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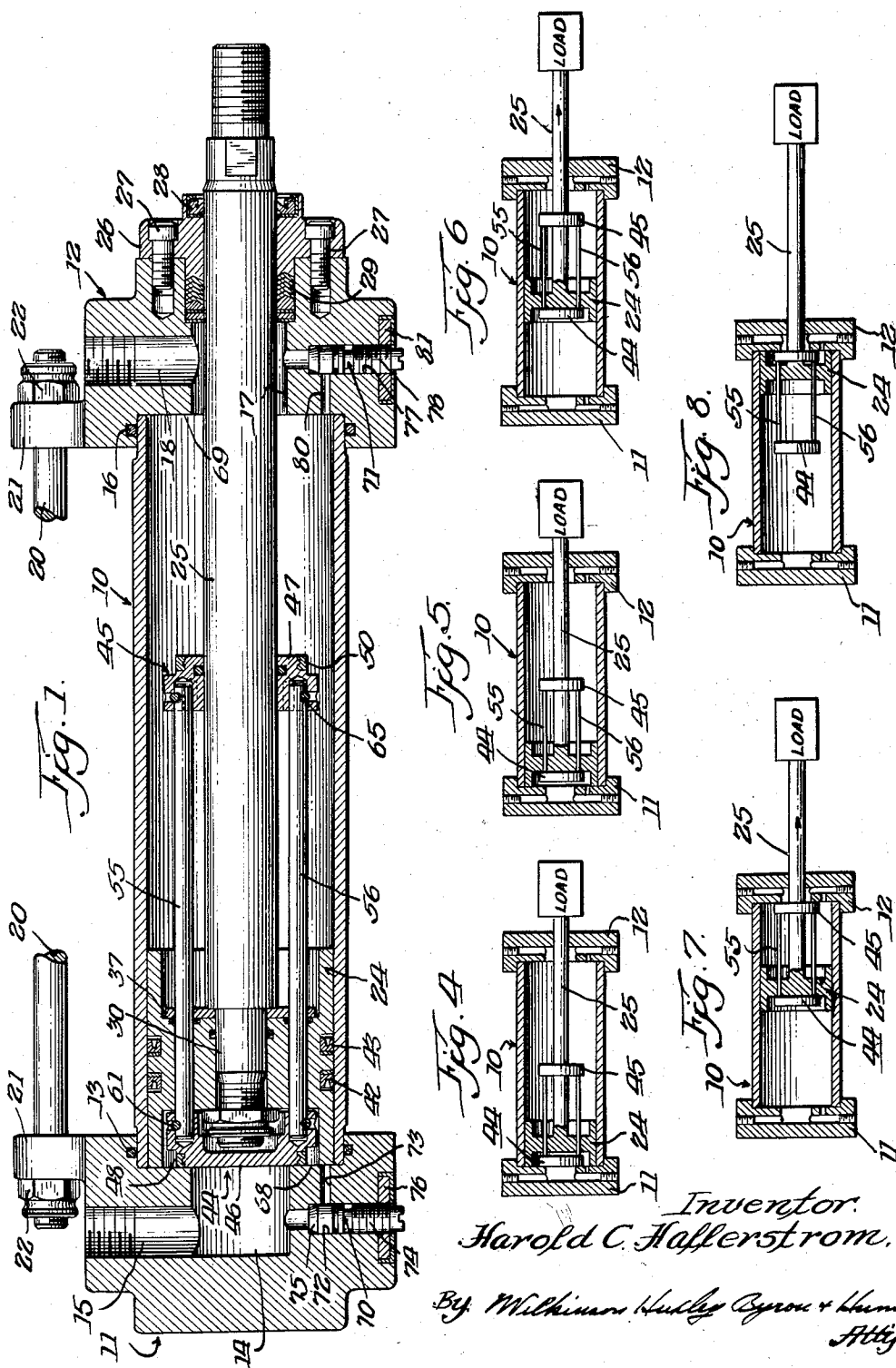
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CUSHIONING DEVICE FOR CYLINDERS

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2,870,744

CUSHIONING DEVICE FOR CYLINDERS

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The invention relates to fluid power cylinders and has reference in particular to a new and improved cushioning device carried by the piston of the power cylinder and which can be rendered effective for cushioning the piston stroke at each end of the cylinder or at one end only.

