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R. E. POWERS ET AL
CYLINDER AND PISTON DRIVE AND RETURN MEANS FOR
USE IN STAPLERS AND THE LIKE

2,985,139

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2 Sheets-Sheet 1

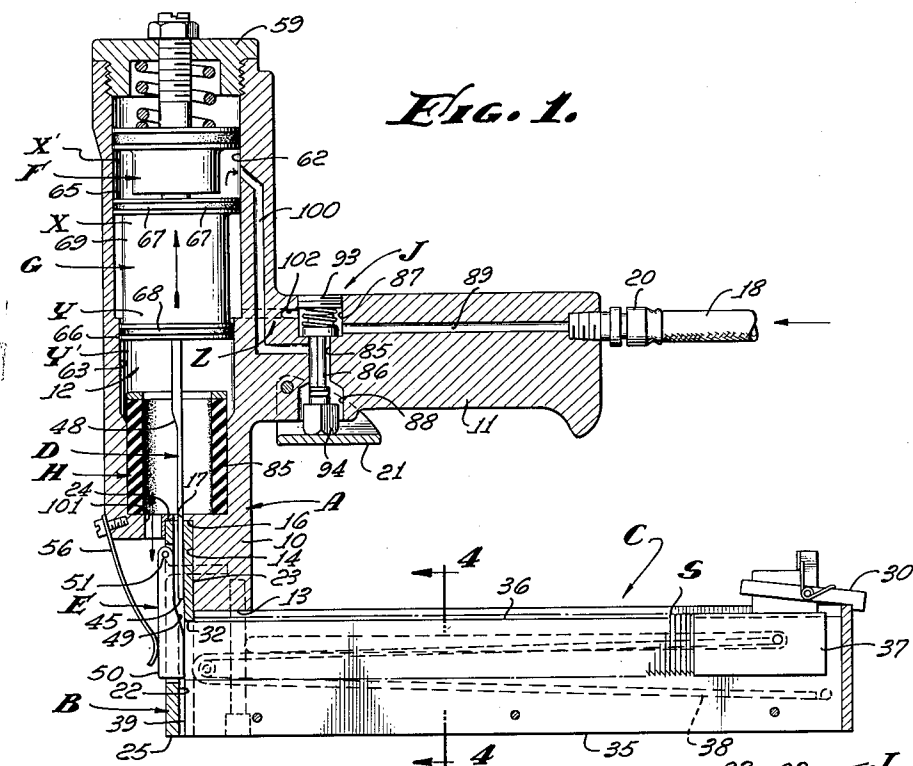


Fig. 1.

Fig. 2.

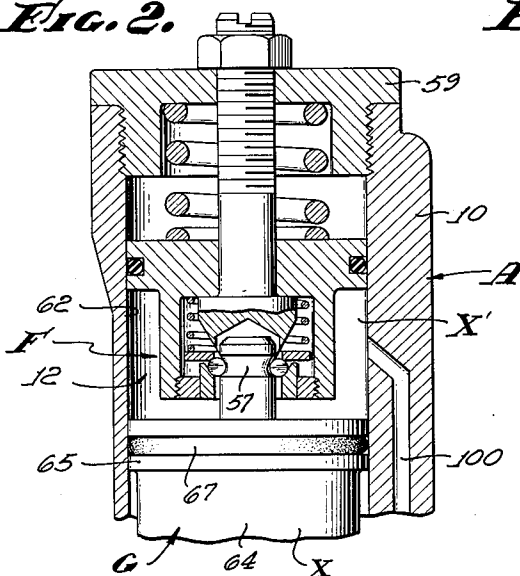


Fig. 3.

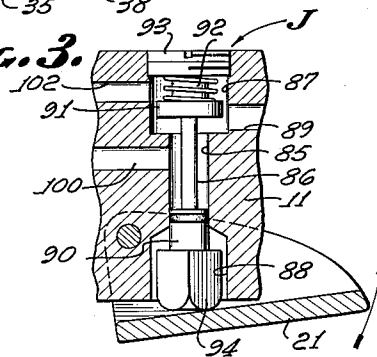


Fig. 4.



