

[54] **FLUID MOTOR CONTROL SYSTEM**

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[22] Filed: **June 3, 1970**
[21] Appl. No.: **42,934**

[52] U.S. Cl. **91/448, 91/461, 137/596.15**
[51] Int. Cl. **F15b 13/042**
[58] Field of Search..... **91/436, 447, 448, 446, 461, 91/304, 444, 445, 454; 137/596.2, 596.13, 596.15**

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[57] **ABSTRACT**

An operator's actuator lever provides for starting, stopping and speed control of a fluid motor and a separate direction lever provides for selecting forward or reverse motor operation. The two levers are supported for pivoting motion along arcs which extend at right angles to each other and a stop carried on the actuator lever blocks shifting of the directional lever except when the motor is stopped thereby avoiding damage to mechanism driven by the motor from sudden reversal at high speeds. Through fluid lines, the levers condition a compact simplified valve assembly which directs driving fluid to a selected side of the motor at a selected rate and which also functions as a make-up valve to avoid cavitation and as a lock valve to resist motor movement by external load forces acting on the mechanism connected to the motor.

3 Claims, 3 Drawing Figures

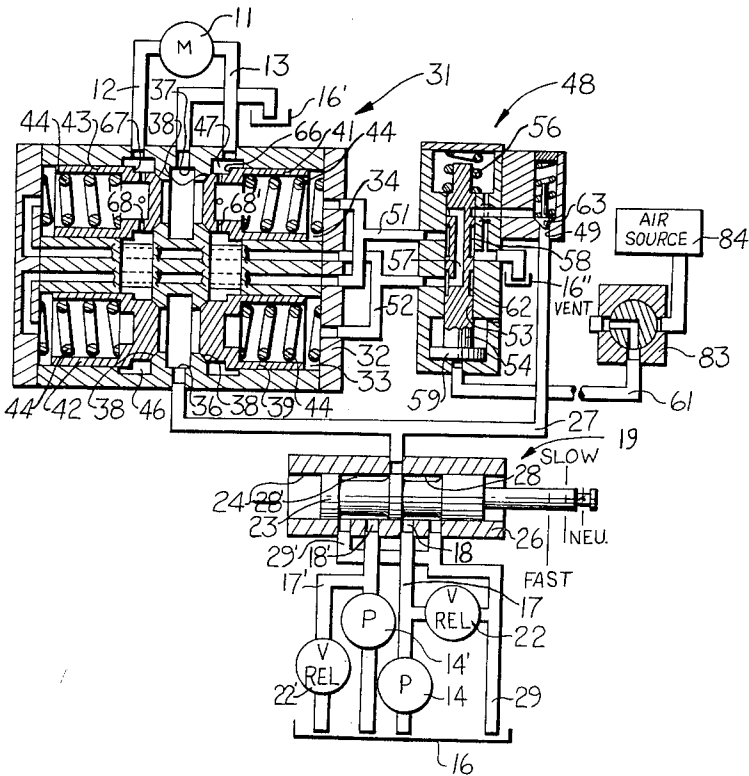


FIG. 1.

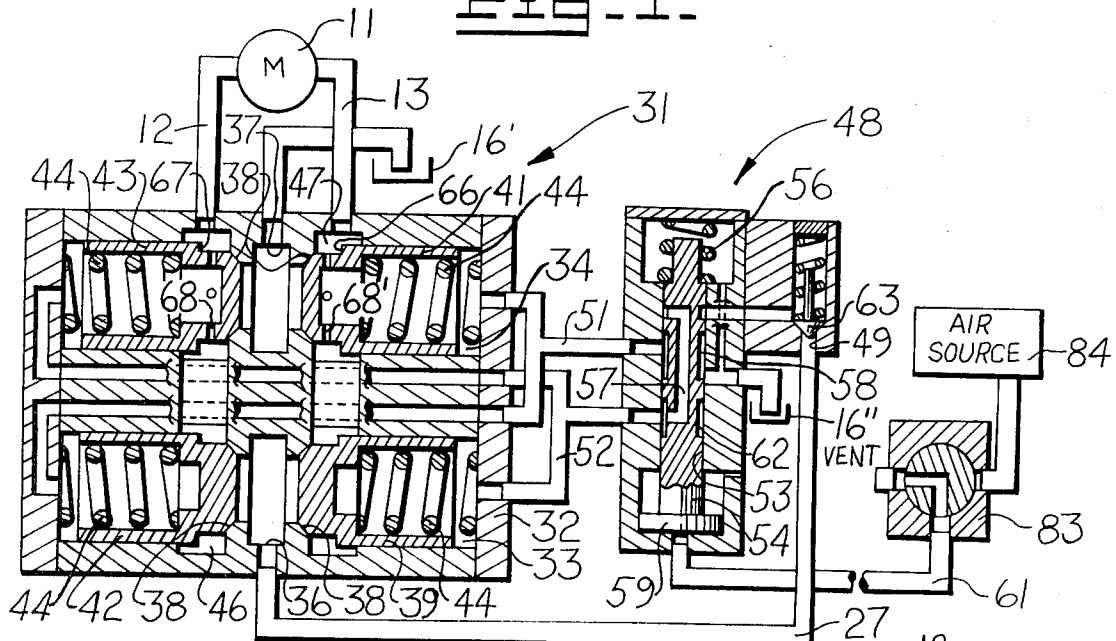


FIG. 3.

