United States Patent

Saari

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[54] POWER DEVICE

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[52] **U.S. Cl.** **60/51,** 277/58, 277/177, 92/86, 92/192

[51] **Int. Cl.** **F15b 3/00**

[58] **Field of Search** 60/51; 92/86, 192; 277/58, 277/177; 227/130

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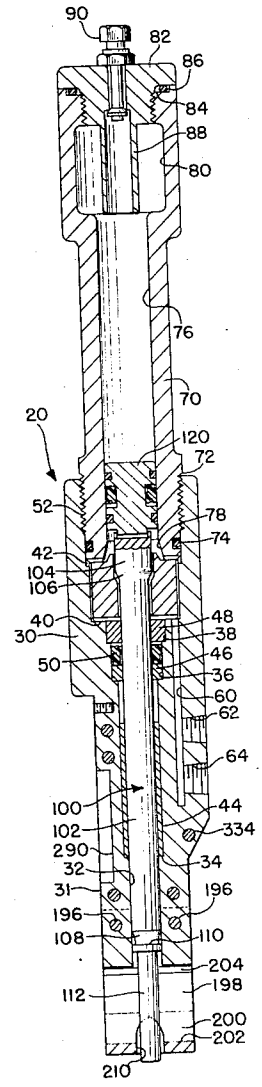
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[57] **ABSTRACT**

A power device having a power reservoir in which a compressible fluid is maintained under pressure, an accumulator piston and a drive piston which are simultaneously movable to retracted or cocked positions by the introduction of a non-compressible power fluid into a cylinder in which the pistons are reciprocably movable, the power fluid acting on exposed areas of the drive piston to move it with the accumulator piston until it reaches its fully cocked position whereupon further movement of the accumulator piston exposes additional areas of the drive piston to the pressure of the power fluid whereby the compressible fluid, acting through the power fluid, imparts drive movement to the drive piston and multiple seal means on said accumulator piston, reservoir means in said accumulator piston to trap any power fluid which has by-passed one of said seals to thereby avoid intermixing of said compressible and non-compressible fluids.

