

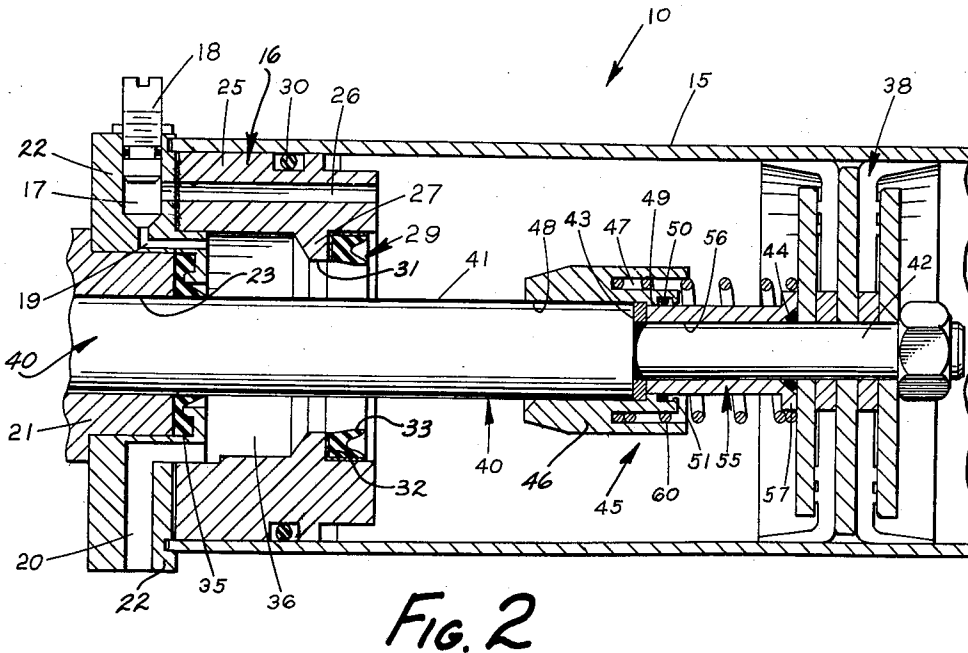
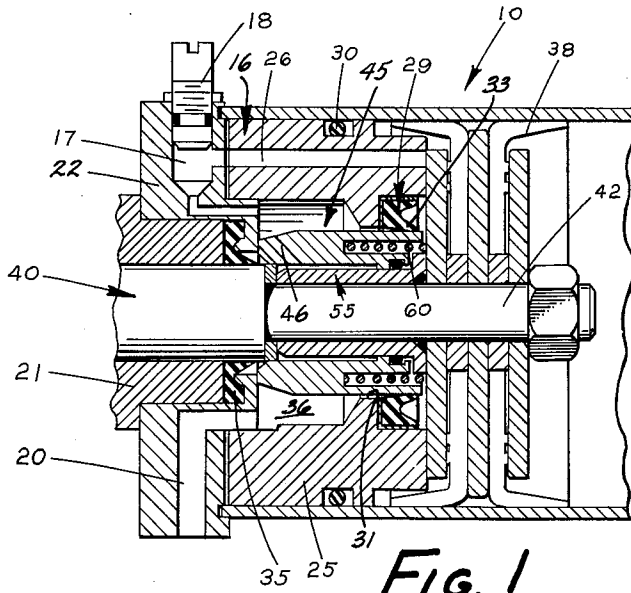
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CUSHIONING STRUCTURE FOR FLUID POWER CYLINDERS

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CUSHIONING STRUCTURE FOR FLUID POWER CYLINDERS

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This invention relates to cushioning structures for a fluid power cylinder.

It has always been a problem in fluid power cylinders to properly cushion the piston as it completes its stroke. Cushioning is necessary to prevent the piston from impacting upon the end of the cylinders resulting in damage to both the piston and the cylinder end. Various structures have been employed to accomplish the cushioning function. Some of these structures include springs of various designs placed between the plunger and the end of the cylinder. The idea of restricting the rate of exit of fluid from the cylinder as the piston reaches this final position has also been employed. Although both of these methods provide a degree of cushioning it has been found that they are not entirely satisfactory particularly in providing a long cushioning stroke without materially increasing the length of the cylinder.

