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SELF RETURNING DRIVE PISTON AND VALVE THEREFOR

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This invention is concerned with a drive piston and valve for a fluid operated motor and particularly relates to a self returning piston that is coupled to an elongate driver blade, such as, for example, a blade in a fastener driving tool, it being a general object of this invention to provide an extremely simple and practical drive piston that returns to a retracted position at the end of each work stroke.

This application is a division of application Ser. No. 714,412, filed Feb. 10, 1958, entitled Drive Piston for a fluid operated motor, now Patent No. 2,959,155.

The manufacture of a tool for driving fasteners is complicated by the construction of a satisfactory drive motor, that is, a motor that not only provides the desired functions but which is also reliable in its operation. This invention relates to fluid operated tools and more specifically to a pneumatic tool wherein an elastic fluid is relied upon to power the tool. In this case, a cylinder and piston type motor is employed, and for the purpose of illustration such a motor is shown employed in a staple driving tool.

In a tool of the type under consideration, wherein a piston is employed to drive a blade, the work stroke of the piston is effected by applying fluid under pressure to one end of the cylinder, after which a return stroke of the piston must be effected. In order to effect a forceful work stroke, a latching means is adapted to restrain the piston until sufficient volume of fluid under pressure is contained within the cylinder for effecting said stroke. In order to effect a return stroke, a spring may be employed, but it is preferred that a fluid operated means be employed thus eliminating said spring. However, the cylinder and piston motor is not double acting in the common sense since one end of the cylinder remains open to atmosphere allowing for rapid movement of the piston toward that end of the cylinder.

It is an object of this invention to provide a piston for operation in a tool of the type under consideration wherein a simple and improved valve element controls fluid flow through the piston in order to effect a return stroke to complete the cycle of operation of the tool.

It is still a further object of this invention to provide a piston for operation in a tool of the type under consideration wherein a minimum of parts and elements are involved and wherein the operation of the tool is highly improved and made more reliable. With the structure herein disclosed there are essentially but three simple ruggedly formed parts involving the piston, the coupler and a head that is anchored to the driver blade, and there is a single element operating as a valve.

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

FIGS. 1 and 2 are detailed sectional views of a portion of a fastener driving tool, FIG. 1 showing the moving parts in an up position and FIG. 2 showing the parts in a down position. FIG. 3 is a sectional view taken through the piston and as indicated by line 3-3 on FIG. 1, and

FIG. 4 is an enlarged detailed view of a portion of the piston and taken as indicated by line 4-4 on FIG. 3.

The cylinder and piston mechanism of the present invention is shown incorporated in a pneumatic or air operated tool or fastener driving device. The drive piston for fluid operated motors that we have provided may be used in connection with 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.

The tool, as illustrated in 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 (not shown). A head is carried by the frame A and adapted to direct fasteners into a piece of work, and a magazine is provided for handling a supply of fasteners such as staples that are received and handled by the head, a driver blade D. A latching means F is provided and adapted to cooperate with and control operation of the driver blade D, a piston G is provided having differentially formed portions X and Y operable in a cylinder 12 in the frame A and adapted to drive the blade D, a coupler H operatively joins the driver blade D and piston G, fluid pressure handling means Z is provided and carried by the piston G, and a valve means (not shown) controls the supply of fluid under pressure to actuate the piston G through a work stroke and to be handled by the means Z to effect a return stroke.

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 a 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 head thereof at the lower end of the cylinder 12.

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 (not shown). The blade D has an upper driven portion 46 at the rear end thereof which couples to a head E to have driving engagement with the piston G.

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 58 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 provide operates in the cylinder 12 and has driving engagement 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 incorporated in the body 10 of the frame A on the longitudinal axis thereof, and is supplied with fluid under pressure by a suitable valve means. The piston G is freely carried in the cylinder 12 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 air pressure is applied the piston G is moved to the bottom of the cylinder 12, and so that when the air pressure is released the piston G is moved to the top of the cylinder 12.