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May 23, 1961 R. E. POWERS ET AL 2,985,139
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Filed Jan. 11, 1957 2 Sheets-Sheet 2

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Filed Jan. 11, 1957

2 Sheets-Sheet 2

Fig. 6.

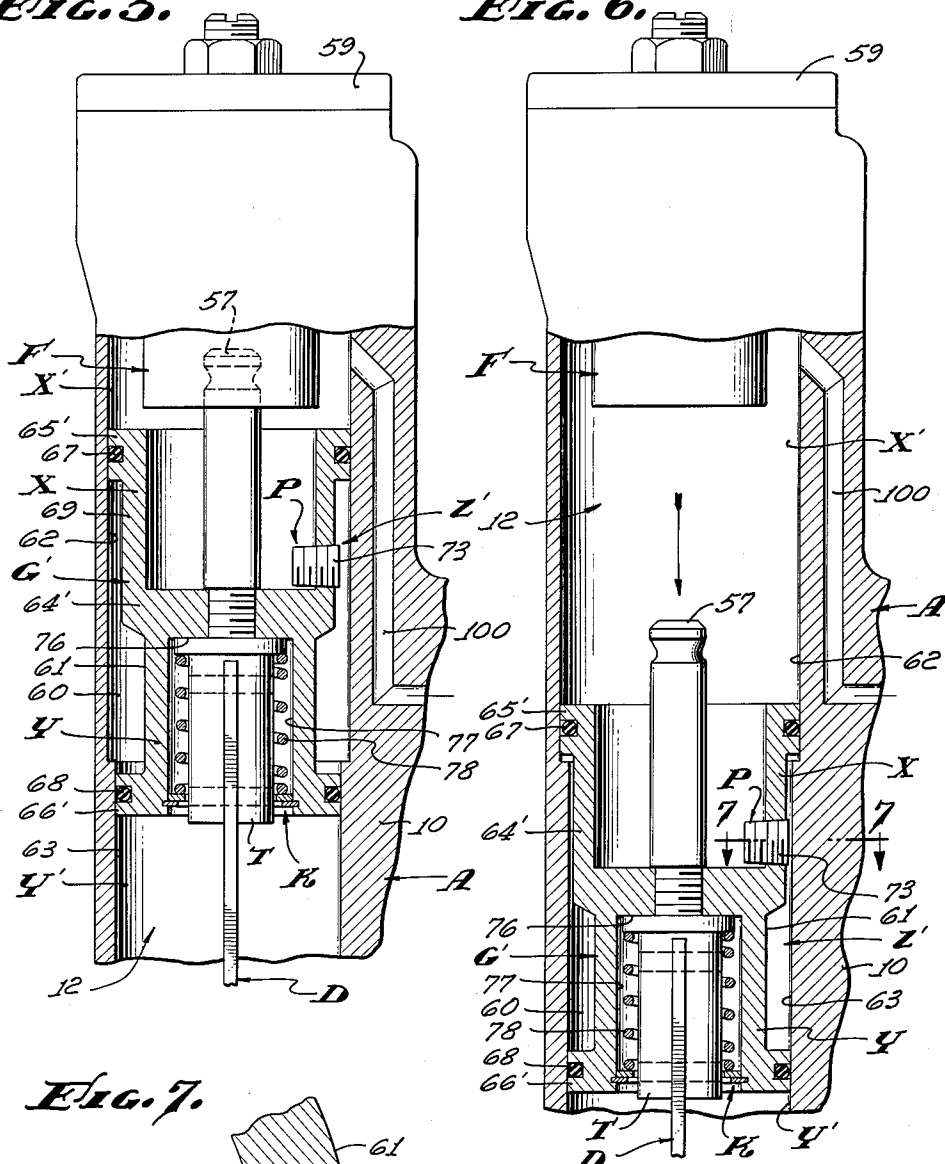
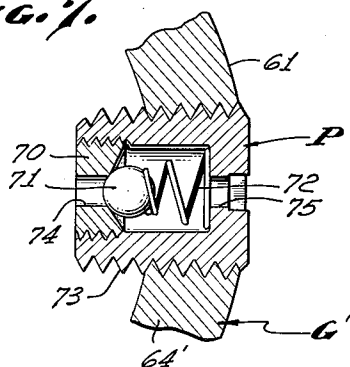


Fig. 7.



