

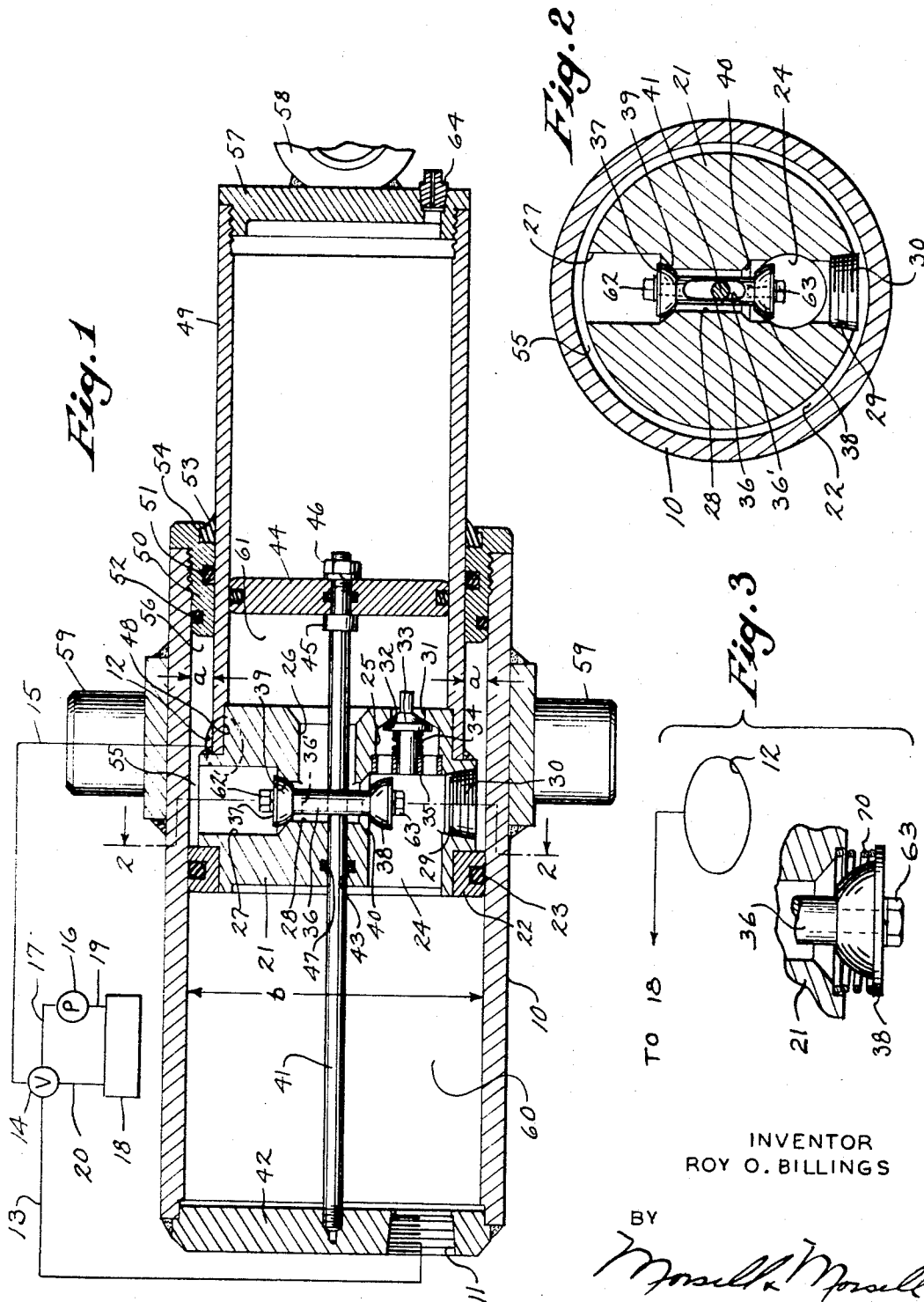
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HYDRAULIC CYLINDERS HAVING A 'QUICK EXHAUST

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HYDRAULIC CYLINDERS HAVING A QUICK EXHAUST

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11 Claims

ABSTRACT OF THE DISCLOSURE

An hydraulic cylinder having a movable piston with a tubular piston rod, and having a fixed disk within the tubular piston rod defining an auxiliary exhaust reservoir between it and the movable piston, a valve in the movable piston which is automatically closed by the fluid pressure during extension movement and which is automatically opened during retraction movement to allow a substantial portion of the hydraulic fluid in the main cylinder chamber to be quickly exhausted into the auxiliary reservoir during such return movement, there being an automatic valve for allowing emptying of said auxiliary reservoir during the extension stroke.