5 Claims, 14 Drawing Figures



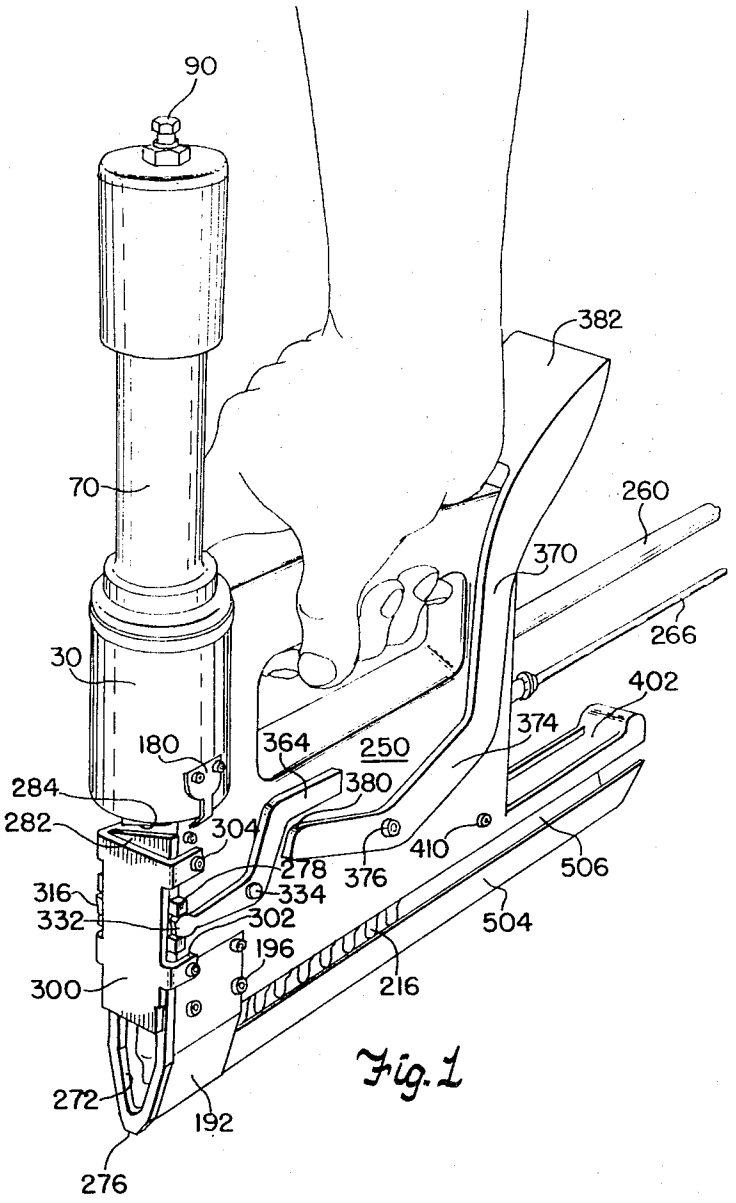


Fig. 1

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Fig. 2

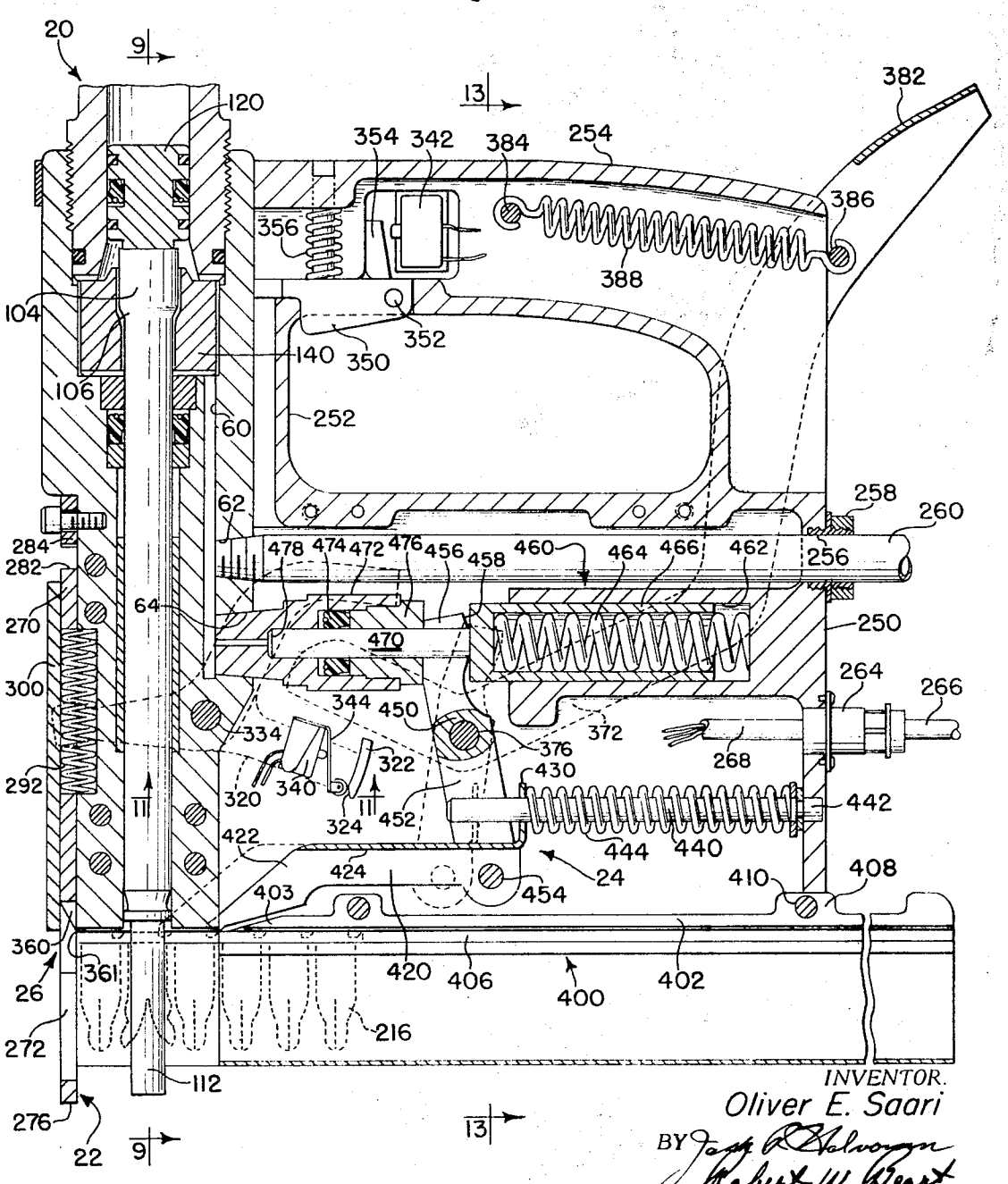

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Fig. 3

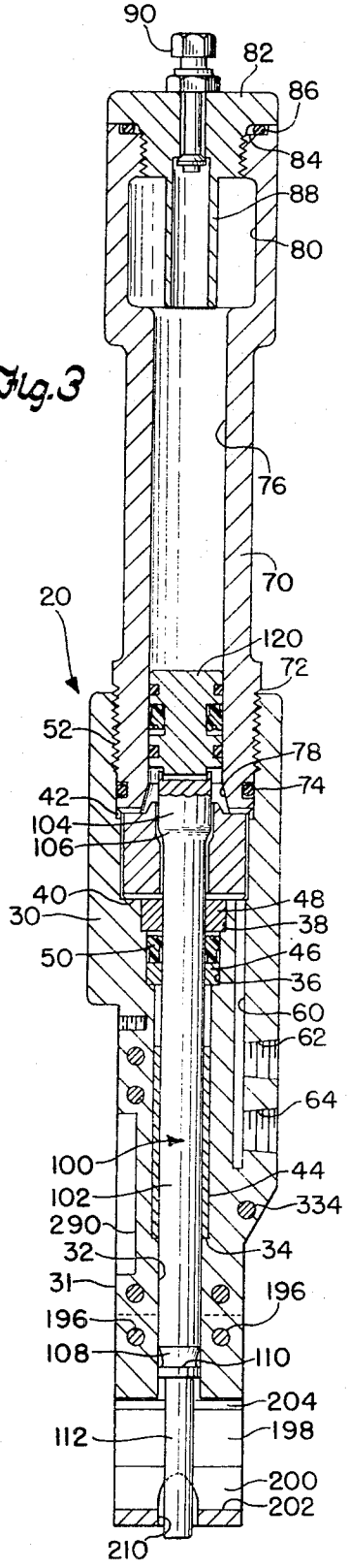


Fig. 4

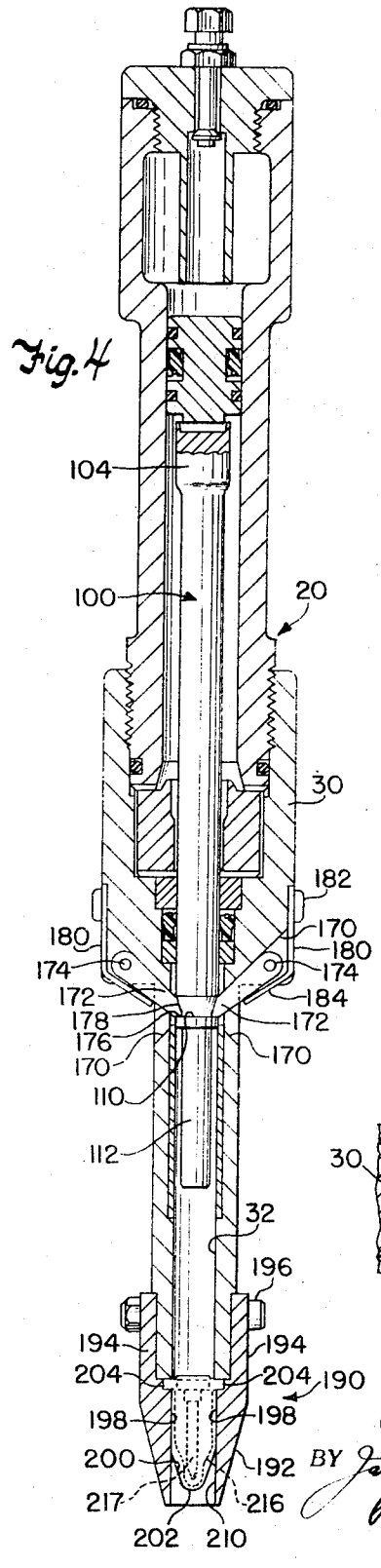


Fig. 12

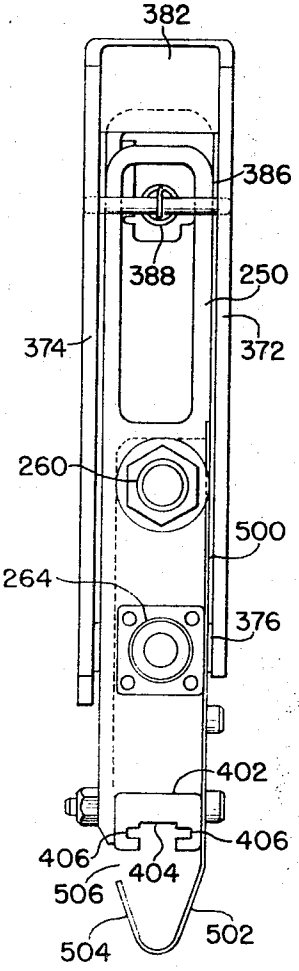
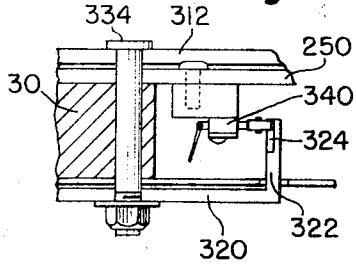


