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[33] **Great Britain**

[31] **55172/67**

[50] Field of Search..... 91/398,  
 397, 421, 43 (Cursory), 20, 31 (Cursory)

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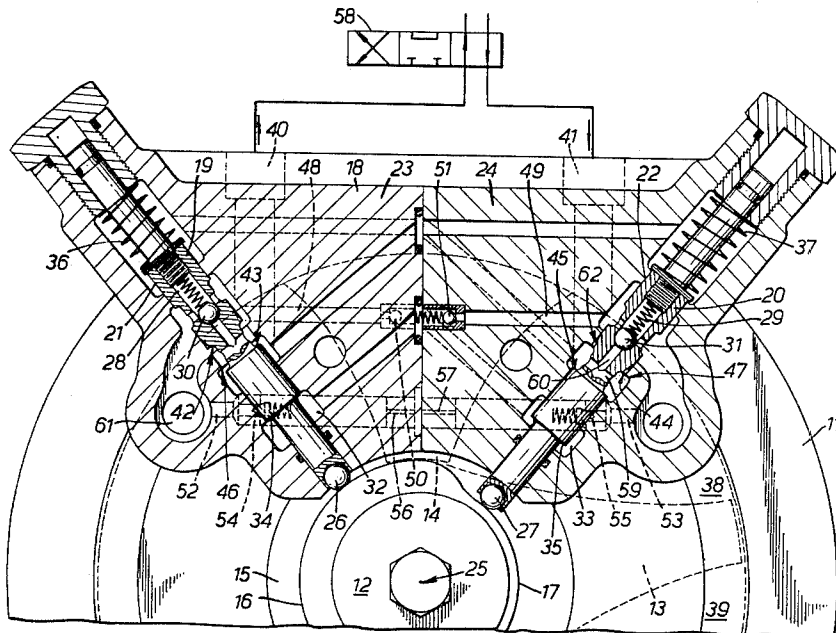
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[54] **RETARDING MECHANISMS FOR ROTARY FLUID PRESSURE OPERABLE ACTUATORS**  
 4 Claims, 3 Drawing Figs.

[52] U.S. Cl..... **91/20,**  
 91/31, 91/397, 91/405, 91/421

[51] Int. Cl..... **F15b 15/22,**  
 F01b 25/04, F15b 13/042

**ABSTRACT:** A fluid-pressure-operable actuator includes first restrictor means, effective upon fluid exhausting from the actuator, which are brought automatically into operation as the actuator approaches the end of its stroke. The actuator also includes second restrictor means operable then automatically to restrict the flow of in-going fluid to the actuator. The two restrictor means thereby provide a very positive arrangement for retarding the actuator as it approaches the end of its stroke.



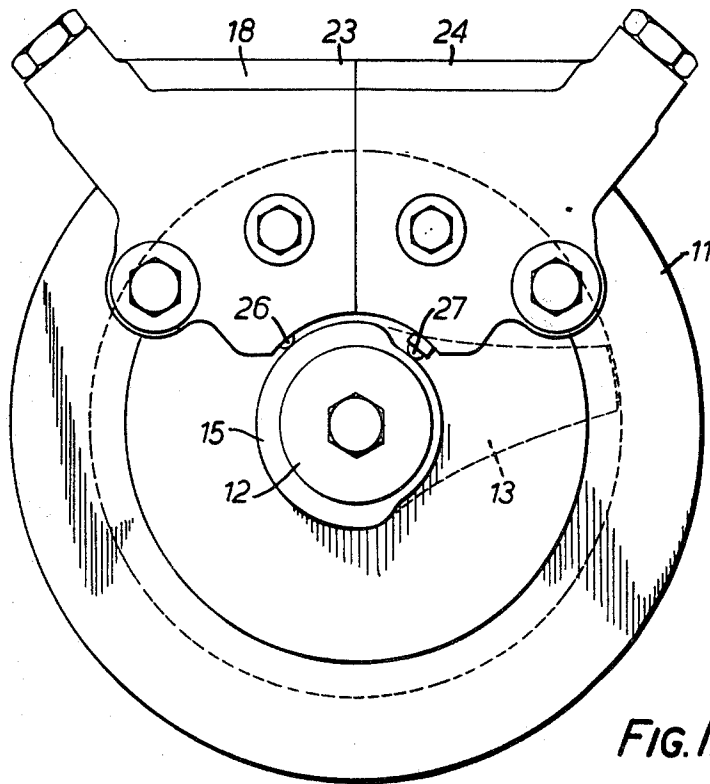


FIG. 1.