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1

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CYLINDER AND PISTON DRIVE AND RETURN MEANS FOR USE IN STAPLERS AND THE LIKE

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7 Claims. (Cl. 121—13)

This invention is concerned with a fluid operated device or drive and in particular with a cylinder and piston drive and return means for use in fastener driving tools, and the like, it being a general object of this invention to provide a fully automatic fluid operated drive for tools of the type under consideration wherein return springs and special controls and valving are virtually eliminated.

Fluid actuated motors in the form of cylinder and piston drives are commonly employed to operate tools, for example stapling guns or fastener drivers. In most tools, driving force is usually required in but one direction, or in other words there is a driving or work stroke and return stroke. Compound or double acting cylinder and piston means have long been used, and valving provided to gain a work stroke as well as a return stroke. In lieu of the valving of fluid to return the piston, many devices employ a return spring. In any case, the valving is complicated and the return springs are not reliable.

Further, in the particular type of tool under consideration, features of construction have made it advisable to avoid the use of double acting cylinder and piston means. That is, the piston of this type of tool operates a driver or blade that is rectangular in cross section which makes it difficult to provide an adequate seal surrounding said blade. Therefore, it has been the usual practice, heretofore, to employ a single acting cylinder and piston means and to provide a return spring.

The use of return springs is a source of trouble in the operation and maintenance of tools since the return springs weaken and often break. A weakened spring will not return the piston the entire length of the stroke resulting in malfunction of the tool, and a broken spring will damage the mechanism by galling the piston and the cylinder walls. It is obvious that a spring has many disadvantages in tools of this type.

An object of this invention is to provide a completely automatic fluid actuated drive and return means therefor that operates through a work stroke and a return stroke when supplied with a single unit volume of fluid under pressure.

It is an object of this invention to provide a cylinder and piston mechanism with means whereby fluid under pressure that is used during the work stroke is also used to effect return of the piston.

It is still another object of the invention to provide a cylinder and piston mechanism with a return means that permits one end of the cylinder to be vented to atmosphere. With the vented end of the cylinder, the work stroke of the mechanism can be carried out with maximum rapidity.

It is also an object of this invention to provide a cylinder and piston mechanism and return means therefor of the character above described that merely requires a

2

simple three-way or pressure and exhaust valve for its control and operation. The valve used to control the device of this invention is manually operable to admit fluid to the head end of the cylinder to effect the work stroke and when released exhausts said fluid to allow the return stroke.

An object of this invention is to provide a simple inexpensive structure for use in a fluid operated device and which operates through a single valve controlled fluid connection to reciprocate the piston through both a work stroke and a return stroke.

The various objects and features of our invention will be fully understood from the following detailed description of the typical preferred forms and applications of our invention, throughout which description reference is made to the accompanying drawings in which:

Fig. 1 is a side sectional view of a fastener driving tool that incorporates the features of the present invention. Fig. 2 is an enlarged detailed sectional view of a portion of the structure shown in Fig. 1. Fig. 3 is an enlarged detailed view of a portion of Fig. 1 and showing the parts in a different operating position. Fig. 4 is a sectional view taken as indicated by line 4—4 on Fig. 1. Figs. 5 and 6 illustrate a second form of the invention and are enlarged detailed sectional views of a portion of the structure, Fig. 5 showing the moving parts in an up position and Fig. 6 showing the parts in a down position. And, Fig. 7 is an enlarged detailed sectional view taken as indicated by line 7—7 on Fig. 6.

The cylinder and piston mechanism of the present invention is shown incorporated in a pneumatic or air operated tool or fastener driving device. The air operated tool and piston therefor that we have provided may be in the form of a stapling gun and, therefore, in the drawings we have illustrated this type of tool. It is to be understood, however, that the present invention is not limited to this particular kind of tool and may be employed in connection with various tools having a cylinder and piston driving means, either hydraulic or pneumatic tools.