The present invention overcomes the above problems by utilizing a telescoping plug as the fluid cushioning means. This plug can have a spring biasing the plug in extended position so as to provide a resilient cushioning means which becomes operable itself after the fluid cushioning means to further cushion the piston movement. This arrangement provides a cushioned stroke for a distance of about 75% longer than current design; however, it does not substantially reduce the distance at which the piston may travel at a maximum rate before cushioning.

It is therefore an object of this invention to provide cushioning means for a fluid power cylinder wherein the length of cushioned stroke is increased substantially.

Another object of this invention is to provide cushioning means for a fluid power cylinder wherein the cushioning means include a resilient telescoped plug.

A further object of this invention is to provide cushioning means for a fluid power cylinder which includes a combination of fluid and resilient cushioning structure.

Yet another object of this invention is to provide cushioning means for a fluid power cylinder wherein the cushioning means is composed of a minimum number of parts which are economical to manufacture and simple to assemble.

These and other objects and advantages of this invention will become more apparent upon reading the specification in conjunction with the accompanying drawings.

In the drawings:

FIG. 1 is a fragmentary cross section of a fluid power cylinder employing the cushioning means of this invention in the fully extended position;

FIG. 2 is a fragmentary cross section of a fluid power cylinder employing the cushioning means of this invention shown in the fully retracted position.

Basically, this invention is concerned with cushioning means for a fluid power cylinder. The fluid power cylinder conventionally has closed ends and a hollow chamber in which a piston is free to operate. A piston rod is connected to the piston and extends through an opening formed in one of the cylinder ends. A bore formed within this one end of the cylinder is provided with a seal mounted extending radially inwardly thereof. The piston rod passes through the bore with sufficient clearance to permit flow of fluid ahead of the piston. However, it carries a telescoping plug biased to extended position and adapted when the piston is forced in a forward direction

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to engage the seal in the bore. This blocks the normal flow of fluid from the cylinder through the clearance between the bore and piston rod to the outlet. Consequently, the fluid thereafter is required to flow through a restricted bypass to the outlet. This bypass is provided with a regulator valve which can be adjusted to control the rate of flow of fluid from the cylinder. By restricting the rate of flow from the cylinder, pressure will build up within the cylinder, and the piston is thereby fluid-cushioned. The plug continues to move with the piston rod until it hits the cylinder end which acts as a stop for the plug. The bushing then telescopes into the plug against the fluid pressure and against the bias of the spring which normally separates the two members. If the spring is made sufficiently strong it will provide an additional cushioning effect for the piston.

Referring to the drawings which show this structure, the assembly consisting of a fluid power cylinder with the cushioning means is designated generally as 10. The assembly includes the cylinder 15 with the end 16, the piston 38 and its rod 40 and the telescoping plug structure 45.

The closed end 16 is formed of three parts, namely the cap 22, bearing plug 21 and sleeve 25 although it should be understood that this end 16 could be constructed of one solid integrated part. As shown, the sleeve 25 is secured within the cylinder wall and the cap 22 is mounted on the end thereof in sealed relationship thereto. The plug 21 fits within a central bore of the cap 22. It has a centrally disposed bore 23 slidably receiving the piston rod 40. The sleeve 25 and plug 21, as previously stated, could be integral parts of the cap 22. Sleeve 25 also has a central bore 36 with a reduced diameter portion 31 formed by the inwardly extending rib 27. This rib 27 also forms a shoulder 32 against which a special type seal 29 is positioned. This seal 29 is U-shaped in cross-section and has a lip 33 projecting radially inwardly beyond the inner diameter of bore portion 31 to provide a seal against the plug 46 (FIG. 1) as will be described in more detail hereinafter. It is important to note that this lip 33 is inclined radially inwardly and toward the right (as viewed in FIGS. 1 and 2) so as to permit fluid to flow in one direction into the cylinder but restrict flow in the opposite direction.

The end 16 is provided with a bypass port formed by the passageways 26, 17 and 19. End 16 also has the combined exhaust and inlet port 20. A groove formed in the outer circumference of sleeve 25 receives an O-ring seal 30 to prevent escape of fluid between the end 16 and the cylinder wall. Seal 35 is provided between piston rod 40 and end 16 to prevent escape of fluid between the piston rod 40 and the wall of the bore 23.