An object of the invention is to provide a simple but effective device for cushioning the piston of a fluid power cylinder for any portion of its stroke, the said device being carried by the piston, and wherein the same may be so constructed and arranged as to be operative for cushioning a stroke length equal to any part of the piston's stroke.

Another object of the invention resides in the provision of a cushioning device for fluid power cylinders which will be slidably carried by the piston of the cylinder so as to project from its respective sides of the piston and which will provide valve members for contact with the end walls of the cylinder for trapping fluid between the piston and the cylinder walls whereby to cushion the stroke of the piston together with its load.

A further object of the invention is to provide a power cylinder cushioning device wherein various cushioning stroke lengths can be obtained by changing the length of the slidable rods carried by the piston and which have the valve members secured to the respective ends thereof.

A further object is to provide a piston cushioning device for use in fluid power cylinders which will give the maximum cushioning effect over the entire length of the cushioning stroke, which will give full pipe flow to the piston area at the start of the return stroke, and which will be fully adjustable so that the intensity of the cushioning action can be varied.

With these and various other objects in view the invention may consist of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings, which illustrate an embodiment of the invention, and wherein like reference characters are used to designate like parts—

Figure 1 is a sectional view taken longitudinally through a fluid power cylinder showing the piston thereof equipped with the improved cushioning device of the invention;

Figure 2 is an enlarged sectional view of the piston and cushioning device as illustrated in Figure 1;

Figure 3 is a transverse sectional view taken substantially along line 3—3 of Figure 2; and

Figures 4 to 8 inclusive are sectional views illustrating diagrammatically the cushioning action of the present device during a piston stroke in one direction.

Referring more particularly to Figures 1 and 2, the fluid power cylinder selected for illustrating an embodiment of the invention includes the tubular cylinder 10

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having open ends and which are closed by the cylinder end members 11 and 12, the end member 11 comprising the rear end of the cylinder and member 12 comprising the forward or piston rod end of the cylinder. The left end of the tubular cylinder 10 has interfitted relation with end member 11 and for sealing purposes the packing ring 13 is provided. As a result thereof this left end of the tubular cylinder 10 has communicating relation with the central bore 14 formed in end member 11 and which in turn joins with passage 15 through which a fluid pressure can be supplied to the cylinder and discharged therefrom. In a similar manner the right hand end of the tubular cylinder 10 has interfitted relation with end member 12, the parts being effectively sealed by the packing ring 16. A central passage 17 extends through the center of end member 12 and the central passage in turn has communicating relation with passage 18 through which a fluid under pressure is delivered to and discharged from the cylinder. The end members 11 and 12 are suitably connected by tie rods 20 which extend through openings in flange portions 21 and are held in connected relation by the threaded nuts 22. The tubular cylinder 10 and the end members 11 and 12 are accordingly fixedly held in associated relation to form a unitary assembly and which is preferably mounted on a fixed support so that the reciprocations of the piston and piston rod of the power cylinder can be caused to perform its intended work.

The numeral 24 indicates the piston in its entirety, Figures 1 and 2, and the numeral 25 indicates the piston rod which has a fixed connection to the piston by means of structure to be presently described. The piston rod extends through passage 17 of the forward end member 12 and this passage is exteriorly closed by means of the gland nut 26 releasably secured to the end member 12 by securing screws 27 and which has a slidable fit with the piston rod 25. The gland nut 26 provides a scraper 28 having encircling relation with the piston rod and which is operative for removing dirt from the piston rod so as to protect the rod bearing and lengthen the life of the packing 29. The packing 29 preferably comprises rod packing of the self-adjusting type including a plurality of standard V rings in combination with a metal adapter. With the gland nut 26 secured on end member 12 the power cylinder is closed except for fluid passages 15 and 18, although the piston rod 25 is free to reciprocate without losing any of the pressure fluid along the rod by reason of the packing 29.