Background of the invention

Field of the invention.—The invention pertains to hydraulic cylinders, and more particularly to hydraulic cylinders of the type which may be employed for opening and closing clamshell buckets, as well as for a variety of other purposes.

Description of the prior art.—The usual double-acting hydraulic cylinder has a piston movable therein and has a piston rod or ram projecting from the piston and slidably projecting from an end of the cylinder. There is usually a port near each end of the cylinder communicating with a valve-controlled hydraulic circuit in such a way that when a control valve is in one position, hydraulic fluid is pumped into one of the cylinder ports against one said of the piston, and simultaneously exhausted from the other cylinder port back through the control valve into a tank or reservoir. For retraction movement the valve is so manipulated as to reverse the hydraulic flow. The hydraulic lines leading to the usual tank are necessarily of restricted size, and the speed of movement through the control valve bank is necessarily limited because of the relatively small orifices. As a result the speed of movement in both directions is relatively slow.

When clamshell buckets are operated they are commonly closed by extension movement of an hydraulic ram and are opened by retraction movement. It is, however, highly desirable to have a quick opening of the clamshell buckets so that their contents are dropped quickly into a truck or other location. Heretofore such opening movement has been objectionably slow.

Summary of the invention

An object of the present invention is to provide means for quickly exhausting hydraulic fluid during retraction movement of an hydraulic ram.

Another object of the present invention is to provide an improved hydraulic cylinder which is relatively simple in design and construction, reliable in operation, and particularly well adapted for the operation of clamshell buckets or other instruments where quick movement in one direction is desirable.

Brief description of the drawing

In the accompanying drawing, in which the same reference numerals designate the same parts in all of the views: FIG. 1 is a longitudinal sectional view through the

improved cylinder showing the piston rod in partially extended position, the hydraulic circuit being indicated diagrammatically;

FIG. 2 is a sectional view taken on the line 2—2 of FIG. 1; and

FIG. 3 is a fragmentary sectional view partially diagrammatic illustrating a modification.

Description of the preferred embodiment

Referring more particularly to the drawing, the numeral 10 designates an hydraulic cylinder having a port 11 near one end and a port 12 near the other end. The port 11 may be connected by an hydraulic line 13 with a suitable, plural-way control valve 14. The port 12 is connected by a line 15 with the control bank. In addition, in the hydraulic circuit there is the usual pump 16 having one side connected with the control valve by a line 17 and having its other side connected with the main tank or reservoir 18 by a line 19. The tank 18 is also connected to the control valve by line 20.

Slidably mounted within the cylinder is a piston 21, there being a sealing ring 22 incorporating an O-ring 23 which surrounds the piston. A bore 24 extends axially part way through the piston and communicates with a bore portion 25 of lesser diameter. Another bore 26 extends axially inwardly from the opposite face of the piston. A radial bore 27 extends part way into the piston from its periphery and merges with a bore portion 28 of lesser diameter. The bore portion 28 intersects the inner end of the axial bore 26 and also is communicable with the bore 24. Another bore 29 which is normally closed by a plug 30 is diametrically opposite the bore 27. The bore 30 communicates with the axial bore 24 to facilitate assembly of the valve member, as will be hereinafter described.

The inner end of the bore portion 25 communicates with a still smaller bore portion 31, there being a tapered valve seat 32 provided by the portions 31 and 25, which seat is controlled by a relief valve 33, the valve 33 being normally urged to closing position by a spring 34 located between the valve and a spiderlike spring retainer 35 which guides the stem of the valve 33 in sliding movement.

Freely movably mounted within the radial bore portion 28 (see FIG. 2) is a tie bar 36 connecting valve members 37 and 38 and forming a dumbbell-like double valve. The valve 37 coacts with a valve seat 39 formed between the bore portions 27 and 28, and the valve 38 coacts with a valve seat 40 formed between the bore portions 28 and 24. A tie rod 41 located centrally and axially of the cylinder 10 has one end anchored in the end head 42 of the cylinder and said rod extends through a bore 43 in the piston and through the axial bore 26. The other end of the rod carries a fixed disk 44, the disk being located between a stop collar 45 and a nut 46. It is to be noted that the tie rod 41 extends through a slot 36' in the tie bar between the valve members 37 and 38. Thus the valve may be operated without interference from the rod. An O-ring 47, within a groove around the bore 43 of the piston, seals around the rod 41 as the piston moves relative to the rod.