In accordance with the present invention the piston G is light in weight, preferably of magnesium, or the like, to provide minimum inertia therein and is characterized by upper and lower portions X and Y of different diameter establishing a chamber 60 therebetween. The piston G occupies the interior of the cylinder 12 in which case the cylinder 12 is also characterized by upper and lower bores 62 and 63 of different diameters. The return means that we have provided involves the provision of said differing diameters in connection with the cylinder 12 and piston B, 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, the lower bore 63 is 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 a shell-like 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 the 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 valve means that is referred to but not shown 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 is preferably formed in and carried by the frame A of the tool and is housed in the grip 11. The valve means is operable to allow passage of fluid under pressure to a passage 95 that is in communication with the upper end of the cylinder 12, while the valve means is normally released to exhaust fluid from the upper end of the cylinder 12.

In accordance with the invention we have provided the fluid pressure handling means Z that is incorporated in the piston G between the upper and lower portions X and Y thereof. The means Z is a valve means that allows fluid to flow in one direction only and checks the flow of fluid in the other direction so that 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 valve of the means Z. As shown, the means Z is incorporated in the construction of the piston G and involves a valve seat 100, a port 101 opening at the seat, and a valve element 102 engaged with the seat to close the port. The valve seat 100 is a circumferentially formed seat at the exterior of the piston G and formed in the intermediate cylindrical portion 69 of the piston between the portions X and Y. The port 101, or ports as shown, extends from the interior of the piston G in communication with the upper end thereof and opens at the seat 100. The valve element 102 is a circular element, preferably a band or the like, of elastic material. In the case illustrated, the valve element 102 is an elastic band of rubber that encircles the piston G and which is constricted onto the seat 100. As shown, the valve element 102 normally closes the port 101 so that external fluid pressure will not enter the piston G, but so that internal fluid pressure is free to pass into the chamber 60. In practice the band form-

ing the valve element 102 is circular in cross section and in the form of an O ring sealing ring, and in which case the seat 100 is arcuate in form to cooperate with the inner diameter of the element 102. It will be apparent how the O ring shaped valve element 102 seals fluid under pressure in the chamber 60.

When fluid under pressure is applied to the upper end of the cylinder 12 the piston G moves downwardly and the chamber 60 is charged with fluid under pressure. Upon release of fluid from the upper end of the cylinder 12 the valve 102 of the means Z operates to retain fluid under pressure in the chamber 60. The fluid that is employed to operate the piston G 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. 1.

The coupler H is provided to universally couple the driver blade D to the piston G and also involves means to arrest or damp the piston G and blade D independently of each other. The coupler H cooperates with a head E at the upper end of the driver blade D and is characterized by a single body 99 of resilient or elastic material, preferably of rubber or the like, that flexibly joins the piston G to the blade D and which engages the bottom of the cylinder 12 to arrest the piston G and blade D.

The driving head E is rigidly coupled to the driver blade D and is free of the piston body 64 of the piston G. In accordance with the invention the head E is formed of a light weight material, for example of aluminum or the like, to provide minimum inertia in the driver blade D. In practice, the head E is carried within a recess 103 entering the lower end 66' of the piston G and is positioned and guided therein by the coupler H, as hereinafter described. As shown, the recess has a flat bottom 106 in a plane normal to the central longitudinal axis of the piston G, and the recess has a smooth cylindrical wall 107 turned concentric with said axis. The head E has driving engagement with the piston body through the bottom 106 and has clearance with the wall 107.

The head E is characterized by a radially projecting flange 110 and a center portion 111 that is coupled to the driver blade D. The flange 110 forms disc-shaped element that has an upper face 112 for engagement with the bottom 106 and has a lower face 113 for engagement with the coupler H. The upper face 112 is spherically shaped to have a point of engagement with the bottom 106, that is, the face 112 is convexly formed concentrically with the axis of the blade D. The center portion 111 is in the form of a depending extension substantially smaller in diameter than the flange 110 and of substantial longitudinal extent. Said center portion 111 is round in cross sectional configuration and has centering engagement with the coupler H.

