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FLUID PRESSURE MOTOR

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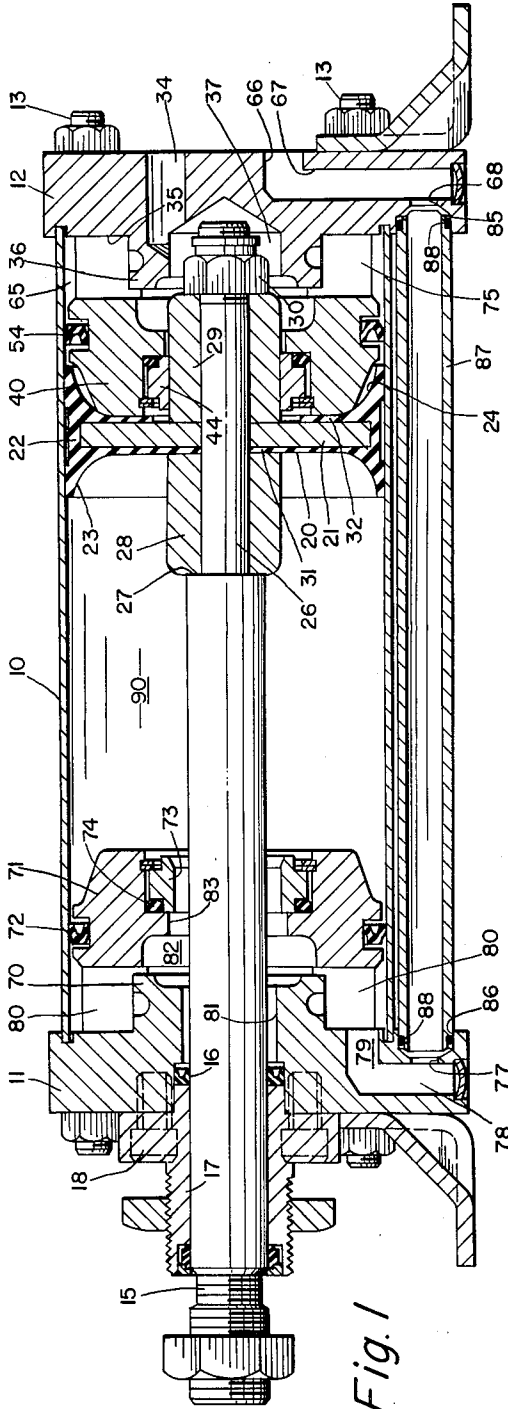


Fig. 1

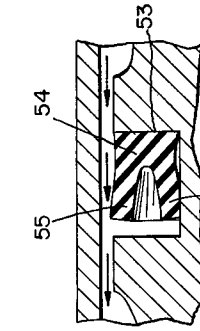


Fig. 4

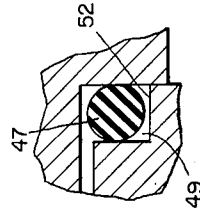


Fig. 3

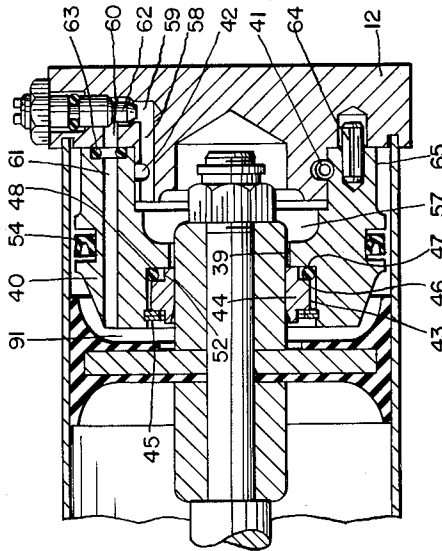


Fig. 2

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FLUID PRESSURE MOTOR

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This invention relates to fluid pressure motors of the type comprising a cylinder with a piston reciprocable therein.