Fig. 11



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Fig.5

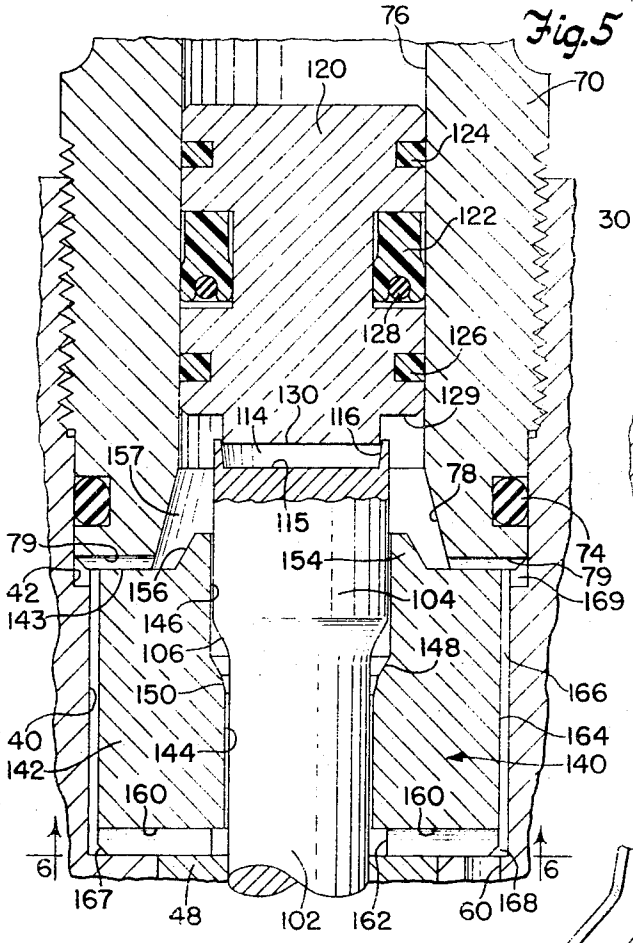


Fig.6

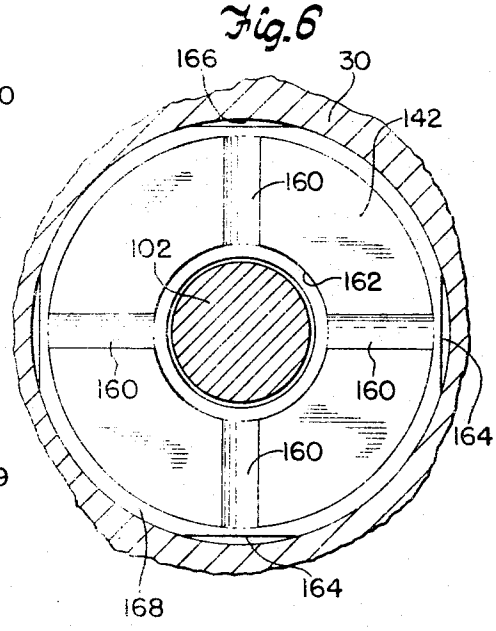


Fig.10

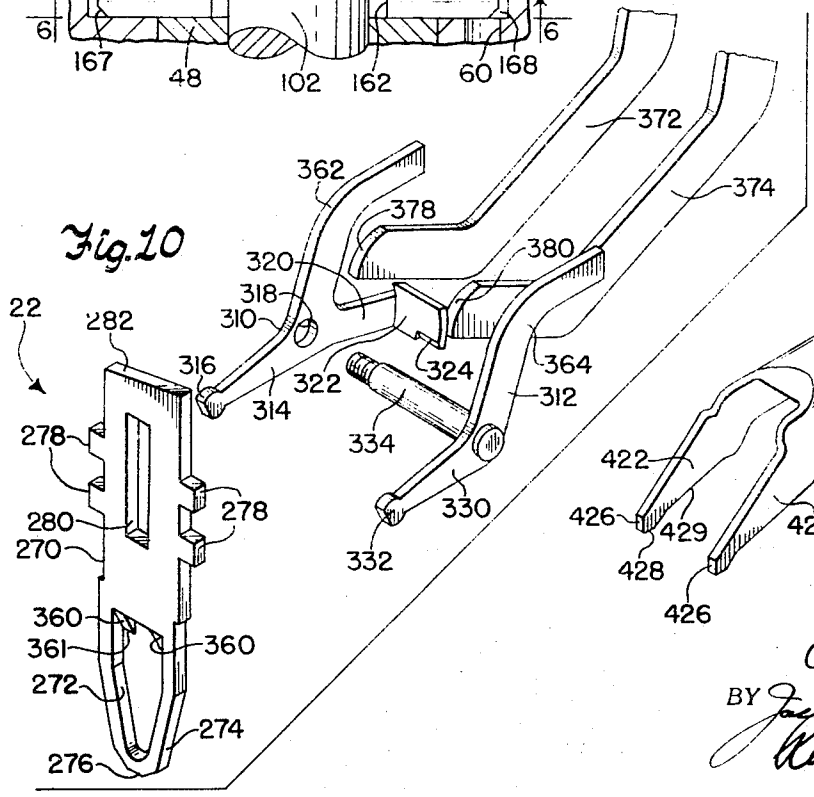
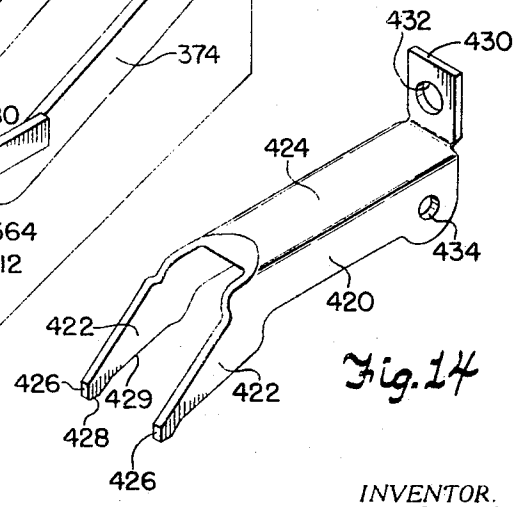


Fig.14



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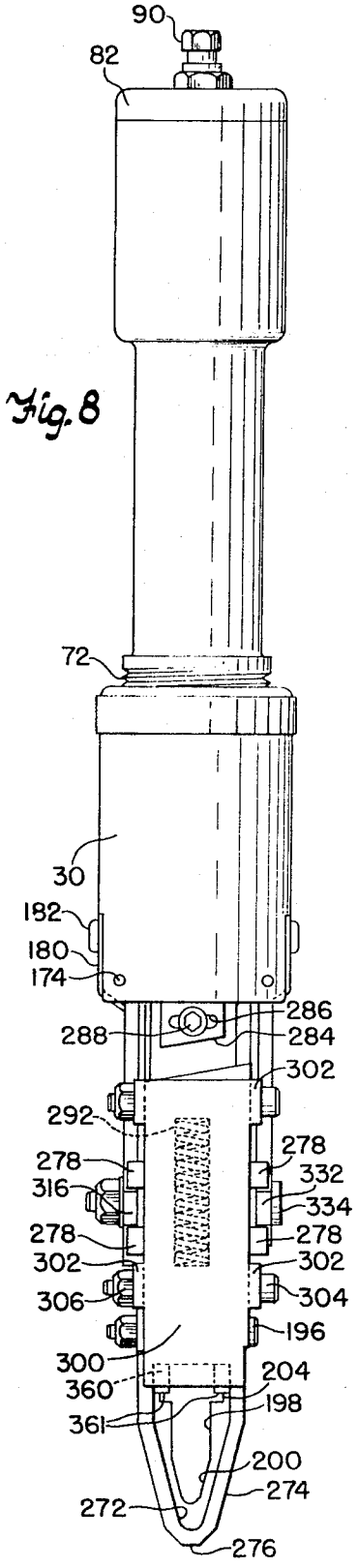


Fig. 8

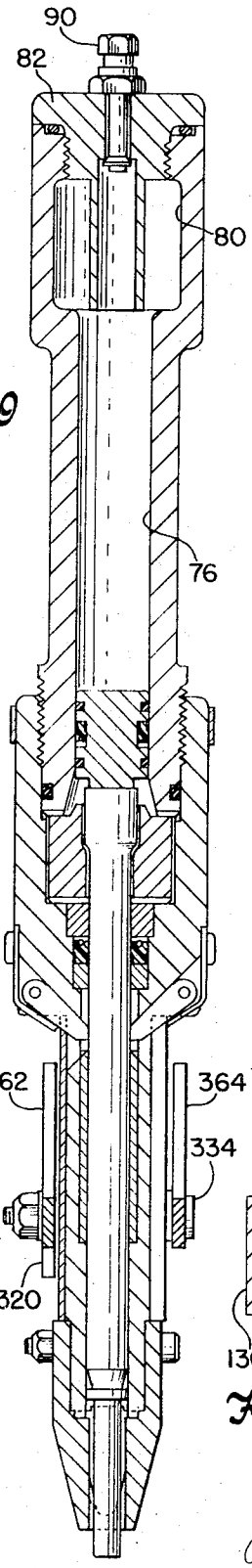
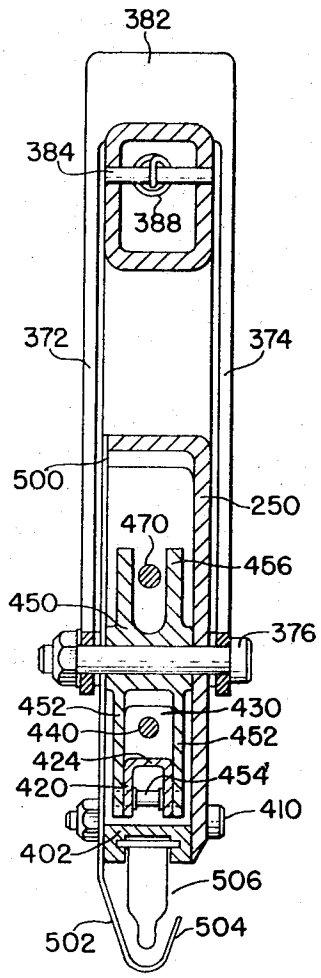