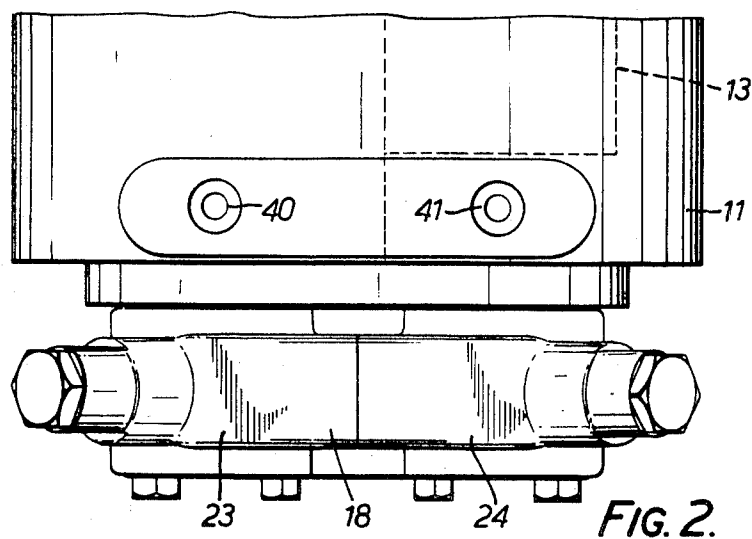


FIG. 2.

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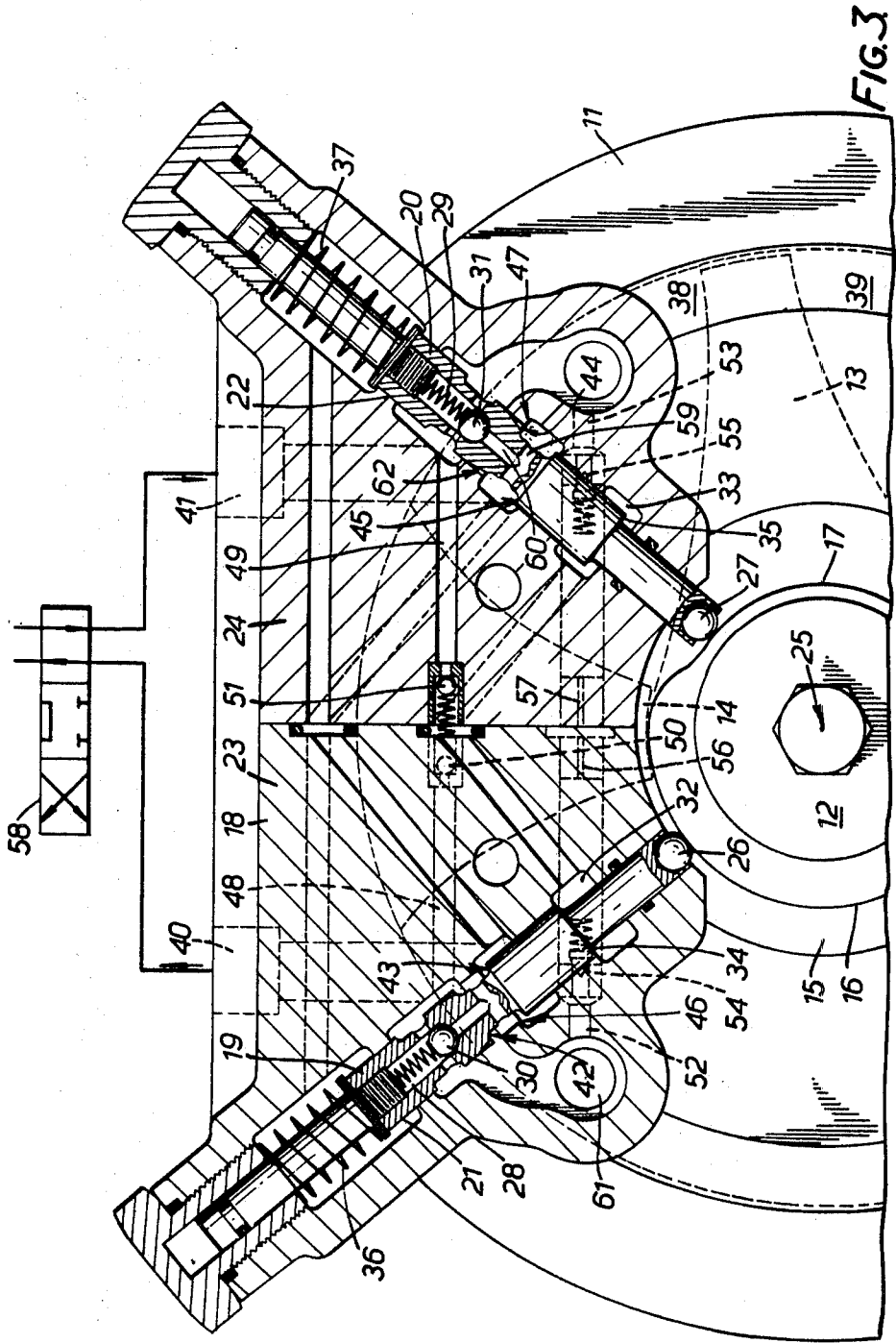