An object of the invention is to provide a cushioning means which will bring the piston to a smooth stop at the end of its stroke and which permits the piston to start its return stroke with a minimum of resistance from the cushioning means.

Fluid pressure motors of this type sometimes provide a dash pot arrangement for cushioning the piston at the end of its stroke. Such arrangements may include parts which telescope as the piston nears the end of its stroke, one of the telescoping parts being on the piston and the other on the cylinder. Such parts, when telescoped, form a cushioning chamber between the piston and cylinder. A restricted passage from the chamber to an exhaust port bleeds the fluid from the chamber at a restricted rate to permit fluid trapped in the cushioning chamber to build up in pressure for providing the cushioning action. In such arrangements, when the piston travel is to be reversed, fluid under pressure is admitted to the exhaust port, which thus becomes a pressure inlet, and acts on a portion of the piston to move it in the opposite direction. As the piston starts to move in such opposite direction, the cushioning chamber enlarges, reducing the pressure and creating a suction in the cushioning chamber. Meanwhile, fluid under pressure from the inlet port flows through the restricted passage to the cushioning chamber but not quickly enough to overcome the tendency to draw a vacuum. The suction thus created in the cushioning chamber tends to hold the piston back so that it does not quickly start on the return stroke.

It is an object of the present invention to provide a means for rapidly admitting pressure fluid to such a cushioning chamber upon reversal of the piston stroke so that the piston can start the reverse stroke quickly.

It is another object to provide a check valve of relatively large fluid flow capacity for retaining fluid under pressure in the cushioning chamber during the cushioning function and which opens to rapidly admit fluid to such chamber when the piston stroke is reversed.

It is another object to provide a novel form of check valve arrangement for accomplishing the function just described.

It is another object to provide one of the telescoping parts of the cushioning device with a floating sleeve which centers itself over the other telescoping part with a minimum of resistance to radial centering movement.

It is another object to provide a simple and economical construction of a cushioning chamber arrangement that may be easily disassembled for servicing.

It is another object to provide a simple and economical method of mounting a transfer tube between the heads of a double acting cylinder whereby externally open ports for supplying and exhausting fluid to each end of the cylinder may be formed in but one of the heads and one of such ports is connected to the other of said heads by said transfer tube.

Other objects will be apparent from the following description and from the drawings in which:

FIG. 1 is a longitudinal section view of the piston and cylinder assembly showing the piston at one end of its cushioned travel.

FIG. 2 is a section view of one end of the cylinder

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taken in a plane perpendicular to the plane of FIG. 1 and showing the piston after it has started its return stroke.

FIG. 3 is a fragmentary view of the packing between the cushioning sleeve and adaptor.

FIG. 4 is a fragmentary view of the sealing ring which serves as a check valve between the cushioning chamber and a fluid port.

The cylinder includes a cylinder tube 10 to the ends of which are attached heads 11 and 12 by means of tie rods 13 which extend from one head to the other.

A piston rod 15 extends through the head 11 and is sealed with respect thereto by a packing 16 held in place by a gland 17 attached to the head 11 by bolts 18.

Mounted on the piston rod is a piston generally designated 20 which comprises a rigid disk 21 upon which is mounted a resilient annulus 22 having lips 23 and 24 which make sealing contact with the cylinder tube 10.

The piston rod 15 has a reduced diameter portion 26 terminating in a shoulder 27 and threaded at its end. The piston is clamped to the piston rod between a pair of bushings or plungers 28 and 29 by means of a nut 30. The resilient annulus 22 has a transverse web 31 which is clamped between the disk 21 and bushing 28. The opposite web 32 terminates short of the bushing 29 and the latter bears directly on disk 21.