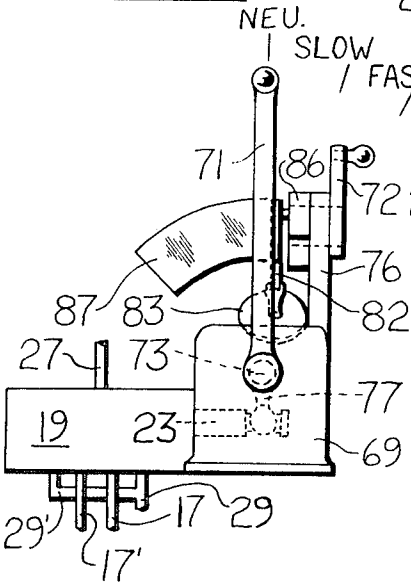
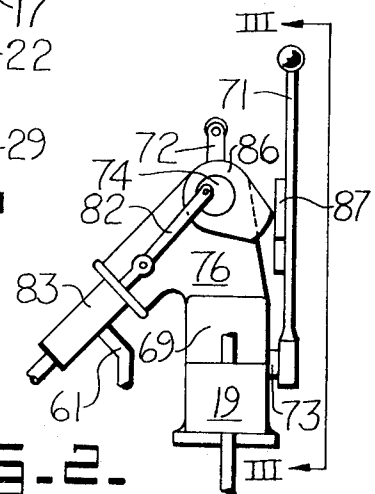


FIG. 2.



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FLUID MOTOR CONTROL SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to fluid driven motors and more particularly to control systems therefor which enable an operator to start and stop the motor and to select the direction of operation thereof and which prevent adverse effects from external load forces acting on the motor.

Fluid driven motors are frequently controlled through operator's levers which provide for starting, stopping and changes of speed and for shifts between forward and reverse operation. An earthmoving scraper of the form described in U.S. Pat. No. 3,452,458, for example, is typical of apparatus having such controls. In a scraper of this kind the movement of earth into the bowl is assisted by an elevator which may be driven by a rotary fluid motor. For efficient operation, the operator of the scraper must be able to start and stop the elevator at various times and it is helpful if the elevator can be reversed to assist in discharging material. Many other devices with essentially similar control requirements are known to the art.

Basically, the operator's control levers provide for starting and stopping the flow of driving fluid to the motor and for selectively directing the driving fluid to either of two fluid ports at the motor. In many instances, such as the scraper usage discussed above, the control system should also counteract certain undesirable effects which can arise from external load forces reacting on the motor. In particular, the control system should forestall cavitation if the motor is turned at a rate greater than that provided for by incoming driving fluid. Further, it is often desirable that the control system provide a locking action when the motor is inactive whereby load forces do not cause motor motion at such times. Still further, sudden reversals of the motor while in operation may cause damage to the driven mechanism. This is true, for example, in the scraper described above. Elevator damage can easily occur if the drive motor is suddenly reversed in the course of a loading operation. Preferably, the motor control should be designed to block undesirable motor reversals.

Heretofore, fluid motor control systems have included a complex of essentially separate fluid circuit elements to accomplish the several objectives discussed above insofar as the prior systems are capable of providing these results at all. These systems are undesirably bulky, costly and complex and in general do not provide all of the desirable functions discussed above.

SUMMARY OF THE INVENTION

This invention is a system for controlling the movement of driving fluid for a fluid motor to provide for selective starting and stopping and to further provide for forestalling cavitation and resisting unwanted motor movement from external load forces. These functions are provided by a simple low cost assembly of four valves in a single body wherein the valves respond to fluid pressures from the motor and from remote valves which are operated by the operator's control levers or the like. In a preferred form, the operator's motor actuator lever and direction selector lever are interlocked whereby the motor cannot be reversed except when stopped.

Accordingly, it is an object of this invention to provide a more compact economical and versatile system for controlling a fluid motor.

The invention, together with further objects and advantages thereof, will best be understood by reference to the following description of a preferred embodiment taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing:

FIG. 1 illustrates apparatus for controlling the operation of a fluid motor in accordance with the invention wherein certain components are shown in section and certain other components are shown in schematic form;

FIG. 2 is an elevation view illustrating the construction of operator's control lever mechanism for the system of FIG. 1; and

FIG. 3 is a side view of the control lever mechanism of FIG. 2 taken along line III—III thereof.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawing and more particularly to FIG. 1 thereof, a rotary fluid motor 11 which is controlled by the present invention may be of conventional design and is therefore shown schematically in the drawing. Motor 11 may, for example, operate the elevator of a self-loading scraper of the kind hereinbefore discussed however it will be appreciated that the present control system is not limited to this particular usage. A motor 11 of this form has two fluid ports 12 and 13 to which driving fluid may be supplied. If driving fluid is supplied to one such port 12 forward operation of the motor occurs and the fluid is discharged through the other port 13. Conversely, if driving fluid is supplied through port 13, reverse operation of the motor occurs with the fluid being discharged through the other port 12.