The tool, as illustrated in Figs. 1 to 4 of the drawings, is adapted to be handled manually and involves, generally, a frame A having a body portion 10 and a handle or grip portion 11, a head B carried by the frame A and adapted to direct fasteners into a piece of work, a magazine C for handling a supply of fasteners such as staples and cooperating with the head B so that the staples are received and handled by the head, a driver blade D, a guide means E for handling the staples and accommodating the driver blade D so that it is continuously guided by the head B, latching means F adapted to cooperate with and control operation of the driver blade D, a piston G having driving connection with the driver blade D, a damping means H for the piston G, and valve means J adapted to control the supply of fluid under pressure to actuate the piston G.

The frame A carries the various elements of the tool, and is shaped to be conveniently handled by a person. The frame A involves, generally, the body portion 10 and the handle or grip portion. The body portion 10 is a simple elongate part having a cylinder 12 extending longitudinally thereof and having an opening or passage 17 extending longitudinally through the lower head end thereof at one end of the cylinder 12, and is characterized by a flat front face 13 and a recess 14. The front face 13 is at the forward end of the body and is normal to the longitudinal axis of the body, while the recess 14

is in the form of a flat seat spaced laterally of the axis of the body and parallel therewith. The said seat extends rearwardly from the face 13 to a shoulder 16 where the passage 17, that is rectangular in cross sectional configuration, opens to the exterior of the body. The shoulder 16 is normal to the longitudinal axis of the body.

The handle or grip portion 11 is provided to give the person handling the tool a convenient means to hold the tool and is a simple grip of ordinary construction that projects from the body 10. In practice, the grip 11 may be substantially normal to the axis of the body and may project therefrom as clearly shown in Fig. 1 of the drawings.

In structures of the type under consideration, it is common practice to provide a fluid pressure supply connection 18 at the grip 11, such as a pneumatic hose or the like, and also to include a control means at the grip 11. It is to be understood that any suitable fluid pressure supply can be provided without affecting the present invention. When compressed air is employed, as in the case illustrated, the hose of the power connection 18 is attached to the grip 11 through a quick disconnect 20 and the valve means J is under control of a finger operated trigger 21.

The head B is, in effect, an extension of the body 10 of the frame A and is provided to receive and deliver fasteners such as staples to the work being acted upon by the tool. The head B is carried by the body 10 in the recess 14 and is provided with a longitudinal guideway 22 that extends through and opens at the ends of the head B. The head B has a bottom face 23 engaged with the seat of recess 14, it has a rear end face 24 normal to the axis thereof and engaged with the shoulder 16, and it has a front end face 25 engageable with the work.

In the particular form of the invention shown, the guideway 22 is adapted to handle fasteners or staples S that are U-shaped and formed of wire, or the like, having a pair of sharpened ends (see Fig. 4). The staples referred to are substantially elongate with straight parallel shanks joined by a curved back. It will be apparent how the guideway 22 can be proportioned so that it will readily pass the staples with clearance and will act upon the staples to guide them as they are delivered through the head B and from the tool. The guideway 22 is a continuation of the passage 17 above described and guides the driver blade of the tool as well as the staples S that are handled thereby.

A fastener or staple receiving opening 32 extends laterally through the head B, which opening enters the bottom face 23 of the head and opens into the passage 22 so that the staples S fed to the head B are properly guided and aligned with the passage 22 before they are engaged by the driver blade D of the mechanism. The passage 22 has a staple guiding portion at the front of the head B of sufficient width to freely pass a fastener or staple handled by the head B, and the passage 22 has a blade guiding portion rearward of the first mentioned portion that is of increased width in order to accommodate the relatively large plunger or driving blade D.

The magazine C is adapted to handle a supply or stack of fasteners or U-shaped staples S and involves, generally, a case 35 carried by the frame A, a guide 36 within the case 35, a follower 37 adapted to advance the fasteners or staples, and a feed spring 38 yieldingly urging the follower toward the head B. The case 35 is carried by the front face of the body 10 and is an elongate part that projects laterally from the frame A. The case is shell-like in form and the guide 36 is a core-like part that is coextensive with the case 35 and is carried between the side walls thereof. As shown in Fig. 4 of the drawings, the case 35 and guide 36 are shaped so that a longitudinal passage 40 is formed, which pas-

sage conforms in general configuration to the U-shaped staples S which are handled by the head B.