End cap 12 on its inner side has a transverse face 35 surrounding a cylindrical axial extension 36 which has a central recess 37. One end of a hollow adaptor 40 fits closely over the end cap extension 36 and is retained thereon, in abutment with the surface 35 by a pin 41 which projects into an annular groove 42 in the extension 36. The adaptor 40 has a bore 39 and a counterbore 43 within which a sleeve 44 is retained by a snap ring 45. The sleeve 44 has a relatively large clearance, between its outer diameter and the wall of counterbore 43. The sleeve 44 has a step at one end forming a transverse surface or face 46 which is substantially parallel to the bottom surface 47 of the counterbore 43, and both surfaces are substantially normal to the axis of the cylinder. A rubber O-ring 48 seals against the surfaces 46 and 47 and normally has a clearance 49 between its inner diameter and the cylindrical wall 52 of the step in the sleeve, as well as a clearance between its outer diameter and the wall of the counterbore 43. These clearances permit the sleeve 44 to readily shift in radial directions for proper alignment with bushing 29, with which it has a close sliding fit, since such radial shifting is accomplished without compressing the packing 48 between the wall 52 and the counterbore 43. Also, such clearances by avoiding radial compression of the packing, permit the sleeve 44 to remain in its position of adjusted alignment after the bushing is retracted therefrom during reciprocation of the piston to avoid undue wear on the parts.

The adaptor 40 has a packing groove 53 in its outer periphery which contains a sealing ring 54, which as hereinafter described serves as a check valve, having inner and outer lips 55 and 56 whose free ends are directed toward the piston 20.

The end cap recess 37 is open to recess 57 in the adaptor 40 and the latter recess communicates with the inner end of the adaptor by means of passages 58, 59 and 60 in the end cap 12 and passage 61 in the adaptor. An adjustable restrictor valve 62 is threaded into the end cap for restricting the flow through said passages and a rubber O ring 63 seals passage 60 to prevent leakage therefrom between adaptor 40 and end cap surface 35. A pin 64 locates the adaptor angularly with respect to the end cap 12 to insure alignment of passages 60 and 61. The end cap recess 37 is also open to chamber 65 between the adaptor 40 and tube 10 and between ring 54 and end cap

12 by means of slots 75 through adapter 40. The slots 75 are of relatively large fluid carrying capacity for a purpose to be described later.

End cap 12 also has a port 66 opening externally thereof and connecting with port passage 67 and 68.

End cap 11 has an inward extension 70 upon which is mounted an adapter 71 that is identical with adapter 40 and carries sealing ring 72, sleeve 73 and packing 74 which are identical respectively with sealing ring 54, sleeve 44 and packing 48.

End cap 11 has connecting port passages 77, 78, and 79 which communicate with slots 80 in the adapter 71 which in turn lead to chamber 90 through recess 82 and bore 83 of adapter 71 and the interior of sleeve 73.

Ports 68 and 77 lead to counterbores 85 and 86 respectively. A transfer tube 87 connects the two counterbores. Each end of the tube has an outer diameter portion having a close slide fit within the respective counterbore and a reduced diameter portion 88 upon which is mounted a packing ring for sealing against the respective counterbore 85 and 86. The length of the transfer tube is such that its ends do not bottom simultaneously within the counterbores 85, 86. Also, the outer diameter portion at one end of the tube remains within the respective counterbore in the event the tube bottoms at its opposite end within that counterbore. This arrangement provides predetermined sealing pressure by the packings 88 which is independent of the longitudinal positioning of the tube within the counterbores and makes it unnecessary for the transfer tube length to be precisely machined as would be the case if both ends required bottoming simultaneously with the clamping of the cylinder tube 10 between the end caps 11 and 12.

In explaining the operation of the device, assume first that the piston rod 15 is in a partially extended position in which the piston 20 is about midway of the cylinder tube so that bushings 28 and 29 are clear of sleeves 44 and 73. To fully retract the piston rod from this position, fluid under pressure is admitted to port 66 by the use of a suitable valve, not shown. The fluid under pressure passes through the ports 67, 68, tube 87, ports 77, 78 and 79, slots 80, recess 82, bore 83, and sleeve 73 into chamber 90, and bears on piston 20 to move the same to the right as viewed in FIG. 1. As the piston moves to the right, fluid within chamber 91 between the piston and adaptor 40 exhausts through sleeve 44, bore 39, recesses 57 and 37 to port 34.