The piston rod 40 has a trunk portion 41 and a neck portion 42 which is secured in a centrally disposed bore of piston 38 by nuts as shown. The trunk 41 of the piston rod 40 extends through the bore 36 of sleeve 25 and the bore formed in the collar 21. As previously stated sufficient clearance is provided between the walls of bore 36 (including reduced portion 31) and trunk 41 to permit flow of fluid therethrough.

The telescoping plug structure 45 is located at the juncture of trunk and neck portions 41 and 42. This structure includes a washer 43 surrounding the piston rod neck 42 and abutting the end of the piston rod trunk 41, a bushing 55 positioned between the washer 43 and the piston 38, a plug 46 slidably mounted on piston rod 40 and a spring 60 biasing the plug in extended position (FIG. 2).

The bushing 55 has an upturned flange 57 which engages the piston 38. It is provided with an annular relief beneath the flange 57 to receive an O-ring seal 44 which prevents fluid from passing between the bore in the piston 38 and the piston rod neck 42.

The plug 26 has a bore 48 slidably receiving the trunk 41. It has a tapered nose for purposes which will be

explained more fully subsequently. The other end of the plug 26 is provided with an annular groove 47 adapted to receive one end of the spring 60.

The bore 48 of the plug has an inwardly projecting annular shoulder 49 slidably mounted on the bushing 55. This shoulder operates as a stop to limit the forward movement of the plug. The bore 48 is also provided with an annular groove receiving an O-ring seal 50 and a retainer lip 51 which maintains the O-ring seal 50 in position. This O-ring 50 engages the plug 48 and the bushing 55 and prevents fluid from passing between the members.

The spring 60 of the coil type surrounds the bushing 55. One end of the spring 60 is received by the annular groove 47 formed in the plug 46 and the other end of the spring surrounds the flange 57 and abuts the piston 38. The spring 60 constantly urges apart the plug 46 and bushing 55. This spring can be made sufficiently strong to supplement the cushioning effect of the fluid.

Operation

In operation, the piston rod 40 of the fluid power cylinder 10 is connected to some type of mechanism to be actuated. The piston rod 40 is reciprocated by applying fluid to alternate sides of the piston by conventional mechanism (not shown). Thus, the piston 38 is protracted, or moved toward the left as shown in FIG. 1, by applying fluid to the right side of the piston 38. The piston rod 40 is retracted, moved to the right as viewed in FIG. 2, by applying fluid pressure to the left side of the piston 38.

The cushioning means of this invention is shown only on the left side of the piston 38. However, it is to be understood that within the broadest aspect of this invention the cushioning means of this invention may be utilized on both sides of the piston.

As the piston rod 40 is protracted the piston 38 approaches the cylinder end 16. Since the plug 46 is carried by the piston rod 40 the nose portion thereof will eventually engage the lip 33 of seal 29 and be guided therein by the tapered nose. This blocks the flow of fluid from the interior of the chamber through the bore 36 to the outlet port 20 and requires the fluid to seek a different exhaust path from the cylinder. As a result the fluid is exhausted through the bypass in the end 16 which includes the passageway 26 formed in sleeve 25, and passageways 17 and 19 formed within the cap 22. The bore 36 within the sleeve 25 is of greater diameter than the plug 46 which affords an annular space to complete a flow path to the port 20. By restricting the flow of fluid from the cylinder the pressure within the cylinder is increased providing an air cushion for the piston 38. The degree of air cushioning can be regulated by the valve member 18.

As the piston rod 40 continues to protract the plug 46 moves therewith until its nose engages the cylinder end 16 which prevents further movement. Notice that the plug 46 is in continuous contact with the seal 29 from the time it engages the seal until it abuts the cylinder end 16 providing for a continuous air cushion during this interval of travel.

When the plug 46 is stopped the piston rod 40 continues to move relative to the plug 46 causing the bushing 55 to telescope within the plug 46 against the compression of spring 60. During this telescoping movement the fluid cushioning is continued. Further, the piston 38 is further cushioned by the spring 60 if it is made sufficiently strong. However, within the broader aspect of this invention the spring need not be sufficiently strong to produce any effective cushioning.