At its terminal end the piston rod 25 is reduced in diameter as at 30 and said reduced end is threaded as at 31. The piston 24 is formed with a central bore 33 extending through the piston and which central bore receives the reduced end 30, the threaded end 31 extending beyond the bore 33 and receiving the securing nut 34. Each end of the piston is recessed, with the recess formed in the left hand end of the piston being indicated by numeral 35 and the recess formed in the right hand end being indicated by numeral 36. It will be noted that the securing nut 34 has location within recess 35 at the left hand end of the piston, whereas, plate 37 is located in the base of recess 36 for the purpose of retaining the packing rings 38 and 39, the utility of which will be presently described. An additional packing ring of somewhat larger size, indicated by numeral 40, is positioned within groove 41 and said ring has encircling relation with the reduced portion 30 of the piston in order to seal the passage 33 to prevent flow of pressure fluid from one side of the piston to the other. Additional sealing

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means in the form of special sealing rings of rubber, such as 42 and 43, are provided and are located in grooves on the cylindrical surface of the piston and which have contact with the inside cylindrical wall of the cylinder 10 for sealing the piston with respect to said cylinder walls. The packing rings 42 and 43 are preferably V-shaped in transverse section and it will be observed that ring 42 is directed toward the left, whereas ring 43 is directed toward the right so that one ring is principally operative to seal the piston during travel of the same toward the left, whereas, the other ring is operative to seal the piston during travel toward the right.

In accordance with the invention, the piston 24 has operatively associated therewith a cushioning device for cushioning the movement of the piston at each end of its stroke by trapping some of the fluid between the piston and an end of the cylinder. The device essentially consists of a left hand valve member 44 and a right hand valve member 45, each valve member presenting a flat exterior surface such as 46 and 47, respectively, and each valve member in combination with the flat exterior surface being provided with a sealing ring such as 48 and 50.

When the piston 24 is at the end of its stroke in a left hand direction the valve member 44 is located within recess 35 formed in the left end of the piston. When the piston is located at the end of its stroke in a right hand direction valve member 45 will be located within recess 36 formed in the right hand end of the piston. Accordingly, valve members 44 and 45 have certain structural characteristics which are similar. However, with this exception their physical shape is quite different. This is due to the fact that since valve member 44 fits within recess 35 it is necessary to provide a central cavity such as 51 on the inside surface of this valve member for receiving the projecting threaded end 31 of the piston rod and for also receiving the securing nut 34 which assists in securing said piston rod to the piston. Since valve member 45 is mounted on piston rod 25 so as to have slidable movement on the piston rod, the said valve member is provided with a central passage 52 through which the piston rod extends, and the valve member is additionally provided with the packing ring 53 having encircling relation with the piston rod for effecting a fluid-tight seal therewith.

The valve members 44 and 45, although having location on respective sides of the piston 24, are suitably connected to each other by means of the valve member tie rods 55 and 56. Said valve member tie rods extend through openings in the piston such as 57 and 58, respectively, the openings being concentric with the packing rings 38 and 39 retained in place by the plate 37, as previously described. The valve member tie rods 55 and 56 are therefore slidable with respect to piston 24 although having a pressure-tight mounting in the piston due to the sealing action of rings 38 and 39. The valve member 44 is bored at spaced locations for receiving the ends of the valve member tie rods 55 and 56 for which purpose the ends project beyond the central section of the piston and into the recess 35. A circumferential groove such as 60 is formed in the exterior wall of valve member 44 and a retaining ring 61 is located in said groove and in slots formed in the valve member tie rods 55 and 56, respectively.

Accordingly, the retaining ring 61 functions as a locking member to hold the valve member tie rods in operative assembled relation with the valve member 44 and in order to prevent displacement of the retaining ring 61 stop pins 62 and 63 are provided and which have location at the respective terminal ends of the retaining ring 61. Thus the retaining ring is held against rotation within groove 60. However, the same can be removed in order to release the valve member tie rods by expanding the ring and springing the same loose from the valve member 44. For this purpose the retaining ring is flexible and has the ability to expand and contract to vary the effective

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diameter of the retaining ring. The opposite right hand ends of the valve member tie rods 55 and 56 are received in openings formed in the valve member 45 and in a similar manner the circumferential groove 64 receives the retaining ring 65 which coacts with slots formed in the valve member tie rods for releasably locking the valve member 45 to said valve member tie rods. The retaining ring 65 is held against angular displacement by means of the stop pins 66 and 67.

