber and fire the cartridge. Piston **45** as a result of this moves downward in the barrel **40** driving the fastener member by the impact of the fastener with the ported end of piston rod **46** into the material against which the muzzle has been pressed against. By having the free end of piston rod **46** ported **47**, the weight of the piston rod is lessened at its impact end thus lessening the impact transmitted therefrom to the fastener and the impact felt by the piston rod. The port **47** at the free end of the piston rod also serves to trap air and control the velocity of the piston rod and with the lessened mass of the rod increase its service life. The bumper guard **200** also softens the impact of the piston or the muzzle.

Subsequent to the firing of the fastener the barrel is thrown downward in barrel housing **12** to the breech open position seen in FIG. **4** with the abutment of stop pin **41** after having moved between slotted extension **51** against adjusting nut **13** limiting this movement. The cartridge exhaust gases are vented through slot **44**. As the barrel is thrown open ejector finger **53***a* retains a sufficient grip on the rim of the firing cartridge so that the cartridge is ejected from the cartridge opening **42**. However, the momentum imparted to the cartridge by the movement of the barrel is sufficient to strip the cartridge from the barrel as illustrated in FIG. **4**. Throwing the barrel open also causes the piston to move downwardly with the barrel with movement of the piston in the downward direction being halted by the abutment between guide pin **48** and the piston.

If it is desired to fire the tool and have the piston receive less impact force and hence transmit less impact force to the fastener member than with the tool as previously operated, adjusting nut **13** is rotated so as to move upwardly along barrel housing **12**. Adjusting nut **13** can be precisely located along barrel housing **12** by moving it to a fixed location relative to guide lines **17**. By moving nut **13** towards the breech block **24** of barrel housing **12** subsequent to the tool being fired and before the barrel is opened stop pin **41** does not abut nut **13** at the same position relative to the barrel housing when the barrel is moved to open the breech as was the case when the nut was in its previous position. Stop pin **41** now abuts the edge of the nut **13** nearer to the breech block of the barrel housing (FIG. **11**) when the breech is opened. As a result of this piston **45** will not move to the uppermost portion of chamber **43** when the barrel is thrown open since the piston abuts guide pin **48** which is fixed relative to the barrel housing and does not move as the adjusting nut moves. The piston is now spaced the same distance from the uppermost portion of chamber **43** as the distance between the stop pin **41** and the lowermost portion of slotted extension **51**, as illustrated in FIG. **11**.

When the tool is cocked in the manner previously described piston **45** will maintain its position in barrel **40** as a result of the friction between the cylinder and piston and thus will not be in the uppermost portion of chamber **43** as viewed in FIG. **12**. By having the piston spaced a distance from cartridge receiving opening **42** the impact of the cartridge will not be as great on the piston since there is a greater volume in which this impact may be dissipated. Similarly, the piston will have a shorter stroke since it has already been advanced towards the fastener which is loaded in muzzle **15** and thus the impact force from the cartridge will act on the piston and hence the fastener for a shorter period of time.

The adjusting nut provides accurate control for varying the amount of the force applied to the piston and hence to the fastener. This is achieved in a simple manner thus overcoming one of the drawbacks of prior art powder activated tools.

We claim:

1. An improved powder actuated tool for driving a fastener into a body, the tool having a barrel having a bore opening extending substantially therethrough, one end of the barrel having a breech opening in communication with the one end of the bore adjacent thereto and adapted to receive a propellant device, the other end of the barrel having a muzzle opening terminating in the other end of the bore, the barrel having a slot extending along a portion of the length of the barrel intermediate the ends thereof and through the wall of the barrel to the bore; a barrel housing for slidingly supporting the barrel for movement along the length thereof, the barrel housing having a cavity therein disposed adjacent the line of travel of the breech opening of the barrel for providing access to the breach opening when the barrel is moved in a forward direction extending toward the muzzle opening to a loading and unloading position in which the end of the barrel having the breech opening is substantially clear of the cavity, when the barrel is moved in a rearward direction to a firing position the breech opening being closed by being adjacent to a wall portion of the cavity; and a piston disposed in the bore of the barrel, the forward portion of the piston being adapted to strike a fastener disposed in the bore of the barrel adjacent the muzzle opening when the piston is propelled during firing in a forward direction in the bore, the driving energy applied to the piston being an inverse function of the distance of the piston from the breech opening at the time of firing; the improvement comprising:

means extending through the slot in the barrel for stopping the forward travel of the piston at a predetermined stopping position relative to the housing when the piston is moved in a forward direction into engagement with the stopping means in response to frictional engagement of the piston with the barrel as the barrel is moved towards the loading and unloading position; and

means mounted on the housing between the breech opening of the housing and the forward end of the housing and movable in the forward and the rearward directions for adjustably limiting the sliding of the barrel in the forward direction to a forward extreme position, the limiting means engaging a member fixedly mounted on the barrel to limit the sliding of the barrel to the forward extreme position as the barrel is moved in the forward direction, thus causing the piston when in engagement with the stopping means to be placed in a predetermined position relative to the breech opening of the barrel, whereby the relative position of the piston to the breech opening can be selected to thereby control the driving force to be applied to the piston.

2. The improved powder actuated tool of claim **1** in which the piston stopping means comprises a piston stop pin mounted on the barrel housing and extending into the bore of the barrel through the slot therein for abutment with a portion

of the piston facing in the forward direction when the barrel is moved to the loading and unloading position.

3. The improved powder actuated tool of claim 2 in which the piston stop pin is mounted adjacent the muzzle end of the barrel housing.

4. The improved powder actuated tool of claim 1 in which the barrel limiting means comprises an adjusting nut threadedly mounted about the exterior surface of the barrel housing adjacent the forward end of the breech opening thereof for adjustable movement in the forward and the rearward directions in response to rotation thereof, the adjusting nut being adapted for a portion thereof facing in the rearward direction to abut the member fixedly mounted to the barrel when the barrel is moved to the loading and unloading position, thus limiting the forward movement of the barrel to the forward extreme position.

5. The improved powder actuated tool of claim 4 in which the member fixedly mounted to the barrel comprises a barrel stop pin mounted to the barrel adjacent the breech opening end thereof, the barrel stop pin extending through the cavity in the barrel housing for abutment with the rearward facing portion of the adjusting nut when the barrel is moved to the loading and unloading position, thereby adjustably limiting the sliding of the barrel in the forward direction.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,652,003 Dated March 28, 1972

Inventor(s) Ignazio Leonardo and Harold C. Pfeiffer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 37, "cylinder" should be -- barrel --.

Column 2, line 39, "cylinder" should be -- barrel --.

Column 2, line 40, after "barrel" insert -- housing --.

Column 2, line 40, "cylinder" should be -- barrel --.

Column 3, line 38, "left" should be -- bottom --.

Column 4, line 22, insert -- U-shaped -- before "slot".

Column 4, line 26, "cylinder" should be -- barrel --.

Column 4, line 48, "cylinder" should be -- barrel --, in both instances.

Column 4, line 56, delete "to the" (first occurrence).

Column 6, line 7, "cylinder" should be -- barrel --.

Signed and sealed this 28th day of November 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR. — Attesting Officer

ROBERT GOTTSCHALK — Commissioner of Patents

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