FIG. 3

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## RETARDING MECHANISMS FOR ROTARY FLUID PRESSURE OPERABLE ACTUATORS

### FIELD OF THE INVENTION

This invention relates to fluid-pressure-operable actuators.

### SUMMARY OF THE INVENTION

According to this invention a fluid-pressure-operable actuator includes first restrictor means which are effective upon the fluid which exhausts from the actuator, and which are brought automatically into operation as the actuator approaches the end of its stroke, at least in one direction, and includes also second restrictor means, operable then to restrict the flow of in-going fluid to the actuator, which are brought into operation by the application thereto of a pressure signal derived from a point in the out-going flow upstream of the first restrictor means.

By so restricting both the in-going flow and the out-going flow of the actuator, a very positive method of retarding the actuator as it approaches the end of its stroke is achieved.

The actuator may be of the linear type or alternatively of the rotary or semirotary type.

The first restrictor means may be automatically brought into operation by a cam directly connected to and operable by the output member of the actuator.

Where it is required that the actuator should be retarded at both ends of its stroke, the first and second restrictor means are so designed that both can be alternately operable upon in-going fluid and both can be alternately operable upon out-going fluid, so that in one direction of operation of the actuator the said pressure signal can be derived from a point upstream of the first restrictor means, while in the opposite direction of operation the said pressure signal can be derived from a point on the upstream side of the second restrictor means. Accordingly, the restrictor means preferably each comprise two restrictors which can be brought alternately into operation.

The first and second restrictor means may both include valve spools and in each case the said pressure signal may be applied to or near one end portion thereof, preferably in opposition to at least spring pressure. The two restrictors of each restrictor means may be of such construction as to afford different operating characteristics, and preferably comprise lands of differing effective shape.

In order to overcome the setting up of undesirably high pressures in the actuator, for example due to heavy external loading applied thereto, crossline relief valves may be provided to enable the elevated pressure side to be relieved to the low-pressure side of the actuator.

Such relief valves may be of the two-stage type and the actuator may be arranged such that the said spools form the second stage elements of the relief valves.

Check valves are preferably provided in those lines which transmit said pressure signals.

### BRIEF DESCRIPTION OF THE DRAWINGS

Of the three accompanying drawings:

FIG. 1 is an end view of a semirotary or oscillatory hydraulically operable actuator,

FIG. 2 is a plan view of a part of the actuator shown in FIG. 1, and

FIG. 3 is a part sectional view which is an enlargement upon FIG. 1.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, a semirotary or oscillatory hydraulically operable actuator comprises a casing 11, the end closure walls of which are secured to a cylindrical center portion by means of bolts. Apertures are provided in the walls to form bearings which support a rotor 12 for oscillatory motion within the casing. Formed integrally with the rotor is an output shaft connectable by splines to a device to be

operated by the actuator. The rotor has a single vane 13, while a single fixed vane 14 is secured to the inner wall of the center portion of the casing by means of set bolts. Suitable sealing means are provided in known manner in association with the fixed vane and also in association with the rotor vane, an further suitable sealing means are provided in association with the shaft portion of the rotor.

The end of the shaft remote from the spline portion extends to the exterior of the actuator casing and carries a cam 15, keyed thereto and having a portion 16 of constant diameter which continues for 210° of the cam, and a further portion 17 of constant, but smaller diameter for 100°, the effective lift portions being afforded by the change from one diameter to the other.

Also bolted to the exterior of the actuator casing is a two-piece valve casing 18 which incorporates two spools 19 and 20 which are axially slidable in suitable bores 21,22 in the casing parts 23,24, which are radially directed with respect to the axis 25 of rotation of the rotor and which each incorporate, at the radially inner end portion, a ball 26,27 which engages the surface of the cam 15.