As the piston rod nears the end of the retraction stroke and bushing 29 enters the sleeve 44, the latter readily centers itself over the bushing without radially compressing the packing ring 48 and the close sliding fit therebetween cuts off the flow of fluid therethrough from chamber 91. The fluid thus remaining in chamber 91 becomes trapped and builds up in pressure with continued retracting movement of the piston rod to cushion stopping of the rod at the end of the stroke. During this cushioning action, the lips 55 and 56, which are normally in contact with the cylinder tube and the bottom of groove 53 respectively, are spread by fluid pressure within chamber 91 into still tighter sealing engagement therewith. At the same time, there is a gradual escape of fluid from chamber 91 by way of the restricted passages 61, 60, 59, and 58 to recesses 57 and 37 and then to exhaust port 34. By means of valve 62 the restriction through passage 59 may be varied so as to control the rate at which fluid bleeds from chamber 91 and hence controls the cushioning action.

The piston movement may be reversed before the piston head bottoms on the inner end of the adaptor by reversing the flow of fluid in ports 34 and 66 through the means of a control valve, not shown. Upon such reversal of flow, fluid under pressure enters recesses 37 and 57 through port 34 and acts upon the end of the piston rod on an effective area determined by the outside diameter of bushing 29 to urge the piston rod toward its

extended position. As the piston rod moves in this direction, chamber 91 rapidly enlarges and tends to draw a vacuum therein since pressure fluid from port 34 (and recesses 37 and 57) cannot enter fast enough through restricted passages 58, 59, 60 and 61. The suction from such vacuum would normally cause a slow movement of the piston rod in reverse direction until the bushing 29 had been withdrawn from the sleeve 44. However, such slow movement is avoided due to the action of ring 54.

Thus, fluid under pressure from recesses 37 and 57 gains ready access to chamber 65 through the relatively large slots 75 and deflects lip 55 away from the cylinder tube 10 to pass into chamber 91. The ring 54 thus acts as a check valve to prevent flow from chamber 91 to chamber 65 but permits flow in the opposite direction. Since the diameter of lip 54 is relatively large it need deflect only a small amount from tube 10 to pass a substantial quantity of fluid in a short time, thus providing unrestricted flow from chamber 65 to chamber 91. To insure such unrestricted flow, the outer diameter of adapter 40 has a substantial clearance with the inner diameter of cylinder tube 10.

It will also be noted that sealing rings 54 and 72 are confined between the relatively fixed parts 10 and 40 and are not in contact with moving parts. Thus they are not subject to rubbing wear on the lips thereof. As a result, the lips 55 and 56 may be thinner and more flexible than otherwise so as to deflect a substantial amount to permit large flow rates at relatively low pressure drops across the seal when the sealing rings are in the open position as illustrated in FIG. 4.

As soon as bushing 29 is withdrawn from sleeve 44 there will be a free flow of fluid through the sleeve into chamber 91 to act on the full area of the piston head for continuing the extending stroke. During such piston extending stroke fluid from chamber 90 exhausts through sleeve 73, slots 80 and ports 79, 78 and 77, transfer tube 87, and passages 68, 67, to port 66. Upon entrance of bushing 28 into sleeve 73 a cushioning action occurs which is similar to that described above in connection with the piston retraction stroke and further description of the same is not thought necessary. Likewise, upon another reversal of fluid pressure in ports 34 and 66, the piston rod will start on its retracting stroke and ring 72 acts as a check valve in the same manner as ring 54 to permit fast starting of the return stroke.