The guide 36 enters the fastener or staple receiving opening 32 and terminates in a flat end 39 that occurs in the plane of the bottom wall of the guideway 22. The follower 37 conforms with the configuration of and is slidably carried in the passage 40 and is yieldingly urged toward the head B by the feed spring 38. Means is provided to prevent the follower 37 from entering the guideway 22. The fasteners or staples S are inserted into the magazine C through the open top thereof by simply engaging them over the guide 36 ahead of the follower 37 tensioning the spring 38. As clearly shown in Fig. 1, a spring biased latch 30 secures the follower 37 in a retracted position when desired, thus facilitating insertion of the fasteners.

The driver blade D is essentially a slender elongate part rectangular in cross sectional configuration and terminates at its forward end in a flat fastener or staple driving face 45. The blade D has a staple driving portion at the forward end thereof which occupies the staple guiding portion of the guideway 22 when the driver is in the advanced position (not shown), and also has a stem that is guided by the blade guiding portion of the guideway 22. As shown, the blade D is provided with an inclined cam or face 48 that is pitched upwardly and rearwardly and which is provided to shift the guide means E herein-after described.

The guide means E is in the form of a closure or gate 50 that is pivotally carried by the head B so that it normally substantially occupies the top of the head B. As shown, the gate 50 is elongate and is shiftable carried by the head B by means of a pivot pin 51. The gate 50 normally occurs in a position where it forms a continuation of the guideway 22. As shown, the gate 50 is provided with a cam face 49 that cooperates with the face 48 above referred to provided on the driver blade D. By providing the cooperating cam faces 48 and 49, the gate 50 is shifted or moved outwardly in order to allow the driver blade D to advance. A spring 56 is provided to yieldingly hold the gate 50 in a down or normal position where it forms a continuation of the guideway 22 and thereby guides the staples handled by the tool and also guides the driver blade D of the tool. A head construction for a fastener driver of the type referred to is particularly set forth and claimed in Letters Patent No. 2,784,406 issued to Richard E. Powers, March 12, 1957.

The latching means F that may be employed in tools of the type under consideration is adapted to cooperate with and control operation of the piston G, later described. The means F is provided to couple with and to hold the piston G at the upper end of the cylinder 12 and to release the piston G when sufficient fluid pressure has been established in the cylinder to effect the desired work stroke. The latching means F may involve suitable mechanism to carry out the function referred to without affecting the present invention. For example, the latching means F may involve means adapted to releasably couple to a head 57 that projects from the top of the piston G, and a pressure responsive release means adapted to release the head 57 from the upper end of the cylinder 12. The upper end of the cylinder 12 remote from the head B is closed by a cap 59, the latching means F being threadedly engaged through an opening in the cap for adjustment.

The piston G that we have provided in accordance with the present invention operates in the cylinder 12 and has driving connection with the driver blade D. The piston G is adapted to drive or move the driver blade D forwardly or downwardly and is adapted to be damped or snubbed separately from the driver blade D. The cylinder 12 is carried by the body 10 of the frame A on the longitudinal axis thereof, and is supplied with fluid under pressure by the valve means J, as hereinafter described. The piston G is freely carried in the cylinder 12

5

6

and is actuated to retract and to advance in the cylinder. In the particular tool illustrated throughout the drawings, the ordinary compression return spring is eliminated which is usually provided within the cylinder 12 ahead of the piston G to return the piston to a retracted position. The tool illustrated is operated entirely by fluid pressure so that when the trigger 21 of the tool is operated the piston G is moved to the bottom of the cylinder 12, and so that when the trigger 21 is released the piston G is moved to the top of the cylinder 12. The trigger 21 controls the valve means J later described.

In accordance with the present invention the piston G is light in weight, being made of aluminum or of magnesium, or the like, and is characterized by upper and lower portions X and Y of different diameter. The piston G occupies the interior of the cylinder 12 in which case the cylinder 12 is also characterized by upper and lower bores X' and Y' of different diameter. The return means that we have provided involves the provision of said different diameters in connection with the cylinder 12 and piston G, and further involves the provision of a pressure supply means Z in communication with the cylinder 12 between the portions X and Y of the piston G.