The piston 21 has its outer peripheral portion of reduced diameter as at 48. Fitted on said portion is the inner end of a tubular piston rod 49. The piston rod is slidable in a gland 50 which is threaded into the end of the cylinder 10, there being an O-ring seal 51 between the tubular piston rod 49 and the gland and there being another O-ring seal 52 between the gland and the outer cylinder. Thus the tubular piston rod slides between the gland and the periphery of the fixed disk 44. In addition, there is a flexible wiper 53 of rubber or synthetic material received in a groove 54 of the gland and adapted to wipe the outside diameter of the tubular piston rod 49

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during sliding movement of the latter. Between the inner end of the tubular piston rod 49 and the sealing ring 22 is a peripheral portion of the piston which is of lesser diameter than the outside diameter of the seal 22 but of greater diameter than the outside diameter of the tubular piston rod to provide an annular chamber 55 which communicates with an annular chamber 56 surrounding the tubular piston rod. The port 12 communicates with these annular chambers, as is clear from FIG. 1.

The outer end of the tubular piston rod 49 may be closed by a cover 57 having a breather 64 therein to allow ingress and egress of air, the breather being of any suitable type having an air passageway and an air filter. The cover may carry a tubular boss 58 for connection with the bucket (in the case of a clamshell bucket) or with any other device to be operated. Inasmuch as these cylinders are usually pivotally supported, oppositely projecting trunnions 49 may be provided.

Operation

In use of the device, with the control valve manipulated to cause flow from the pump 16 into the port 11, hydraulic fluid such as oil under pressure will enter the main cylinder chamber 60 and will act upon the left-hand face of the piston 21 to move the piston toward the right. At the same time, this fluid pressure will act upon the valve 38 to maintain this valve closed, it being noted that when the valve 38 is closed the valve 37 is open to provide for communication between the auxiliary reservoir 61 and the annular chambers 55-56. Thus oil within the auxiliary reservoir 61 is exhausted through the bores 26 and 27 and out of the port 12 into the main reservoir 18. At the end of the stroke the projecting end of the relief valve 33 strikes the inner face of the fixed disk 44 to relieve the pressure in the chamber 60, thus preventing stripping of the tie rod 41 or breakage of parts.

To cause retraction movement, the valve 14 is manipulated in a suitable manner to reverse the flow, i.e. to cause the flow from the pump 16 to pass through the line 15 into the port 12 of the hydraulic cylinder. This oil under pressure fills the annular chambers 55 and 56 and causes movement of the piston 21 toward the left. At the same time it acts to close the valve 37 and simultaneously open the valve 38. Opening of the valve 38 provides communication between the main cylinder chamber 60 and the auxiliary reservoir 61 of the tubular piston rod, which is located between the disk 44 and the piston. Nearly half of the oil to be exhausted from the chamber 60 will enter the auxiliary reservoir 61, and the remainder of the oil will be exhausted in the normal manner through the port 11 and ducts 13 and 20 to the main reservoir 18. Because of the position of the auxiliary reservoir 61 in the novel tubular piston rod 49, retraction movement is very quick. In addition to the above it is to be noted that the cross-sectional area of the annular chamber 56 at (a) is about $\frac{1}{2}$ of the cross-sectional area at (b). Thus movement of the piston in a retraction direction is greatly accelerated compared with the movement in the extending direction.

From the above it is apparent that a very fast retraction movement can be obtained in the case of clamshell bucket operation. The digging stroke for closing the clamshell bucket takes about four seconds, for example. The retraction stroke, on the other hand, is accomplished in about one and one-half seconds, in this example. Thus when the improved cylinder is used with a clamshell bucket, there is a quick opening action which gives a throwing effect to sand or dirt in the clamshell. This is very advantageous in clearing the bucket. The quick exhaust feature of the present invention is obviously advantageous for other uses, such as operation of presses and machine shop equipment.

The construction is very simple to manufacture. The piston 21 may be produced by simple axial and radial boring strokes and the dumbbell-like valve 36 may be easily as-

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sembled when the plug 30 is removed. It is to be noted that the valve members 37 and 38 proper are separable and removably held in position by bolts 62 and 63 which are threaded through concentric openings in the valve members.

While the invention is particularly suitable in connection with double-acting hydraulic cylinders, it is obvious that certain features of the invention are desirable in connection with single-acting cylinders to aid in quick retraction movement of the piston. FIG. 3 illustrates such application of the invention to a single-acting cylinder. In FIG. 3 there is a spring 70 which normally urges the valve 38 to opening position. The spring must be so balanced, however, that during extension movement of the ram the hydraulic pressure will act to close the valve 38 against the action of the spring. During such extension movement, hydraulic fluid within the chamber 61 will be exhausted out of the port 12 and line 15 just as heretofore described in connection with FIG. 1, except that line 15 will extend directly to the reservoir 18 instead of going through the valve 14. Upon retraction movement of the ram, which in a single-acting cylinder is usually caused by the weight of a load or by gravity, the spring 70 acts to open the valve 38, the spring being so balanced that it is stronger than the hydraulic pressure in the chamber 60 during such retraction movement. This opening movement allows a substantial portion of the fluid in the chamber 60 to be exhausted into the auxiliary reservoir 61, just as in the principal form of the invention, to thus aid in quick retraction movement.