The center portion 111 is provided for coupling the driver blade D to the head E establishing a positive connection between these two elements so that they operate together as a unit. In the case illustrated, the head E has a slot 115 provided therein and entering the center portion from the lower end thereof. The slot 115 is vertically disposed and extends diametrically of the head intersecting the central axis thereof. As shown, the slot 115 terminates in a flat bottom adapted to have flat driving engagement with the top end of the blade D. The driver blade D slidably enters the slot 115 and a pin 117 is passed diametrically through the head and blade coupling the two elements together.

The coupler H of resilient or elastic material retains the head E within the recess 105 and centered with the piston G. Further, the coupler H holds the head E in working position relative to the bottom 106. The body 99 of material forming the coupler H has a central bore 120 extending therethrough to receive the central portion 111 of the head E, and it has a flat top 121 adapted to have flat engagement with the bottom face 113 of the

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flange 110. The outer diameter of the center portion 111 has frictional engagement with the bore 120, the coefficient of friction between the head E and bore being substantial due to the particular materials involved, as described.

The coupler H is characterized by a buffer portion 125 that underlies the piston G and/or head E, said buffer portion 125 being a circular ring-shaped part having an outer peripheral portion underlying the bottom 66' of the piston G, and/or an inner peripheral portion underlying the face 113 of the head E. The buffer portion 125 has a bottom 126 and an outer wall 127, the bore 120 forming the inner wall thereof.

The outer peripheral portion of the buffer portion 125 has an upper face 128 projecting radially from the wall 122, while the inner peripheral portion is joined integrally with the central portion of the body 99 that is secured in the recess 105. The face 128 has flat engagement with the bottom 66' of the piston G so that the outer peripheral portion of the buffer portion 125 acts beneath the piston G to arrest it. The top 121 has flat engagement with the face 113 so that the inner peripheral portion of the buffer portion 125 acts beneath the head E to arrest the blade D. As illustrated, the buffer portion 125 is preferably formed with both outer and inner peripheral portions so that both the piston G and blade D are arrested simultaneously and independently by compression of said individual portions of the buffer against the bottom 12' of the cylinder 12.

From the foregoing, it will be apparent that the various parts are made of relatively light weight materials, as specified, with the result that low inertia values are involved in said moving parts. Therefore, the driving forces in the tool are obtained by introducing a substantial charge of fluid under pressure, and with the result that a very quick and forceful work stroke is effected. At the end of the stroke the piston G and/or the head E are arrested independently of each other through compression of the body 99 of resilient material. Further, at the end of each work stroke the compressed elastic fluid entrapped in chamber 60 acts to return the piston G upwardly to the initial latched position.

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Having described only a typical preferred form and application 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 variation 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 drive piston for a fluid operated motor and operable in a cylinder to reciprocate therein, and including, a cylindrically shaped body slidably engaged in the cylinder, and having upper and lower heads of different diameters operating in separate bores, a valve seat between the piston heads and at the exterior of the piston, a port in communication with one end of the piston and opening at the seat, and a valve element of electric material encircling the piston and engaged with the seat.

2. A drive piston for a fluid operated motor and operable in a cylinder to reciprocate therein, and including, a cylindrically shaped body slidably engaged in the cylinder, and having upper and lower heads of different diameters operating in separate bores, an annular valve seat between the piston heads and at the exterior of the piston, a port in communication with one end of the piston and opening at the seat, and a band-shaped valve element of elastic material encircling the piston and engaged with the seat.

3. A drive piston for a fluid operated motor and operable in a cylinder to reciprocate therein, and including, a cylindrically shaped body slidably engaged in the cylinder, and having upper and lower heads of different diameters operating in separate bores, an annular channel shape valve seat between the piston heads and at the exterior of the piston, a port in communication with one end of the piston and opening at the seat, and an O ring-shaped valve element of elastic material encircling the piston and engaged with the seat.

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