Each end member is provided with a fluid metering valve for adjusting the intensity of the cushioning action on the piston. The metering valve for end member 11 is indicated by numeral 70 and the metering valve for end member 12 is indicated by numeral 71. Valve 70 is located in passage 72 leading from the central passage 14 and the passage 72 is also in communication with the orifice 73. The lower end of valve 70 is threaded at 74 for threaded connection with the end member 11 and the tapered end 75 will permit varying amounts of fluid to escape to the passage 14, depending on the position of valve 70 with respect to the orifice 73. The indicating disc 76 has indicia marked thereon so that as the valve 70 is rotated the particular cushion speed setting for the position of the valve is indicated. The valve member 71 has location within passage 77 in end member 12 and is threaded at 78, the said passage 77 communicating with passage 17 and with the orifice 80. The indicating disc 81 indicates the cushion speed setting for the various relative positions of the valve member.

The valve members 44 and 45 are each releasably connected to the valve member tie rods 55 and 56 at respective ends of the valve member tie rods and the valve member tie rods are in turn mounted by the piston 24 for slidable movement with respect to said piston. Accordingly, when the piston is located adjacent end member 11 the valve member 44 will be located within recess 35 and when the piston is located adjacent end member 12 the valve member 45 will be located within recess 36. The operation of the cushioning device can best be understood by reference to Figure 1, and Figures 4 to 8 inclusive, the latter figures illustrating diagrammatically the position of the various parts during one complete stroke of the piston. As shown in Figures 1 and 4, the piston is located in its extreme left hand position in contact with end wall 68, of end member 11. The flat surface 46 of valve member 44 is also in contact with wall 68 and due to the flat contacting surfaces of the parts, together with the sealing ring 48, the bore 14 and passage 15 are effectively sealed with respect to the tubular cylinder 10. The piston is now in a position to start a working stroke in a direction to the right and upon pressure fluid being admitted to passage 15 the same will exert a force on valve member 44 equal to the area exposed by the central bore 14 times the pressure of the fluid.

In accordance with the invention the valve member 44 has a certain amount of clearance or play with respect to the depth of the recess 35, as indicated by x, Figure 2. In other words, the thickness of valve member 44 is less than the depth of the recess by the amount of the clearance indicated by x and when the force as above explained is exerted on valve 44 its initial movement will take up said clearance, see Figure 5. The initial shifting of the valve member 44 permits the pressure fluid to exert its effect upon substantially the entire face of the piston and the piston therefore has a rapid acceleration in its movement toward the right.

In Figure 6 the piston and cushioning device are moving toward the right, with the piston being located substantially in mid-position as regards cylinder 10, in which position the cushioning device has not as yet become effective. In Figure 7 the piston has moved to the right a sufficient distance to cause contact of valve member 45 with end member 12. More particularly the flat surface 47 of valve member 45 is in contact with the flat surface 69 provided by end member 12 and thus passage

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17 is completely sealed off, with the result that fluid which had heretofore been discharging through passages 17 and 18 is now trapped in this end of the cylinder between the piston and end member 12. However, the trapped fluid can still flow through orifice 80 and into the passage 17 as permitted by the metering valve 71. The changing from a free flow through passage 17 to a considerably reduced metered flow through orifice 80 results in an increase in pressure on the trapped fluid. Thus movement of the piston is cushioned in an effective manner. The pressure comes from the fluid which is pushing the piston plus the pressure resulting from overcoming the inertia of the weight of the load attached to the piston rod. Eventually the piston and cushioning device will be positioned as shown in Figure 8 wherein it will be observed that the parts are ready for a piston stroke in a left hand direction. During this return piston stroke the action of the cushioning device is the same as described and the piston movement is cushioned to an extent as predetermined by the setting of the valve member 70.

Various cushioning stroke lengths can be obtained by using longer or shorter valve member tie rods. In fact, it is possible to obtain a cushioning stroke length equal to any part of the piston stroke without the length of the cylinder itself being affected. Although each stroke of the piston is positively and adequately cushioned, nevertheless the piston will respond on its return stroke to full fluid pressure and acceleration will be rapid until the cushioning device again becomes effective.