When the spring is substantially fully compressed the piston 38 engages the end of sleeve 25 which stops further movement. The protraction of the piston is now complete and the piston 38 can come to rest gently against the end of sleeve 25 as a result of the cushioning means.

The piston 38 and piston rod 40 are retracted by applying fluid pressure to the left side of the piston 38 through the port 20 and past the lip 33 of seal 29 which flexes and opens a passageway when pressure is applied from the left as viewed in FIGS. 1 and 2. As the piston 38 retracts the spring 60 expands separating the plug 46 and the bushing 55. This causes the washer 43 on piston rod neck 42 to engage the abutment shoulder 49 on plug 46 and carry the plug with the piston rod. The plug 46 and bushing 55 are completely withdrawn from the sleeve 25 and seal 29 as shown in FIG. 2. The cushioning plug is now in position for another stroke of the fluid power cylinder.

It can be seen that the invention disclosed herein provides an extremely effective cushioning arrangement for a fluid power cylinder. By utilizing the telescoping plug, cushioning can be obtained during a much greater part of the piston stroke without sacrificing space within the cylinder. Thus, more effective cushioning is obtained within the same distance of piston travel than was previously possible. The cushioning means utilized herein is constructed of a minimum number of component parts and is therefore economical to manufacture and assemble.

While a preferred embodiment of this invention has been described, it will be understood that modifications and improvements as incorporate the principles of this invention are to be considered as included in the hereinafter appended claims unless these claims by their language expressly state otherwise.

I claim:

1. Cushion structure for a fluid power cylinder comprising: a closed cylinder; a piston and piston rod operable in said cylinder, a cylinder end including a bore having seal means; an outlet port communicating with said bore; said piston rod carrying a telescoping plug; means biasing said plug to an extended position with respect to said piston; restricted bypass means communicating with said cylinder and outlet port; movement of said piston in one direction causing said plug to enter said bore and engage said seal thereby preventing fluid from flowing through said bore to said outlet and providing fluid cushioning for said piston, said plug when first entering said bore starting said cushioning, and then abutting said cylinder end for a period of time causing said plug to be retracted against said biasing means to provide further cushioning of said piston.

2. Cushion structure for a fluid power cylinder comprising: a closed cylinder, a piston and piston rod operable in said cylinder, a cylinder end including a sleeve portion having an inwardly projecting annular rib defining a bore, seal means seated against said rib, said piston rod having a trunk portion and a neck portion, cushion means including a plug slidably disposed on said trunk portion and a bushing surrounding said neck portion and disposed between said trunk portion and said piston, said plug having shoulder engaged by said trunk portion for carrying said plug when said piston is moved in one direction, spring means received between said plug and said bushing urging said members apart, an outlet port formed in said end, movement of said piston in the other direction causing said plug to enter said bore and engage said seal means preventing normal flow of fluid through said bore to said outlet, fluid bypass means to said outlet to restrict the flow of fluid to said outlet thereby increasing the pressure within said cylinder to cushion said piston, said plug being adapted to move further into said bore and engage the cylinder end for a period of time during which it is forcibly retracted over said bushing against the bias of said spring, and thereby provide continued cushioning of said piston.

3. Cushion structure for a fluid power cylinder comprising: a cylindrical chamber; a piston and piston rod operable in said chamber; said chamber having an end with a centrally located bore communicating with an

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outlet port and said chamber for exhausting fluid from said chamber; a telescoping plug reciprocally mounted on said piston rod and aligned with said bore; said plug having a diameter slightly smaller than said bore to be received therein to restrict flow from said chamber to said outlet port; a restrictor passage means for passing fluid from said chamber to said port in a restricted manner while said plug is located in said bore; said plug being slidably movable between an extended position away from said piston and a retracted position adjacent said piston; said plug being normally extended and adapted to enter said bore as said piston approaches said end whereby a cushioning effect is begun; said plug being adapted to move further into said bore and against said end with continued piston movement; said plug being

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forcibly retractable toward said piston when held in its position against said end, to continue to cushion said piston; and said plug being again extensible upon movement of said piston away from said end.

4. The structure in claim 3 wherein said plug is biased to its extended position by a spring.

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