Fig. 9

Fig. 13



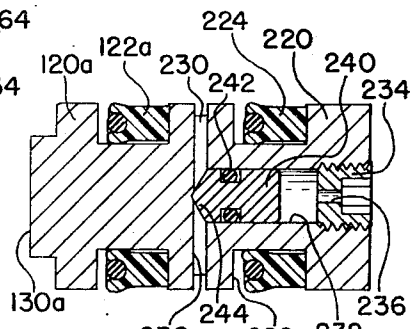


Fig. 7

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POWER DEVICE

BACKGROUND OF THE INVENTION

The prior art which is best represented by the patent to Emmett L. Haley, U.S. Pat. No. 3,150,488, generally discloses a power device utilizing a compressible fluid in a power reservoir under pressure and an accumulator piston and a drive piston which are simultaneously moved to retracted or cocked positions by the introduction of a noncompressible power fluid into a cylinder in which the pistons are reciprocably movable, whereby the pistons, and particularly the accumulator piston, is moved against the compressible fluid to compress same and provide energy for the driving of the drive piston at a predetermined time. One of the more vexing problems in the operation of such a device, is the sliding seal on the accumulator piston. Under certain circumstances, the non-compressible power fluid, which is under high pressure, tends to by-pass the sliding seal and to enter the portion of the cylinder accommodating the compressible fluid. Under these circumstances, the non-compressible power fluid is atomized within the compressible fluid and tends to create an undesirable situation due to the contamination.

SUMMARY

This invention relates to a power device having a power reservoir in which a compressible fluid is maintained under pressure, an accumulator piston and a drive piston which are simultaneously movable to retracted or cocked positions by the introduction of a non-compressible power fluid into a cylinder in which the pistons are reciprocably movable, the power fluid acting on exposed areas of the drive piston to move it with the accumulator piston until it reaches its fully cocked position, whereupon further movement of the accumulator piston exposes additional areas of the drive piston to the pressure of the power fluid, joined with the compressible fluid acting through the power fluid as a linkage mechanism, imparts drive movement to the drive piston.

More specifically, the invention relates to an accumulator piston having multiple seal means for sliding engagement with the cylinder. Further, the accumulator piston of this invention, has a centrally disposed reservoir means which communicates with the periphery of the accumulator piston intermediate the multiple seals to trap any power fluid which has by-passed the seal closest to the non-compressible power fluid.

Additionally, the reservoir includes a free floating piston having one end exposed to the compressible power fluid whereby removal of the pressure on the non-compressible power fluid permits the compressible power fluid to act on said free floating piston to evacuate the reservoir and to force the non-compressible fluid back past the seal into the cylinder. Further advantages will be apparent when the specification is read in conjunction with the drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a preferred embodiment of the invention showing it being gripped by an operator;

FIG. **2** is a side elevation in partial section of the preferred embodiment of the invention;

FIG. **3** is a side elevation in partial section of the power unit used by the invention with the power drive piston in extended position;

FIG. **4** is a front elevation in partial section of the power unit shown in FIG. **3** with the power drive piston in retracted position;

FIG. **5** is an enlarged partial section of the accumulator piston, the upper end of the power drive piston, and the brake of the device shown in FIGS. **2–4**;

FIG. **6** is a partial bottom end view in section taken along line **6—6** of FIG. **5**;

FIG. **7** is a side elevational view of a second embodiment of the accumulator piston;

FIG. **8** is a front elevational view of the device shown in FIG. **1**;

FIG. **9** is a front elevational view in partial section similar to the view in FIG. **4** but with the power drive piston in extended position and having the cut-off mechanism mounted on the side thereof, taken along line **9—9** of FIG. **2**;

FIG. **10** is an expanded perspective view of the elements of the control and cut-off mechanism;

FIG. **11** is partial sectional view, from the bottom of the invention as viewed in the drawings along line **11—11**, showing a portion of the control means of FIG. **10** in operative relationship to the switch means being controlled;

FIG. **12** is an end view of the device shown in FIG. **2** as viewed from the righthand end of that drawing;

FIG. **13** is a partial sectional view taken along the line **13—13** in FIG. **2**; and

FIG. **14** is a perspective of the feeder finger means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein similar parts are designated by similar numerals, the invention contemplates a new and improved portable power tool with a cylinder body forming a power unit including a reservoir in which a compressible fluid is maintained under pressure. An accumulator piston and a drive piston positioned in said cylinder are simultaneously movable to retracted or cocked positions by the introduction of a non-compressible power fluid into the cylinder in which the pistons are reciprocably movable with the power fluid acting on exposed areas of the drive piston to move it with the accumulator piston until the drive piston reaches its fully cocked position whereupon further movement of the accumulator piston exposes additional areas of the drive piston to pressure of the power fluid. At this point the compressible fluid acting through the accumulator piston upon the power fluid in the cylinder imparts drive movement to the drive piston. The device is fully operable only when it is properly positioned with respect to a workpiece or structure. The tool has means for deactuating a pump used to supply the non-compressible power fluid, before the drive piston reaches its fully cocked position, if the power device is not so properly positioned. The drive piston and the body cylinder include cooperable means for slowing or braking the movement of the drive piston as it approaches its fully extended position to minimize shocks to the body particularly when the power of the drive piston is not utilized for driving an object, such as a fastener, but rather is actuated in free flight. An automatic recycling feed means is provided which is sequentially operated during each operation of the power device. The feed means generally acts upon a collated strip of devices which are to be sequentially acted upon by the power device. Further, there is provided a cut-off mechanism for eliminating portions of the collating means used for holding the devices to be acted upon by the tool.

Thus, the device generally includes the power device **20** having a combined mechanical-electrical control means **22**, a feed means **24**, and a cut-off mechanism **26**.

POWER SOURCE

The power device **20** includes a stepped body portion **30** having a central pass-through bore **32** of a predetermined diameter. The bore **32** is provided with a plurality of counterbores **34**, **36**, **38**, **40** and **42** which are each progressively larger diameters for ease in assembly of various items coaxially within the bore. Counterbore **34** accepts a metallic sleeve bearing **44** while counterbores **36** and **38** accept bearings **46** and **48** respectively with a sealing member **50** being sandwiched between the two bearings and restrained thereby against axial movement. Radially offset in body **30** from the central bore **32** is an axially extending fluid passageway **60** communicating with the lower extremity of counterbore **40**, as viewed in FIGS. **2** and **3**, and having a pair of lateral ports **62** and **64**, for purposes best set forth hereinafter.

A cylinder **70** provided at one end with an external threaded portion **72** is threaded into counterbore **42** with its mating

threads 52. The cylinder 70, adjacent said one end, has an annular recess adapted to accept an O-ring sealing member 74 for sealing engagement with an unthreaded portion of the side wall of counterbore 42. The cylinder 70 has a bore 76 including a taper 78 at its lower extremity, adjacent said one end, and an enlarged cavity at its opposite or upper extremity forming a chamber 80. The upper end of the chamber 80 is threadedly apertured to accept a mating threaded cap 82 and further includes a recess 84 for acceptance of an O-ring seal 86 which is compressibly captured between the flange of cap 82 and the end wall portion of chamber 80. The cap 82 is centrally apertured and provided with a cylindrical extension 88 which is tubular in form and extends into the chamber 80 for a substantial portion of the axial extent of chamber 80. A valve means 90 is positioned within the bore of the cap 82 and communicates with chamber 80 for purposes best set forth hereinafter.