What I claim is:

1. A double-acting fluid pressure operated cylinder having a main chamber with a fluid port, having a closure closing one end of said main chamber, having a slidable piston forming the other end of the main chamber, and having a piston rod projecting from the end of the cylinder opposite said end closure, wherein the improvement comprises having the piston rod of tubular form and of relatively large cross-section, a disk fixedly supported within the tubular piston rod against which the inside diameter of the tubular piston rod is sealingly and slidably engaged to provide an auxiliary fluid reservoir of variable size within the piston rod and between the piston and said disk, an annular seal between the outside diameter of said tubular piston rod and the cylinder, there being an annular fluid space between said annular seal and the piston and surrounding the piston rod, and there being a fluid port communicating with said annular space, duct means in the piston affording communication between the auxiliary reservoir and the annular fluid space, a first valve controlling said communication, duct means within the piston affording communication between the main cylinder chamber and the auxiliary reservoir, a second valve controlling said last communication, means providing for closing movement of said second valve and opening movement of said first valve when the piston is being extended and for closing movement of said first valve and opening movement of said second valve when the piston is being retracted, said last movement providing for quick exhaust of a substantial portion of the fluid from the main cylinder chamber into the auxiliary reservoir of the tubular piston rod during such retraction movement.

2. A double-acting fluid pressure operated cylinder as set forth in claim 1 in which there is an axially extending tie rod on which the piston is slidable anchoring the fixed disk to the end closure of the cylinder.

3. A double-acting fluid pressure operated cylinder as set forth in claim 1 in which the piston has means including a relief valve for releasing fluid pressure from the main cylinder chamber into the auxiliary reservoir when the piston reaches the end of its extension stroke.

4. A double-acting fluid pressure operated cylinder as set forth in claim 1 in which there is a connection between the first and second valves in the piston so that one valve

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is automatically opened when the other valve is closed, and vice versa.

5. A double-acting fluid pressure operated cylinder as set forth in claim 1 in which the piston has an internal radial bore with a seat for the first valve at one end and for the second valve at the other end, in which there is communication between one end of said radial bore and the annular fluid chamber, communication between the other end of the radial bore and the main cylinder chamber, and communication between the auxiliary reservoir and the radial bore, and in which movement of the first and second valves provides for communication either between the auxiliary reservoir and the annular chamber or between the auxiliary reservoir and the main cylinder chamber.

6. A double-acting fluid pressure operated cylinder as set forth in claim 5 in which there is a connecting bar between the first and second valves to provide a dumb-bell-like shape with the connection bar slidable in said radial bore.

7. A double-acting fluid pressure operated cylinder as set forth in claim 6 in which the connection bar is slotted and in which there is an axially extending tie rod on which the piston is slidable extending through the slot of the tie bar and anchoring the fixed disk to the end closure of the cylinder.

8. A double-acting fluid pressure operated cylinder as set forth in claim 6 in which there is a plugged opening in the periphery of the piston opposite one end of the valves to facilitate assembly.

9. A double-acting fluid pressure operated cylinder as set forth in claim 8 in which the two valves are removably connected to the connecting member.

10. A fluid pressure operated cylinder having a main chamber with a fluid port, having a closure closing one end of said main chamber, having a slidable piston forming the other end of said main chamber, and having a

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piston rod projecting from the end of the cylinder opposite said end closure, wherein the improvement comprises having the piston rod of tubular form and of relatively large cross-section, a disk fixedly supported within the tubular piston rod against which the inside diameter of the tubular piston rod is sealingly and slidably engaged to provide an auxiliary fluid reservoir of variable size within the piston rod and between the piston and said disk, duct means in the piston affording communication between the auxiliary reservoir and main chamber, a valve controlling said communication and positioned to be moved by fluid pressure to closed position during extension movement of the piston, there being means for exhausting fluid from said auxiliary reservoir during such extension movement, and means for causing opening movement of said valve during retraction movement of the piston to provide for quick exhaust of a substantial portion of the fluid from the main chamber into the auxiliary reservoir of the tubular piston rod during such retraction movement.

11. A fluid pressure operated cylinder as claimed in claim 10 in which the means for causing opening movement of the valve during retraction movement of the piston is a spring which is so balanced as to cause said opening movement during retraction and to permit closing movement during extension movement of the piston.

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