As illustrated in Figs. 1, 5 and 6 of the drawings, the cylinder 12 has upper and lower bores 62 and 63 forming the cylinder portions X' and Y', the lower bore 63 being somewhat smaller in diameter than the upper bore 62. Thus, there is a differential between the effective diameters of the two bores 62 and 63.

The piston G is formed of a body 64 of material, for example light weight material as above specified, and has upper and lower piston heads 65 and 66 at the upper and lower portions X and Y respectively. The head 65 is slidably operable in the bore 62 of cylinder 12 while the head 66 is slidably operable in the bore 63 of the cylinder 12. As shown, suitable sealing rings 67 and 68 are provided at the two heads 65 and 66, and are preferably O ring type sealing rings carried in annular grooves provided in the peripheries of the heads, respectively. As shown, a turned portion 69 extends between the heads 65 and 66, preferably of a diameter slightly smaller than the lower head 66.

The damping means H is provided to decelerate the body 64 of the piston G and damps or snubs the piston at the end of the work stroke. The damping means H is in the form of a snubber 85 and is shown as a body of resilient material, such as rubber or the like, carried within the cylinder 12 and supported by the lowermost head thereof. In accordance with the invention, the snubber 85 is a circular ring shaped part or body that is held in working position by the walls of the cylinder 12 and which surrounds the driving blade D with substantial clearance. The lower head 66 of the piston G engages the snubber ring to compress it. It will be apparent how the snubber 85 slows and stops advance of the piston body 64 at the lower end of the work stroke.

The valve means J is a fluid pressure supply and exhaust means that admits and exhausts operating fluid to and from the top end of the cylinder 12 hereinabove described. The valve means J is preferably formed in and carried by the frame A of the tool and, as shown, is housed in the grip 11. In the case illustrated, the valve means J involves a valve chest 85 formed or machined in the grip 11, and a slide 86 that is shiftably carried in the chest to control flow of fluid. As shown, the chest 85 extends through the grip 11 to open at both the front and back thereof, there being a recess 87 at the back of the chest and a recess 88 at the front of the chest. The recesses 87 and 88 are in the form of counterbores, the recess 87 handling the inlet of fluid under pressure and the recess 88 handling the exhaust of fluid. A pressure supply passage 89 connects the recess 87 to the connection 18 while the recess 88 simply opens to the outside atmosphere at the exterior of the grip 11.

The slide 86 of the valve means J is freely shiftable in

the chest 85 and involves a plunger 90 that is operable in the recess 88 and a valve disc 91 that is operable in the recess 87. A spring 92 is seated in a cap 93 that confines the spring to the recess 87, the spring engaging and yieldingly urging the disc 91 into contact with a seat in the recess. An extension 94 projects from the plunger 90 and is engaged by and is operated by the trigger 21. When the valve means J is actuated to the position shown in Fig. 3 the disc 91 is lifted from the seat allowing passage of fluid under pressure to a passage 100 that is in communication with the upper end of the cylinder 12, while the plunger 90 enters the chest 85 to close the exhaust recess. When the valve means J is released to the position shown in Fig. 1 the disc 91 is seated to close the recess 87 while the plunger 90 opens the recess 88 to exhaust fluid from the upper end of the cylinder 12.

In accordance with the invention we have provided the pressure supply means Z that is in communication with the cylinder 12 between the upper and lower portions X and Y of the piston G. In the first form of the invention, and shown clearly in Fig. 1 of the drawings, the means Z involves a simple fluid connection 102 between the cylinder 12 and the pressure supply passage 89 that is in constant communication with the connection 18. In practice, the connection 102 extends from the recess 87 to the cylinder 12 at a point where the upper and lower bores thereof adjoin. The connection 102 may be a simple bored hole that is offset from the passage 100 above described. It is to be observed that the open communication of the connection 102 with the fluid pressure supply is analogous to communication with a reservoir or with an accumulator to the end that the cylinder 12 is continuously pressured between the piston heads 65 and 66.