On each stroke of the piston the cushioning device is carried by the piston for a part of the stroke and for the remaining part of the stroke the piston has movement with respect to the cushioning device, which is held against movement since one of its valve members will be in contact with an end member. The present cushioning device is further characterized in that one valve member is mounted for slidable movement on the piston rod. Also it can be noted that the maximum length for the valve member tie rods may be such as to space the valve members a distance equal to the distance between the end members.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings as various other forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. In apparatus of the character described, a fluid power cylinder having end members provided with passages for admitting a pressure fluid to the cylinder and for exhausting the fluid therefrom, means for cushioning the impact of the piston of said cylinder with the end members at the end of the piston strokes, said means including a valve member located on each side of the piston, said piston on each side thereof having a recess for receiving the valve member on that side, each valve member having a flat face for valving contact with the flat surface of its respective end member whereby to close the fluid passage in the end member, and tie rods connecting the said valve members, the tie rods extending through the piston and being slidably mounted thereby so that the valve members and tie rods comprise a unitary assembly capable of movement with respect to the piston, whereby during each stroke of the piston one valve member or the other is caused to contact its respective end member to close the fluid passage therein and trap fluid between the piston and the end member, each recess in the piston having a depth greater than the thickness of the valve member to be received therein so that prior to the start of each piston stroke initial movement of a valve member takes place as permitted by the depth of its recess to admit pressure fluid to substantially

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the entire face of the piston, and a metering valve provided by each end member and operative to release the trapped fluid at a predetermined metered rate whereby the travel of the piston is cushioned to the extent desired.

2. In a fluid power cylinder, a cylinder, an end member at each end of the cylinder, ports in said end members connected to a source of fluid power, a piston slidable in said cylinder, a piston rod secured to said piston and slidably guided through one of said end members, means carried by said piston and piston rod for cushioning piston impact with said end members, said cushioning means comprising a pair of valve members, said valve members being on opposite sides of said piston and coacting to selectively close the port in the adjacent end member, said valve member on the rod side of the piston being sealingly slidable on said piston rod, means for connecting said valve members together and supporting same on said piston, and means at each end of the cylinder for controlling the exhausting of fluid upon movement of the piston toward one end of the cylinder and closing of the port at that end by the corresponding valve member.

3. In a fluid power cylinder, a cylinder, an end member at each end of the cylinder, ports in said end members connected to a source of fluid power, a piston slidable in said cylinder, a piston rod secured to said piston and slidably guided through one of said end members, means carried by said piston and piston rod for cushioning piston impact with said end members, said cushioning means comprising a pair of valve members, said valve members being on opposite sides of said piston and coacting to selectively close the port in the adjacent end member, said valve member on the rod side of the piston being sealingly slidable on said piston rod, means for connecting said valve members together and supporting same on said piston, and means in each end member for controlling the exhausting of fluid upon movement of the piston toward one end of the cylinder and closing of the port at that end by the corresponding valve member.

4. A fluid power cylinder as defined by claim 3, wherein said control means in each end member comprises a metering valve.

5. In a fluid power cylinder, a cylinder, an end member at each end of the cylinder, ports in said end members connected to a source of fluid power, a piston slidable in said cylinder, a piston rod secured to said piston and slidably guided through one of said end members, means carried by said piston and piston rod for cushioning piston impact with said end members, said cushioning means comprising a pair of valve members, said valve members being on opposite sides of said piston and coacting to selectively close the port in the adjacent end member, said valve member on the rod side of the piston being sealingly slidable on said piston rod, a plurality of tie rods sealingly slidable in said piston and having said valve members secured to opposite ends thereof, and means in each end member for controlling the exhausting of fluid upon movement of the piston toward one end of the cylinder and closing of the port at that end by the corresponding valve member.

6. A fluid power cylinder comprising, a cylinder, an end member at each end of the cylinder, ports in said end members for admitting a pressure fluid to the cylinder and for exhausting the fluid therefrom, a piston slidable in said cylinder, a piston rod secured to said piston and slidably guided through one of said end members, said piston having recessed end portions, a cushioning device including a pair of valve members, said valve members being on opposite sides of said piston and coacting to selectively close the port in the adjacent end member, said valve members being concentric to said cylinder and the valve member on the rod side of the piston being sealingly slidable on said piston rod, said valve members sized to be freely received in said recessed end portions of said piston and of an axial width less than the depth of said recessed end portions, a plurality of tie rods

sealingly slidable in said piston and having the valve members connected to opposite ends thereof whereby said valve members move together relative to said piston, and means at each end of the cylinder for controlling the exhausting of fluid upon movement of the piston toward one end of the cylinder and closing of the port at that end by the corresponding valve member.

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References Cited in the file of this patent**UNITED STATES PATENTS**

1,604,548	Dapron	Oct. 26, 1926
2,556,698	Loewe	June 12, 1951
2,768,611	Anderson	Oct. 30, 1956
2,786,452	Tucker	Mar. 26, 1957