A portion 28,29 of each of the spools is hollow and incorporates a spring-loaded check valve 30,31.

A respective annular pressure chamber 32,33 surrounds a portion of each spool and the pressure in this chamber is directed upon an annular piston area 34,35 formed on the spool. A mechanical coil spring 36,37 is provided at the radially outer end portion of each spool to bias the spool against the pressure exerted in the chamber.

The chambers 38,39 on either side of the rotatable vane 13 of the actuator have respective ports (not shown) by which liquid under pressure can be supplied to, or by which liquid can be discharged from, those chambers, and these ports communicate with the casing parts 23 and 24 and align with respective porting (not shown) therein. This porting is directly in association with the respective spool valve assemblies and through the intermediary of these assemblies connect respectively through to supply and exhaust connections 40,41 on the exterior of the casing.

The two spools each have lands 42, 43, 44, 45 which are so shaped that when the spool is in that radial position determined by the larger diameter 16 of the cam, no restriction to flow, either into the actuator, or from the actuator, is effected by that spool. However, when the cam is in a position whereby the spool has moved radially inwardly under the effort of its coil spring onto the smaller diameter 17 of the cam, the appropriate land 42,44 affords a restriction to flow of liquid out of the appropriate chamber of the actuator. When the said annular piston area 34,35 of the appropriate spool is subjected to pressure derived from the upstream side of the other spool, the mechanical coil spring 36,37 is compressed and another land 43,45 on said appropriate spool closes towards a fixed portion 46,47 of the casing to create a restriction to flow of liquid into the appropriate chamber of the actuator.

Thus each spool 19,20 provides restrictor means comprising two types of restrictor, one which restricts flow into the appropriate chamber of the actuator and one which restricts flow out of the other chamber of the actuator. In this embodiment for each restrictor means the restrictor on out-going flow comprises a taper-slotted land while the restrictor on in-going flow comprises a normal sharp land.

With each restrictor means a passageway 48,49 connects the upstream side of that restrictor for restricting out-going flow with the annular pressure chamber 32,33 associated with the annular piston area 34,35 of the spool of the other restrictor means, the two passageways 48,49 so formed, each incorporating a check valve 50,51 which permits flow of liquid only in a direction towards the respective annular pressure chamber 32,33.

Further passageways 52,53 are provided across the casing portions which afford crossline relief from one side of the actuator to the other side of the actuator, and vice versa.

These passageways which are shown one superimposed upon the other in FIG. 2, each incorporate a pilot valve 54,55 and a restrictor 56,57 associated therewith. The downstream sides of these pilot valves are respectively open to the annular pressure chamber 32 and 33. In two-stage manner, upon cracking of either of the pilot valves upon a condition of undesirably high liquid pressure in one side of the actuator or the other, the pressure in the respective annular pressure chamber 32,33 associated with the annular piston area 34,35 of the respective spool 19,20 is elevated to displace the spool axially against its coil spring for pressure relief, the spool then acting as the second stage of the respective relief valve.

To particularize on the operation of the actuator in accordance with the present invention, assuming the rotary vane 13 of the actuator to be at one end of its stroke and it is required to move the vane 13 and thus the output member of the actuator in the clockwise direction to the other extremity of its stroke, a control valve 58 associated with the actuator is operated so that pressure liquid is supplied to one of the connections 41 of the actuator while the other connection 40 is in communication with drain. Accordingly, liquid under pressure passes to the appropriate spool 20 and since the cam 15 is in the position in which this, the first spool, is in its radially innermost position, the pressure liquid passes through portion 59 in the spool and the hollow interior 60 of the spool, and through the check valve 31 of the spool to the appropriate chamber 38 of the actuator, whereupon the rotary vane commences to move in the required clockwise direction, discharging liquid in the other chamber 39 of the actuator through the discharge port 61 to the second spool 19 on the other side of the casing parts. This second spool is positioned such that neither of the restrictors 42,43 are operative because the ball 26 of that spool is riding on the larger diameter 16 of the cam 15, whereas with the first spool 20 the taper-slotted restrictor 44 is completely closed while the other restrictor 45 is wide open because the ball 27 of that spool is riding on the smaller diameter portion 17 of the cam 15. The arrangement is such that both restrictors 44,45 of the first spool are bypassed through the check valve 31 in that spool.

With continued movement of the rotor 12 and thus of the cam 15, the ball of the spool 20 first rides up onto the larger diameter 16 of the cam so that this spool assumes the same position as the other spool 19 and flow of liquid into the pressure chamber 38 of the actuator no longer occurs through the check valve 31 in the spool 20, but occurs directly through porting 62 across the spool.