Positioned within the bore 32 is the power drive piston 100 which includes a preferably cylindrical central portion 102 and enlarged upper end portion 104, cylindrical in form and connected to the central portion 102 by an upwardly and outwardly tapering portion 106. At the opposite end of central portion 102, the drive piston is provided with a groove 108 forming a shoulder 110 which faces towards the enlarged end portion. The balance of the lower end of the drive piston 100, in the illustrated embodiment, is a generally reduced cylindrical portion or hammer 112 smaller in diameter than the bore 32 and preferably hardened to serve as the hammer or power impacting portion of the drive piston. The bearing members 44, 46, and 48 are so dimensioned relation to the central portion 102 of the drive piston 100 as to laterally support the device during its axial movement within the bore 32 and into retracted position within cylinder 76. The seal 50 provides a sliding seal which prevents egress of fluids around piston 100 between bore 32 and cylinder 76.

The upper end surface of the enlarged end portion 104 of piston 100 is recessed to form an open end chamber 114 having a bottom wall 115 and side walls 116 which are frustoconical in configuration and have their widest diameter at the free or open end of the chamber.

Positioned within the cylinder bore 76 is a free floating accumulator piston 120 having annular recesses intermediate its extremities to accept the seal 122 and lateral circumferentially disposed bearing means 124 and 126. The seal 122 is preferably a lip seal for sliding engagement with the bore 76 and may be manufactured of urethane. Due to the physical properties of urethane the lip seal 122 is reinforced by a buna-*n* O-ring 128 to provide additional lateral stability to the lip seal 122. Stability of the accumulator piston 120 within cylinder 76 is enhanced by the bearings 124–126 which preferably are of the self-lubricating variety. They may be fabricated from a lubricious plastic material such as those commonly sold under the tradenames of "nylon" or "teflon". A cylindrical projection 130 extends from the lower end of the accumulator piston 120 and is so dimensioned as to be accepted within the frustoconical wall configuration 116 of the open end chamber 114 located in the enlarged head or end portion 104 of the drive piston 100. The juncture between the extension 130 and the side wall 116 intermediate the axial extremities of wall 116 forms an effective seal and yet permits axial separation between the members under specific conditions which will be set forth hereinafter.

Located complimentarily within counterbore 40 and surrounding the drive piston 100 is brake mechanism 140 which includes a body 142 having a central throughbore 144 with a complimentary shape slightly larger by a few thousanths of an inch than the central portion 102 of piston 100, this difference in size being overaccentuated in the drawing for clarity of illustration. An enlarged counterbore 146 is joined to the bore 144 by two frustoconical wall portions 148 and 150 each having a different included angle, portion 148 having an angle of approximately 30° measured relative to the axis of bore 144, while portion 150 has an angle of approximately 15° measured relative to the axis of bore 144. The counterbore 146 is extended axially beyond the one extremity of body 142 by means of the flange 154 which has an outer frustoconical wall 156, having an included angle slightly greater than taper 78 to provide an upwardly opening throat 157, as viewed in FIG. 5, between the facing surfaces of the two members. The opposite extremity of body 142 as best seen in FIG. 6, is provided with a plurality of grooves 160 which extend radially from an annular counterbore 162 forming a recess around the drive piston central portion 102 when positioned within bore 144. The side wall of the body 142 is provided with a plurality of flats 164 which each form a recess 166 extending axially between the brake body 142 and the counterbore 40 of main body portion 30. The end of the side wall adjacent grooves 160 is chamfered as at 167 to form an annular chamber 168 between the brake 140 and the bottom wall of the counterbore 40, while the same time, providing communication between the axial chambers 166 formed by the flats 164 and the grooves 160. The axial extent of brake body 142 is slightly greater than the axial extent of counterbore 40, whereby the body 142 extends into counterbore 42 forming an annular cavity 169. The lower extremity of cylinder 70 when screwed in tightly bears against the upper wall 143 of brake body 142. Cylinder 70 further is provided at its free end with a plurality of grooves 79 which are generally radially extending and communicate with cavity 169. Thus, free access is provided for fluids introduced through bore 60 to the chamber 168 for passage either through grooves 160 and counterbore 162 thence upwardly between piston 100 and bore 144, into contact with the undersurface of portion 106 or, from chamber 168 through axial recess 166 into chamber 169 and thence through grooves 79 and throat 157 into contact with the exposed undersurface area 129 of accumulator piston 120, as will be further discussed hereinafter.

Intermediate the extremities of the body 30, a pair of oppositely disposed slots 170 communicate between the exterior and the bore 32. In the preferred embodiment, the body 30 has an enlarged upper section and a reduced lower portion and the slots 170 are generally positioned at the juncture between these two sections. Positioned within slots 170 are a pair of fingers 172 each being rotated at one end on a pin 174 mounted in the enlarged upper section. Each finger 172 has an abrupt shoulder 176 at its opposite extremity. Adjacent to shoulder 176 is a sliding or cam surface 178 adapted to ride on the central portion 102 of the piston 100 and with the abrupt shoulder 176 adapted to cooperate with the shoulder 110 of the drive piston 100. A leaf spring 180 is fastened by a rivet or screw 182 at one end and at its opposite or free end 184 bears against each of the fingers 172 to serve as a biasing means to urge the fingers 172 into engagement with the piston and its associated shoulder 110. The fingers 172 effectively control the upper limit of travel of the piston 100 while permitting free movement of the piston to an extended or lower position, as viewed in the drawings. It will be apparent that other means such as spring loaded balls or plungers that can be hydraulically or spring actuated will operate effectively as a stop means.

At the free end of the body 30 adjacent bore 32, there is provided a nose piece 190, having a tapered lower portion 192 adapted to permit entry of the tool into confined spaces. The upper portion of nose piece 190 is defined by a pair of flanges 194 which are apertured for acceptance of a pair of bolts 196 for fastening of the nose piece in embracing relation to the body 30. The interior of the nose piece in is further defined by a fore and aft passageway having a pair of opposed vertical sidewalls 198 and lower inwardly tapering portions 200 which meet in a radiused section 202 on the vertical axis of the nosepiece. At the upper end of the passageway defined by walls 198 a track means is positioned and defined by oppositely extending grooves 204, while centrally of the noisepiece 190 there is located a vertical bore 210 which traverses the fore and aft passageway. This particular nosepiece was designed to accept a collated strip 216 of fasteners 217 shown

in phantom in which the collating means **216** includes individual plastic elements or holders having laterally extending head means adapted to ride in track **204** and a body portion adapted to position a fastener **217** held by the collating means in coaxial position with the drive piston within the bore **210**. The bore **210** has a dimension sufficiently large to accept the hammer portion **112** of the drive piston **100** plus the material thickness of the collating means.

In the operation of this power source several physical relationships must be kept in mind. The area of the face or surface **115** of the piston head, defined by the frustoconical wall **116**, is greater than the cross-sectional area of the drive piston **100** at the seal **50** so that when the sidewall **116** seals between the projection **130** on the accumulator piston and the drive piston head, any fluid pressure which is exerted on the drive piston tends to move the piston head toward the accumulator piston and hold it in tight engagement therewith. Accordingly, fluid pressure introduced through port **62** into the bore **60** of the body and thence through the chamber **168**, grooves **160** and bore **144**, when the accumulator piston and the drive piston are in the position illustrated in FIGS. **2**, **3**, **5** and **9**, will tend to force the drive piston head into engagement with the accumulator piston **120** and tend to move the drive piston **100** upwardly as seen in these figures.

Compressed gas is introduced into the power accumulator or compressed gas chamber **80** through valve **90**. It will be apparent that when the chamber **80** is charged with a gas under pressure, the accumulator piston **100** will be forced downwardly, as seen in FIG. **3**, to tend to hold the drive piston in the position illustrated in FIG. **3**, and with the projection **130** moved into sealing relationship with the frustoconical sidewall **116**. The compressed gas charge that is introduced through valve **90** normally has a pressure of approximately 2,000 p.s.i. A suitable gas for use in a device of this type is nitrogen, although other forms of non-explosive, compressible gases can be used with equal facility.