Upon release of fluid from the upper end of cylinder 12 of the mechanism thus far described the fluid under pressure that is in communication with the cylinder 12 between the heads 65 and 66 acts against the larger piston head 65 to move it upwardly to the position shown in Fig. 1. Thus, the differential action obtained by providing the upper and lower piston portions X and Y and corresponding cylinder portions X' and Y' of different diameters results in automatic return of the piston G to the upper end of the cylinder 12. It is to be observed, however, that the difference in diameter of the said upper and lower portions of the cylinder and piston are not enough to materially effect the work stroke of the device.

The lower end or head of the cylinder 12 is open to atmosphere through a substantially large port 101 (see Fig. 1), so that there is little or no restriction to rapid movement of the piston G in the cylinder 12 during the work stroke.

Referring now to the second form of the invention illustrated in Figs. 5, 6 and 7 of the drawings, we have provided a modified pressure supply means Z' involving, generally, a recess 61 in the cylinder body and a fluid control P in connection with the said recess. The second form of the invention may incorporate all of the features above described in the first form of the invention except for the connection 102 which is not employed. As shown, the piston G' is a unit of construction, preferably formed of a single body 64' of light weight material, and the recess 61 is formed in the body 64' intermediate the heads 65' and 66'. The recess 61 may vary widely in form or configuration and is such as to establish a chamber 60 of the desired volume, as circumstances require. In accordance with the invention, the chamber 60 is adapted to receive fluid under pressure which fluid is employed to effect the return stroke of the mechanism. The particular recess 61 that we have illustrated involves a turned portion of reduced diameter that extends between the heads 65' and 66'.

In addition to the foregoing, the pistons G and G' involve means K coupling the driver D to the piston (see Figs. 5 and 6). The driver blade D above described is rectangular in cross section and has flat sides and a

7

flat top. The upper end portion to the blade D is coupled to a head T and receives driving force from the head T, preferably through engagement with the said top end thereof. The piston has a flat downwardly faced bottom 76 that has driving engagement with the top of the head T, and a cylindrical bore 77 depends from the bottom 76 to guide the head T. The bore 77 freely guides the head T there being a spring means 78 that yieldingly urges the head into a normal position where it engages the bottom 76. The means 78 involves a relatively light spring and is such as to allow for considerable movement of the head when it is compressed. It will be understood that the means K, above described, is applicable to both forms of the invention without variations.

The fluid supply means Z' under consideration, is carried by or incorporated in the piston body 64' and is adapted to direct fluid under pressure into the chamber 60. The supply means Z' is shown in Figs. 5 and 6 of the drawings and the control P thereof is illustrated in detail in Fig. 7. As shown, the control P is essentially a valve means that allows fluid to flow in one direction, and checks the flow of fluid in the other direction. That is, the control P involves a check valve, or the like, and may involve a valve seat 70 and a shiftable valve element or ball 71. The valve seat 70 is faced toward the chamber 60 and a spring 72 is engaged with the ball 71 to yieldingly urge it into engagement with the seat. The control P is a unit of construction and involves a valve body 73 that is threaded into the body 64' of the piston G' and which carries the seat 70 and ball 71. The seat 70 has a port 74 in communication with the cylinder 12 above the piston G', and the valve body has a port 75 in communication with the chamber 60. Thus, fluid pressure applied to the cylinder 12 above the piston G' is directed to the chamber 60 and is retained in the chamber 60 by action of the means Z'.

Upon release of fluid from the upper end of cylinder 12' of the second form of the invention, the valve means or control P operates to retain fluid under pressure in the chamber 60. The fluid that is employed to operate this form of the invention is air, or the like, which is elastic or compressible. The compressed fluid that is captured in the chamber 60 tends to expand and acts against the larger piston head 65 to move it upwardly to the position shown in Fig. 5.