I claim:

1. In a fluid pressure motor, a cylinder having a bore therein, a piston reciprocable within said cylinder bore, cooperating means on said piston and said cylinder forming a cushioning chamber when the piston nears the end of its stroke in one direction, a port in the cylinder for admitting pressure fluid into said cylinder, an unrestricted passage along the wall of said bore connecting said port to said cushioning chamber, and check valve means in said unrestricted passage permitting flow of fluid from said port to said chamber and for preventing flow of fluid from said chamber to said port.

2. A fluid pressure motor in accordance with claim 1 in which said check valve means includes a flexible lip which is assisted by pressure of fluid within said chamber to close said unrestricted passage and which is actuated by pressure of fluid between said means and said port for opening said passage, said lip being located between relatively fixed parts for avoiding rubber wear thereon.

3. In a fluid pressure motor, a cylinder having a bore therein, a piston reciprocable within said cylinder bore, an adapter having a bore therethrough fixedly mounted at one end of the cylinder, means on said piston adapted to enter said bore to form a cushioning chamber between said piston and adapter when said piston nears said adaptor, a port in said cylinder for admitting pressure fluid into said cylinder, an unrestricted passage between said adaptor and the wall of said cylinder bore connect-

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ing said port and said cushioning chamber, and check valve means in said passage and associated with said adaptor for permitting flow of fluid from said port to said chamber and for preventing flow of fluid from said chamber to said port.

4. In a fluid pressure motor, a cylinder having a bore therein, a piston assembly reciprocable within said cylinder bore, an adaptor having a bore therethrough fixedly mounted at one end of the cylinder, means on said piston adapted to enter said bore to form a cushioning chamber between said piston and adaptor, a port in said cylinder for admitting pressure fluid into said cylinder, said adaptor being spaced from the wall of said cylinder bore to form an annular chamber therebetween, a passage connecting said port to said annular chamber, yieldable means between said adaptor and said cylinder wall for permitting flow of fluid from said annular chamber to said cushioning chamber and for preventing flow of fluid from said cushioning chamber to said annular chamber.

5. A fluid pressure motor in accordance with claim 4 in which said yieldable means comprises a packing ring having a flexible lip with a free end directed toward said cushioning chamber, said lip being movable by fluid pressure for opening and closing communication between said cushioning chamber and said annular chamber, said packing being isolated from contact with said piston assembly for avoiding rubbing wear thereon due to said reciprocation of said piston assembly.

6. In a fluid pressure motor, a cylinder tube, a piston reciprocable within said cylinder tube, a cylinder head closing one end of the cylinder tube and having an axial extension projecting toward the piston, a hollow adaptor telescoped over said extension and fixedly attached to said head, means on said piston adapted to enter said adaptor to form a cushioning chamber between said piston and adaptor when said piston nears said adaptor, a port in said cylinder head for admitting pressure fluid into said cylinder tube, said adaptor being spaced from said cylinder tube to form an annular chamber therebetween, a passage through said adaptor connecting said port with said annular chamber, yieldable means between said adaptor and the internal wall of said cylinder tube permitting flow of fluid from said annular chamber to said cushioning chamber and for preventing flow of fluid from said cushioning chamber to said annular chamber.

7. A fluid pressure motor in accordance with claim 6 in which said adaptor has an annular groove in its outer surface and said yieldable means comprises a packing ring within said annular groove and having a flexible lip movable into engagement with said cylinder tube wall by fluid pressure within said cushioning chamber and out of engagement with said cylinder tube wall by fluid pressure within said annular chamber.