In similar manner, out-going flow from the exhausting actuator chamber 39 occurs in unrestricted manner and continues to do so as the rotor rotates as long as the ball 26 of the second spool 19 is riding along the larger diameter 16 of the cam 15. However, as the rotor approaches the end of its stroke, the ball 26 of the second spool rides down the cam onto the smaller diameter 17, whereupon the second spool 19 moves radially inwardly to bring the taper-slotted restrictor 42 into effective exhaust-flow-restricting operation, thereby slowing up movement of the rotor. Consequently, a pressure drop is created across this restrictor, and the said passageway 48 which is connected at a point upstream of this restrictor takes a pressure signal through the respective check valve 50 in that passageway to the annular pressure chamber 33 associated with the first spool 20, whereupon the said annular area 35 of the first spool senses the coming into operation of the restrictor 42 of the second spool 19 and accordingly moves radially outwardly against its coil spring 37. In consequence the normal sharp land 45 of the first spool 20 closes towards the fixed structure of the assembly thus to place restriction upon the flow of in-going pressure liquid to the pressure chamber 38 of the actuator.

Thus, with the rotary vane 13 closely approaching the end of its stroke, restriction to flow is not only provided upon the exhausting liquid from the actuator, but is also provided on

the in-going liquid to the actuator so that a very positive means of retarding the actuator rotor is provided.

When it is required to operate the actuator in the opposite sense, the control valve 58 is merely changed over and the system of spools, check valves, passageways and annular piston areas operate in exactly the converse sense, the taper-slotted land of the first spool then operating to afford restriction to out-going flow as the rotor nears the end of its stroke in the opposite direction, while the normal sharp land of the second spool operates to restrict the in-going pressure fluid to the actuator.

Actuators in accordance with this invention are particularly suited for installation in earth-moving vehicles for operating digging implements thereof.

We claim:

1. A rotary fluid-pressure-operable actuator comprising:

- a. a first component,
- b. a second component, the two components being capable of relative rotational movement,
- c. a vane carried by at least one of the components, the vane and components defining two variable-volume actuator chambers,
- d. a first duct in the actuator communicable with one of said chambers,
- e. a second duct in the actuator communicable with the other of said chambers,
- f. a first fluid connection for the actuator whereby the first duct is connectible to a source of pressure fluid or to exhaust, and a second fluid connection for the actuator whereby the second duct is connectible to said source or to exhaust, to permit increase in volume of one of said chambers and decrease in volume of the other of said chambers, and vice versa,
- g. two first flow control means, one for each direction of movement of the actuator, operable, as the actuator approaches an end of its stroke, progressively to throttle the flow of fluid exhaust from one said chamber whereby a pressure differential is created across the respective first flow control means,
- h. two second flow control means, one for each direction of movement of the actuator, and
- i. ducting means adapted to apply said pressure differential to one of said second flow control means so that the second flow control means then throttles the flow of pressure fluid in-going to the other said chamber, each first flow control means and each second flow control means being so designed that they can be alternately associated with in-going fluid and with exhausting fluid, whereby relative rotational movement of said components can be progressively retarded towards both ends of the actuator stroke and finally arrested.

2. An actuator as claimed in claim 1, wherein crossline relief valve means are provided, operable to relieve whichever is the higher pressure side of the actuator to the other, lower pressure, side thereof when the pressure difference across said vane exceeds a predetermined value, said relief valve means being of two-stage type, and the actuator being arranged so that spools which form parts of said first flow control means and said second flow control means also form the second-stage elements of the relief valve means.

4. An actuator as claimed in claim 1, wherein said first flow control means is operable by cam means movable with one of said components pressure, side thereof when the pressure difference across said vane exceeds a predetermined value, said relief valve means being of two-stage type, and the actuator being arranged so that said spools also form the second-stage elements of the relief valve means.

4. An actuator as claimed in claim 1, wherein a check valve is provided in said ducting means to permit flow of fluid along that ducting means only in a direction towards said second flow control means.

UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,576,150 Dated 27 April 1971

Inventor(s) JOHN E. HODGES and CHARLES K. DEAN

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 3. (numbered Claim 4.) should read

---3. An actuator as claimed in claim 1, wherein said first flow control means is operable by cam means movable with one of said components.---

Signed and sealed this 21st day of September 1971.

(SEAL)  
Attest:

EDWARD M. FLETCHER, JR.  
Attesting Officer

ROBERT GOTTSCHALK  
Acting Commissioner of Patent