To cause the operation of the power source to perform some work, such as the driving of a nail, a non-compressible fluid is introduced from a reservoir by a pump, neither of which are shown, but which are well known in the art, through the port **62** into the bore **60** and thence through the various passageways into the clearance between bore **144** in the central body portion **102** of the drive piston **100**, into engagement with the undersurface **106** of the head **104** of the drive piston. As the power fluid is pumped into the main bore, it causes the accumulator piston **120** and the drive piston **100** to be moved upwardly as seen in FIG. **3**. The drive piston is caused to moved upwardly with the accumulator piston since, as was explained above, the area of the surface **115**, as well as the area of the tapered portion **106** of head **104** is greater than the cross-sectional area of the piston **100** at the seal **50** so that the fluid pressure acting on the drive piston tends to force the drive piston toward the accumulator piston. Continued introduction of the power fluid to the bore forces the accumulator piston **120** and the drive piston **100** to move upwardly toward the fully retracted positions thereof illustrated in FIG. **4** against the force exerted by the compressed gas in the power accumulator or chamber **80**. The drive piston and the accumulator move upwardly until the fingers **172** bring their associated shoulders **176** into engagement with the shoulder **110** on the drive piston **100**. At this time, the drive piston is in its fully retracted or cocked position. The accumulator piston, however, is free to continue such movement as the pumping of the power fluid continues. Such separation, as seen in FIG. **4**, separates the seal between the projection **130** and the sidewalls **116**. Once this seal is broken, the pressure of the power fluid is now exerted across the whole cross-sectional area of the face **115** of the drive piston head **104** and as a result, the drive piston is now moved forcibly and with great velocity downwardly due to the force exerted by the compressed gas of the power fluid in the main bore of the cylinder **76**. Since the power fluid is non-compressible, it serves as a linkage or transfer means for the force being exerted by the compressed gas through the power fluid against the head **104** of the drive piston **100**. The accumulator moves behind and follows the drive piston but since it extends across the full cross-sectional area of the bore of the cylinder, it moves at a slower speed than the drive piston. Such rapid movement of the drive piston, of course, drives the nail or other fastener into the workpiece or structure.

The frustoconical portion **106** at the undersurface of head **104**, is disposed at an angle of approximately 30° to the vertical axis of the piston **100**. This frustoconical shape of the head **104**, causes the head to tend to trap power fluid in the reduced annular shape of bore **146** and thence against the double frustoconical counterbore **148–150**. Additionally, as the head progresses down the cylinder **76**, the power fluid tends to be forced outwardly through the throat **157** and the associated passageways communicating therewith. As a result, the entrapment of the power fluid between frustoconical face **106** and the reduced bore **146** and its associated counterbores **148–150**, slows down the drive piston as it approaches the end of its power stroke and cushions the shock of the engagement between the head **104** and the brake **140**. The accumulator piston **120** is now spaced from the drive piston head due to the presence of the additional power fluid which has been pumped into the cylinder **76**. The pump, of course, may continue to pump during the working or driving stroke of the drive piston, but the movement of the drive piston is primarily due to the force exerted by the compressed gas in the chamber **80** which is transmitted through the accumulator piston to the power fluid, acting as a linkage, against the surface **115**.

The power fluid in front of the accumulator piston is now forced by the pressure of the compressed gas in the chamber **80** and the cylinder **76**, to move backwardly through the various passages into the bore **60** and out the port **62** into the reservoir, not shown. As a result, the accumulator piston moves downwardly until its extension **130** once again engages the wall **116** of the drive piston head and again provides a seal between the head **104** and the accumulator piston **120**. The power source is then again in condition for another cycle of operation.

It will now be apparent that the power source illustrated and described performs work due to the expansion of the compressed gas in the power accumulator or gas chamber **80** and cylinder **76**. The pressure of the gas introduced into the gas chamber **80** may be initially of a relatively large value, say 2,000 per square inch, and with the further compression of the gas in the chamber **80**, due to the movement of the accumulator piston **120** in the cylinder **76** by the non-compressible power fluid, causes it to attain a pressure of a still higher value, say 4,000 pounds per square inch, while the power fluid will reach 6,000 p.s.i. at the time of separation between the power piston and the accumulator piston. Thus, the energy stored in the compressed gas is employed to drive the piston, using the power fluid as a linkage between the accumulator piston and the drive piston, and thus perform such functions as the driving of a fastener into a workpiece. Normally, the volume of the drive piston in its axial movement of approximately four inches is equal to the volume of the accumulator piston in its movement of 1–1 ½ inches during the power stroke. The power fluid is virtually non-compressible and has approximately the same displacement. It should be noted that the extension **88** of the cap **82** serves as a safety device to prevent movement of the accumulator piston **120** out of the cylinder bore **76** into the power accumulator or gas chamber **80**. Thus, the piston **120** is maintained in its oriented position within the cylinder **76**, as well as preventing over-compression of the gas within the chamber **80** by providing a stop to the axial movement of the piston **120** after separation from piston **100** when it contacts the lower extremity of the tube **88**.

It has been found occasionally that the seal **122** under the pressures developed, permits passage of the power fluid into cylinder **76** and comingles it with the compressed gas. Due to the heat generated in the compression of the gas, the power fluid is atomized and can produce an undesirable condition.

To this end, a second embodiment of the accumulator piston is shown in FIG. 7, wherein similar parts are designated by similar numerals with the addition of the suffix "*a*". This embodiment includes virtually a one piece double piston, including portion **120***a* having a single seal **122***a*, and the forward projection **130***a* adapted to seal with the cavity in the end of head **104** in the same fashion as the first embodiment. This embodiment includes an extension **220** provided with a circumferential cavity **222** for acceptance of a second seal **224**. At the juncture between extension **220** and the basic portion **120***a*, there is provided a plurality of transverse passageways **230** which communicate between the periphery of the piston and a central bore **232** which opens through the opposite end of extension **220**. The open end of bore **232** is closed by a threaded plug **234** having a central pass-through bore **236** providing limited ingress and egress to the bore **232**. Positioned within bore **232** is a free floating piston **240** having an annular groove adapted to accept an O-ring seal **242**. The free end **244** of piston **240** is conically shaped and adapted to intersect and close the passageways **230** communicating with the periphery of the embodiment. In the operation of this device in the environment previously described, it will be appreciated that the compressed gases from chamber **80** will pass through the bore **236** and act upon the end of the piston **240** to maintain it in the seated position shown in FIG. 7. In the event that the power fluid should by-pass seal **122***a*, it will seek the passageway **230** and act against the relatively small diameter piston **240** to move the piston to the right, as viewed in FIG. 7, against the compressed gas and to form a reservoir within the bore **232**. The relative cross-sectional areas of piston **240** and seal **224**, are such that the piston will be acted upon more readily by the power fluid than the seal and thus the power fluid will be prevented from passing into the cylinder **76** and chamber **80** to comingle and atomize with the compressed gas.

The power source previously described is fitted in the illustrated embodiment to a body shell **250** having a central aperture **252** defining a hand grip portion **254**. A rear aperture **256** is adapted to accept appropriate fittings **258** for the acceptance and mounting of tubular means **260** carrying the power fluid from its reservoir and supply pump, not shown, to the port **62**. Also positioned in casing **250** at its rear or righthand end, as viewed in FIG. 2, are terminal means **264** for providing electrical access to the control cable **266** on the exterior and internal wiring **268** on the interior of the casing for control of the external pump and its supply of power fluid to the power source. Other details of the casings in body **250** will be described hereinafter with reference to the specific features being described.

CONTROL MEANS

In the operation of power source, it is necessary to provide mechanical detection means which will insure that the tool is in the proper position for operation prior to the power stroke by the piston. Additionally, control means are provided which are interconnected electrically with the mechanical detection means for purposes of remotely controlling the pump and reservoir which are located at a distance from the power tool. Further, means must be provided for controlling the position of the extreme end of the hammer portion **112** relative to the workpiece since the extended position of the hammer extremity is a definite physical relationship relative to the lower end of the nosepiece upon the completion of the power stroke and the extension of the power piston **100** internally of the body.