8. In a fluid pressure motor, a cylinder having a closed end, a piston reciprocable within said cylinder, said cylinder at said closed end having a portion with a bore and a counterbore and a transverse surface therebetween, a fluid port in said cylinder in communication with said bore, a hollow sleeve attached to said portion and having a step in its outer surface forming a transverse face spaced longitudinally of said cylinder from said surface, and also forming a cylindrical wall spaced from the wall of said counterbore, plunger means on said piston adapted to enter and closely fit the interior of said sleeve to form a cushioning chamber between said piston and said cylinder when said piston nears the end of its stroke toward said closed end, said sleeve being laterally movable on said portion whereby the sleeve is self aligning with respect to said plunger means, a packing ring between said face and surface and continuously compressed into sealing contact therewith, said surface and said face extending substantially normal to the axis of said cylinder whereby said lateral shifting of the sleeve is effected with substantially no change in the longitudinal spacing of said face from said surface whereby said compression of said

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packing ring is unaffected by said lateral shifting, said packing ring being out of contact with both of said walls whereby said lateral self aligning movement of said sleeve is accommodated without compressing the packing in directions radially of the cylinder.

9. In a fluid pressure motor, a cylinder having a closed end, a piston reciprocable within said cylinder, said cylinder at said closed end having a portion with a bore and a counterbore and with a transverse surface therebetween, a fluid port in said cylinder in communication with said bore, a hollow sleeve retained within said counterbore and having a step at one end which includes a cylindrical wall and a transverse face, said face being spaced longitudinally of said cylinder from said surface, plunger means on said piston adapted to enter and closely fit the interior of said sleeve to form a cushioning chamber between said piston and said cylinder when said piston nears the end of its stroke toward said closed end, said sleeve having a loose fit with the wall of said counterbore for permitting lateral shifting of the sleeve whereby the sleeve is self aligning with respect to said plunger means, a packing ring between said face and said surface and continuously compressed into sealing contact therewith, said packing being out of contact with at least one of said walls whereby said lateral self aligning movement of said sleeve is accommodated without compressing the packing in directions radially of the cylinder.

10. A cylinder for fluid motors comprising a cylinder tube, a piston in said cylinder dividing the same into first and second chambers for fluid, a first head for closing said first chamber and a second head for closing said second chamber, means for attaching said heads to the cylinder tube with the heads in predetermined spaced relation, a first port in said first head for admitting and exhausting fluid to and from said first chamber, a second port in said first head isolated from said first port, a third port in said second head communicating with said second chamber, a transfer tube connecting said second and third ports and sealed therein whereby fluid may be admitted to and exhausted from said second chamber via said transfer tube and said second and third ports, at least one end of said transfer tube having a sliding telescopic relation within its respective port and having an endwise clearance therein when said heads are in said predetermined spaced relation whereby attachment of said heads in said predetermined spaced relation may be accomplished without interference by bottoming of said transfer tube in said second and third ports.

11. A fluid motor comprising a cylinder tube, a piston in said cylinder dividing the same into first and second chambers for fluid, a first head for closing said first chamber and a second head for closing said second chamber, means for attaching said heads to the tube with the heads in predetermined spaced relation, a first port in said first head for admitting and exhausting fluid to and from said first chamber, a second port in said first head isolated from said first port, a third port in said second head communicating with said second chamber, a transfer tube connecting said second chamber and third ports whereby fluid may be admitted to and exhausted from said second chamber via said transfer tube and said second and third ports, said second and third ports each including a cylindrical bore portion slidably receiving a respective end of said transfer tube, each end of the transfer tube having a reduced diameter portion radially spaced from the wall of the respective bore portion, a transverse shoulder extending between the reduced diameter portion and said outer diameter, a packing ring on each of said reduced diameter portions in sealing contact therewith and with the respective bore portion wall and retained therebetween against the action of fluid pressure by said shoulders, said transfer tube having an overall length less than the distance between the bottoms of said bores when said heads are in said predetermined spaced relation and said transfer shoulders being spaced apart so that each re-

mains in its respective bore when the opposite end of the transfer tube bottoms in its bore, the entire outer end surface of each of said packings between the respective reduced diameter portion and bore portions being exposed to fluid pressure within said bore portions for maintaining equal pressure upon said packings regardless of the position of said transfer tube between said heads.

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