From the foregoing it will be readily seen that we have provided an extremely practical cylinder and piston mechanism that incorporates a return means. The structure that we provide requires only a simple three way pressure and exhaust valve to control its operation, and is dependable in its operation. In operating the device or tool of the present invention it is merely necessary to connect the valve means J to a suitable pressure supply connection 18. In the first form of the invention the piston immediately returns to the upper end of the cylinder. In the second form of the invention, regardless of the piston position, the valve means J is operated to admit fluid under pressure to the upper end of the cylinder 12. Said fluid under pressure is communicated to the chamber 60 through the control P and retained in the chamber by the valve action thereof. Upon release of fluid pressure from the upper end of the cylinder 12, after completion of the work stroke, the piston G' is returned to the upper end of the cylinder by action of the expanding fluid in the chamber 60. The above cycle of events occurs each time a work stroke is effected.

Having described only the typical preferred forms and applications of our invention, we do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to ourselves any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims.

Having described our invention, we claim:

1. A cylinder and piston drive adapted to be operated by elastic fluid under pressure, including, a cylinder with

8

bore of different diameters, a drive piston slidably carried in the cylinder and with a slidably sealed portion in each bore and having a space therebetween, and a valve carried by the piston and admitting fluid under pressure from the cylinder to the space between the said slidably sealed portions of the piston and cylinder bores to effect movement of the piston when the cylinder is exhausted.

2. A cylinder and piston drive adapted to be operated by elastic fluid under pressure, including, a cylinder with adjoining bores of different diameters, an elongate drive piston slidably carried in the cylinder and with spaced head portions slidable in each bore and having sealed engagement therewith, a recess in the piston between said heads thereof and forming a chamber with said cylinder, and a valve carried by the piston to open into said chamber and admitting fluid under pressure from the cylinder and to the said chamber and retaining said fluid to be sealed therein to effect movement of the piston when the cylinder is exhausted.

3. A cylinder and piston drive adapted to be operated by elastic fluid under pressure, including, a cylinder with bores of different diameters, a fluid connection at one end of the cylinder, a drive piston slidably carried in the cylinder and with a slidably sealed portion in each bore and having a space therebetween, and a valve carried by the piston and admitting fluid under pressure from said end of the cylinder to the space between the said slidably sealed portions of the piston and cylinder bores in order to effect movement of the piston to said end of the cylinder when fluid pressure is released from said connection.

4. A cylinder and piston drive adapted to be operated by elastic fluid under pressure, including, a cylinder with upper and lower bores of different diameters, a fluid connection entering the upper bore, a drive piston carried in the cylinder and with upper and lower head portions slidable in and in sealed engagement with the upper and lower bores respectively, and a check valve carried by the piston and admitting fluid under pressure from the upper bore of the cylinder and to a chamber formed by the heads sealed with the bores in order to effect movement of the piston to the upper end of the cylinder when fluid pressure is released from said connection.

5. A cylinder and piston drive adapted to be operated by elastic fluid under pressure, including, a cylinder with upper and lower bores of different diameters, a fluid connection entering the upper bore, a drive piston carried in the cylinder and with upper and lower head portions slidable in and in sealed engagement with the upper and lower bores respectively, a recess in the piston between the heads thereof and forming a chamber, and means carried by the piston and admitting fluid under pressure to the chamber between the heads and retaining said fluid between the heads sealed with the bores in order to effect movement of the piston to the upper end of the cylinder when fluid pressure is released from said connection.

6. A tool of the character described including, a cylinder with upper and lower bores of different diameters, a drive piston slidably carried in the cylinder and with upper and lower head portions with a space therebetween and slidable in and in sealed engagement with the upper and lower bores respectively, a fluid connection at the upper end of the cylinder, a vent at the lower end of the cylinder, and a check valve carried by the piston and admitting fluid under pressure from the upper end of the cylinder and to the space between the heads sealed with the bores in order to effect movement of the piston to the upper end of the cylinder when fluid pressure is released from said connection.

7. A tool of the character described including, a cylinder with upper and lower bores of different diameters, a drive piston slidably carried in the cylinder and with upper and lower head portions slidable in and in sealed engagement with the upper and lower bores respectively, a recess in the piston between the heads thereof and

forming a chamber, a fluid connection at the upper end of the cylinder, a vent at the lower end of the cylinder, and a check valve carried by the piston and admitting fluid under pressure to and retaining said fluid in the recess forming the chamber between the heads sealed with the bores in order to effect movement of the piston to the upper end of the cylinder when fluid pressure is released from said connection.

5

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