As best seen in FIGS. **1**, **2**, **3**, **8** and **10**, there is provided a flat front face **31** on the lower portion of body **30**, adapted to accept a detector blade **270** in sliding superposed relationship thereto. Detector blade **270** is basically a rigid, flat structure having a lower cutout portion **272** at one end which is greater than and generally complimentary in cross-sectional configuration to the passage through the nosepiece defined by walls **198** and **200**. The exterior edge surface at said one end of plate **270** forms a nose or reduced section **274** generally complimentary to the sloping wall **192** of the nosepiece and terminating in a flat surface **276** at its free extremity for contact with the work surface. A pair of lugs or dogs **278** extend laterally from opposite side edges of the blade **270** intermediate their extremities. An aperture **280**, generally rectangular in shape, is positioned centrally and intermediate the extremities of the blade. The opposite or upper end **282**, as best seen in FIG. **10**, presents a cammed or sloped surface which is non-perpendicular to the side edges of the blade. End **282** is adapted to cooperate with movable plate **284**, as best seen in FIG. **8**, having an elongated transverse aperture **286** and a retaining screw **288** affixed to the front face **31**. Lateral adjustment of plate **284** will, in cooperation with surface **282**, determine the extent of movement of the detector blade **270** in an upward direction, as viewed in the drawing, along the front face **31**. An elongated cavity **290** is provided in face **31** and adapted to accept a spring member **292** having a diameter substantially equal to the combined measurement of the thickness of the blade **270** and the depth of the cavity **290**. After spring **292** is positioned within the cavity **290**, the blade **270** is positioned with the spring member located within the aperture **280**. A flat cover plate **300** is positioned over the blade **270** and the assembly maintained in place by lateral flanges **302** extending rearwardly from plate **300** and secured to the body **30** by suitable means such as a screw **304** and nut **306**. The cover plate **300** maintains the blade **270** in free sliding relationship to the front face **31** with the spring **292** centering the blade **270** when forces tending to move the blade in either direction have been removed. The lower extremity of blade **270** defined by surface **276** normally extends beyond the free extremity of nose piece **190** before contact with a work piece.

The effects of movement of the detector blade upwardly against spring **292** when contacting a work piece are translated into useable impulses by means of a pair of levers **310** and **312** mounted on opposite sides of body **250**. The lever **310** has a forward portion **314** terminating in a cammed bulbous tip **316** adapted to be accepted between the adjacent side lugs **278**. Lever **310** is provided with a central pivot point aperture **318** and a rearwardly extending arm **320** terminating in a laterally extending flange **322** having a cammed surface **324** adjacent its lower edge, as viewed in FIGS. **2** and **10**. Lever **312** is provided with a forward portion **330** and a similar bulbous tip **332** for acceptance between the lugs **278** on the adjacent side of **270**. Intermediate the extremity of lever **312**, there is positioned a stud **334** at its pivot point and adapted to be accepted within the pivot point aperture **318** of the lever **310**.

Within the case **250** there are positioned two switches **340** and **342**. Switch **340** is provided with a spring pivot arm **344** adapted to be in contact with the cam **324** of lever **310**. In the upper portion of casing **250**, there is provided in the hand grip aperture **252** a trigger switch lever **350** pivoted at **352** and having an upwardly extending lever **354**. The switch trigger **350** is adapted to act against adjustable spring **356** when an upward pressure is brought to bear on trigger **350**, as viewed in FIG. **2**, to swing flange **354** into contact with switch **342**. Switches **340** and **342** are connected in series internally of the casing by appropriate means with the cable **268**. When the trigger **350** is squeezed, switch **342** is closed, but the circuit will not be complete unless the detector blade **270** is moved upwardly, as viewed in FIG. **2**, so as to pivot lever **310** and move the cam surface **324** downwardly to actuate switch **340** and thereby close the series circuit. If pressure against the nose **276** of blade **270** is removed, as by removal of the tool from the work surface, the circuitry will be opened and electrical power to the pump which supplies the power fluid will be cut off and the power stroke will be unable to proceed in its cycle. Thus, the tool must be in a predetermined position for driving, as well as having the trigger **350** depressed in order to carry out its sequence of firing.

CUT OFF MECHANISM

The collated strip **216** with which the tool is adapted to operate includes a plurality of fasteners **217** which are maintained in a predetermined spaced relation by the supporting strip. The proposed strip, which has been indicated will be disclosed in a co-pending application, envisages a series of plastic carrying means for orientation of the fasteners with the head portions of the carrying means being interconnected. After a series of fasteners have been fired, the carrying means or strip, will be ejected forwardly through the aperture **272**. At times, when spacing of the environment are tight, it is necessary to dispose of the strip and hence a cutoff mechanism has been provided. The detector blade **270** is provided on opposite upper sides of the aperture **272** with a pair of depending knives **360** having knife edges **361**. The back surface of each knife **360** is co-planar with the surface of blade **270** riding on the front surface **31** while the front surface of each knife **360** is tapered to intersect said back surface and provide the cutting edge **361**. The detector blade levers **310** and **312** include upper extensions **362** and **364** respectively which extend upwardly and rearwardly from the pivots **318** and **334**. For operation of this device, a manual lever **370** is mounted on body **250** and provided with a pair of arms **372, 374** pivoted centrally thereof at **376** and having cammed surfaces **378** and **380** at their respective far extremities. The lever **370** is provided with a yoke connecting portion **382** at its upper extremity forming a handle for manual engagement by the operator. A pin **384** is positioned internally of the handle **254** of casing **250** and a similar pin **386** extends between arms **372** and **374**, intermediate the extremities of lever **370**. A tension spring **388** extends between the pins **384** and **386** and maintains the lever **370** and its associated cam surfaces **378** and **380** out of contact with the upper portions **362** and **364** of detector blade levers **310** and **312** with pin **386** serving as the stop means which by engaging with case **250** serves as the lever orientation means. Depressing lever **270** by application of a force to the handle **382**, pivots the lever **370** about point **376** to bring the cam surfaces **378–380** into engagement with the undersurface of the upper portions **362** and **364** of the lever arms **310** and **312**. The bulbous connections **316** and **332** at the opposite end of the lever arms then act on the lugs **278** to move the detector blade downwardly against spring **292**, as viewed in FIGS. **2** and **8**, to bring the knife edges **361** into engagement with the collated strip of the type shown in phantom shown in FIG. **2**, to sever the used portions of the strip extending outwardly through the aperture **272**. Release of pressure on handle **382** permits the spring **388** to move the lever **370** back to its position of rest, and spring **292** to return the blade **270** to its normal position of rest.

FEED MECHANISM

As has been previously discussed, the collating means **216** for the fasteners adapted to be used with this embodiment of power tool includes plastic members which are joined at their head and have laterally extending flange means and body means depending from said heads. At the base of the body shell **250**, there is provided a guide rail means **400**, see FIGS. **2, 12** and **13**, which includes a grooved casting **402** having a downwardly opening slot **404** extending the longitudinal length of the casting **402**. The slot **404** includes lateral grooves **406** which are aligned with and complimentary to the grooves **204** in the nosepiece. Suitable flange means **408** are provided to accept fasteners **410** for mounting the casting relative to the body **250**. The collated strip **216** is inserted from the back end of the slot **404**, opposite nose piece **190**, the heads of the strip riding in the grooves **406** and the body portions depending downwardly, as shown in phantom in FIG. **2**.

The feed mechanism includes advancing means for sequentially advancing individual fasteners into position under the hammer **112**. Referring to FIGS. **2, 13** and **14**, the advancing means include fingers means **420** consisting of a pair of narrow sheet metal members **422** interconnected by a flange **424**. An abrupt shoulder **426** is formed at the free end of each of the members **422**, while the undersurface thereof includes a double tapered cam surface designated at **428** and **429**. At the opposite extremity of the finger means **420** and connected to flange **424**, is an upstanding apertured flange **430** having a central aperture **432**. Each of the finger means **420** include oppositely disposed apertures **434** which are in registry with one another and are positioned adjacent the end carrying flange **430**.

A rod **440** is mounted at one end **442**, in the casing **250** by suitable means, such as screw threads or welding, and extends cantilever fashion into the interior of the case **250**. Rod **440** has mounted thereon a compression spring **444**. The spring **440** normally occupies substantially the entire length of rod **440**. The aperture **432** of flange **430** of the finger means **420** is positioned on the free extremity of rod **440** and moved to the right, as viewed in FIG. **2**, to compress the spring **444**. It will be noted that the casting **402** at the end **403** adjacent its juncture with the nosepiece **190**, is milled away to expose the groove **406** to the ends **426** of the finger means **420**. The finger means **420** is pivoted about its aperture **434** and normally spring urged downwardly to the left by the weight of the finger means and the spring **444**.

A double yoke member **450** is pivoted on pin **376** and provides a pair of arm members **452** extending downwardly and embracing the finger means **420**. A pivot pin **454** connects the pivot aperture **434** of the finger means and suitable aperture means in the yoke arms **452**. It should be noted that the aperture **432** in the finger means, is slightly larger in diameter than the rod **440** so that movement of the yoke arms **452** in a direction to the left in FIG. **2** will always permit the finger means **420** to depend downwardly into the groove **406** of the track **400** and the groove **204** in the nosepiece **190**. It should be noted that the spring **444** has a predetermined strength for urging the finger means **420** in the direction to the left toward the nosepiece. To control the advancing means, the yoke has a second pair of arms **456** extending upwardly opposite the arms **452**. The arms **456** have a cam surface **458** on their ear edge abutting the spring urged stop means **460** which has a strength substantially from 4 to 6 times greater than that of power spring **444**. The stop means **460** includes a cavity **462** in the body **250**, a spring **464** and a cap-like plunger **466** which is freely slidable within cavity **462** and in encompassing relation to spring **464**. Plunger **466** acting against the cam surfaces **458** of the yoke **450**, tends to urge the finger means **420** in the direction to the right since spring **464** is many times stronger than the power spring **444** and thereby overcomes the force of spring **444**.

To overcome the stop **460** a piston **470** is provided in opposition to the plunger **466**. A cylinder **472** is threadedly mounted in the port **64** and access provided to the bore **60** carrying the power fluid. Suitable seal means **474** is provided within the cylinder **472** acting against a stop **476**. The piston **470** is so dimensioned that it abuts plunger **466** with one end at all times and in the retracted position, shown in FIG. **2**, is seated on a shoulder **478** at its end opposite the plunger **466**, thereby controlling the relative movement of plunger **466** in an outward or direction to the left.

The operation of the feed means is as follows: When the trigger **350** is squeezed, detector blade **270** is moved to actuate switch **340**, power fluid is introduced through the tube **260** into bore **60**. Power fluid then flows from port **64** into the cylinder **472** and movement of the piston **470** overrides the spring **464** by moving it to the right, as viewed in FIG. **2**. By removal of stop means **460** the power spring **444** is permitted to act upon the flange **430** and attempt to move the finger means **420** to the left. The power piston **100** in its lower or extended position provides a stop means against which the end of the collated strip can come to rest or, as is shown in FIG. **2** in phantom, the hammer portion **112** projects through the interior of one portion of the collated strip and prevents movement thereof until, during the power cycle, the power piston

100 is retracted. When the hammer 112 in its upward movement clears the collated strip, the abrupt shoulder 126 engages a complimentary shoulder in the strip and moves it forward with a rocking of the yoke 450 as shown in phantom. The collated strip has a series of notch-like grooves for acceptance of the shoulder means 426 of the finger 420 and the stroke of the finger means is controlled by the movement of the yoke 450 until it touches the plunger 466 in retracted position. This is a calculated position to insure proper positioning of the collated strip beneath the power piston. When the cycle is complete, the fastener is driven through the collated holder into the work structure and the power fluid is then evacuated through the tube 260. This permits the piston 470 to return to its seated position against shoulder 478 and the spring 464, being much stronger than spring 444, swivels the yoke 450 to the solid line position shown in FIG. 2, thereby retracting the finger means with the cam surfaces 428–430 riding across the upper surface of the collated strip 216 until the shoulder means 426 engage the next notch in the strip. The feeding means is then ready for recycling.

It will be noted in FIG. 13 that the body shell 250 is open on the left side and bottom to provide access to the interior. A thin sheet metal cover 500 is used to cover the interior of the body shell 250. Cover 500 has at one extremity, an inwardly and thence upwardly directed bottom or nose portion 502 which protects the strip of collated fasteners from damage as they are moved along the grooves 406. The upwardly turned portion 504 terminates in spaced relation to the rail casting 402 to provide a slot 506 which permits the operator to move independent or short sections of collated fasteners along the guide rail. It will be recognized, of course, that power means such as a spring, could be used for this purpose, but it has been found unnecessary when access is so readily available through the slot 506.

Thus, it will be apparent to those skilled in the art, that an economical, high velocity, high force, power source is combined with a simple, fail-safe positive positioning of a collated strip of fasteners for driving into a work structure. The safety features, such as a detector blade when mechanically moved, provides a circuit actuating means for remotely controlling the reservoir and pump used for introducing the power fluid into the power device.

I claim:

1. A power device including: a body having a bore; a drive piston reciprocably movable in said bore, said piston having one end portion extendable outwardly of said bore, said body having means providing a cylinder, said drive piston having an end portion opposite said one end portion extending into said cylinder; an accumulator piston reciprocably movable in said cylinder; means biasing said accumulator piston toward said drive piston and into engagement therewith; means for introducing a noncompressible power fluid into said cylinder for moving said drive piston and said accumulator piston toward retracted positions against the force exerted by said biasing means, sad accumulator piston shielding a predetermined area of said drive piston from the force of the pressure of said power fluid when said accumulator piston is in engagement therewith, said drive piston having a smaller total area thereof exposed to said power fluid than said accumulator piston, said accumulator piston including seal means at opposite ends thereof in encircling relationship to contact the wall of said cylinder, port means intermediate the position of said seal members communicating with an internal recess within said accumulator piston, adapted to capture any power fluid which by-passes the first seal means positioned closest to the drive piston.

2. A device of the type claimed in claim 1 wherein said recess means communicates with the end of the accumulator piston opposite to the end in engagement with said drive piston, means closing said recess means adjacent its open end to prevent communication with said bias means in said cylinder.

3. A device of the type claimed in claim 2 wherein said means closing said recess is a secondary piston movable within said recess and communicating with said biasing means to form with said recess a variable reservoir for power fluid which by-passes the seal nearest the drive piston and thereby removes pressure against the second seal.

4. A device of the type claimed in claim 3 wherein said biasing means is a compressed gas, suitable aperture means closing the end of said recess and limiting movement of the secondary piston within the recess.

5. A device of the type claimed in claim 1 wherein said accumulator piston is provided with a pair of spaced annular sealing members, sealing means at one end of said accumulator piston for cooperative engagement with said drive piston, recess means opening through the end of said accumulator piston opposite to said piston cooperative sealing means, port means opening laterally through said accumulator piston and positioned intermediate said annular sealing members and further communicating with said recess, secondary piston means positioned within said recess, apertured means adjacent the open end of said recess for restricting outward movement of said secondary piston, said biasing means acting on said secondary piston through said apertured closure means at the second end of said accumulator piston recess, whereby power fluid by-passing the annular seal means positioned adjacent the end of said accumulator piston in contact with said drive piston will flow into said recess through said port means, said secondary piston maintaining said power fluid under pressure by the biasing means, the area of said secondary piston being less than the accumulator piston and thereby lessening the possibility of power fluid by-passing the second annular seal of the accumulator piston to contaminate the biasing means.

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