Driving fluid is supplied by a pair of pumps 14 and 14' which draw fluid from a reservoir 16. Pump 14' supplies fluid at a faster rate than pump 14 to provide for two speeds. The outlet 17 of pump 14 is communicated with a first inlet 18 of a motor actuator spool valve 19 and the outlet 17' of pump 14' communicates with a second inlet 18'. Pump outlets 17 and 17' are also communicated with the reservoir 16 through relief valves 22 and 22' respectively which establish the basic driving fluid pressure and which return excess pump output to reservoir 16.

Motor actuator valve 19 has a spool 23 movable in an axial direction within a bore 24 of a valve body 26 to a selected one of three positions which respectively constitute a Neutral position at which motor 11 is stopped, a Slow position at which the motor is driven at a first speed and a Fast position at which the motor is driven at a higher speed. Valve 19 has a fluid output conduit 27 situated between input conduits 18 and 18' and spool 23 is provided with a pair of axially spaced circumferential grooves 28 and 28' which communicate inlet 18 with outlet 27 at the Slow position of the valve and which communicate inlet 18' with outlet 27 at the Fast position of the valve. The valve 19 also has return conduits 29 and 29' to reservoir 16 which are communicated with inlets 18 and 18' respectively when the valve 19 is in the Neutral position to return the pump output to the reservoir. Accordingly, the motor 11 may be stopped, started and caused to operate at either of two speeds by manually shifting the valve spool 23, control means for this purpose being hereinafter described.

Pressurized fluid from actuator valve 19 is transmitted to motor 11 through a remotely situated valve assembly 31 which determines the direction of operation of the motor and additionally functions as a makeup valve in the presence of incipient cavitation and as a lock valve to prevent driving of the motor by external load forces.

Valve assembly 31 has a valve body 32 with two parallel bores 33 and 34 therein with the pressurized fluid conduit 27 from valve 19 being communicated with the center region 36 of bore 33. The center region 37 of bore 34 is communicated with fluid reservoir 16'. The center regions 36 and 37 of bores 33 and 34 respectively are defined by annular shoulders each of which forms a valve seat 38 facing away from the center region. Each end region of each of the bores 33 and 34 contains a cylindrical valve member, valve members 39 and 41 being disposed in corresponding ends of bores 33 and 34 respectively and valve members 42 and 43 being disposed in the respective opposite ends thereof each such valve member being formed to seat against one of the seats 38. Each end region of each of the bores 33 and 34 contains a compression spring 44 which urges the adjacent valve member 39, 41, 42 or 43 against the adjacent valve seat 38.

To transmit pressurized fluid from region 36 to a selected side of motor 11, a pair of parallel passages 46 and 47 extend within the valve body on opposite sides of valve seats 38. Passage 46 extends adjacent the valve seats 38 which receive valve members 42 and 43 and is communicated with port 12 of the motor 11 while passage 47 extends adjacent the valve seats which receive valve members 39 and 41 and is communicated with the other motor port 13. Thus, pressurized fluid may be directed to a selected side of motor 11 by opening the appropriate one of valve members 39 or 42 with the fluid discharge from the motor 11 being directed to reservoir 16' by opening the opposite one of the valve members 41 and 43.

The four valve members 39, 41, 42 and 43 are opened and closed to control the direction of operation of motor 11 in response to fluid pressure signals from a direction control valve 48. Valve 48 has a pressurized fluid inlet 49 connected to conduit 27 and has a pair of fluid output conduits 51 and 52. Outlet conduit 51 is branched and communicates with the region of bore 34 behind check valve 41 and with the end region of bore 33 behind valve member 42 while outlet conduit 52 is branched to communicate with the end region of bore 33 behind valve member 39 and the end region of bore 34 behind valve member 43. Valve 48 has a bore 53 with a slidable spool 54 therein which is acted upon by a compression spring 56 that urges the spool towards a position at which an internal passage 57 in the spool communicates pressurized fluid inlet 49 with outlet conduit 52 while another spool passage 58 communicates outlet conduit 51 with fluid reservoir 16'. A piston 59 on the end of spool 54 opposite from spring 56 may be acted upon by fluid pressure from a control conduit 61 to shift the spool to an alternate position at which inlet 49 is communicated with outlet conduit 51 by spool passage 58 while outlet conduit 52 is communicated with drain 16' by another spool passage 62. Valve 48 further includes a check valve 63 at pressurized fluid inlet 49 for blocking a reversed fluid flow therethrough.

If the actuator valve 19 is in the neutral (closed) position and there are no significant external load forces acting on motor 11, all four of the valve members 39, 41, 42 and 43 of valve assembly 31 are held closed by the associated springs 44. If the actuator valve 19 is then opened by being shifted to the Slow or Fast position, pressurized fluid is admitted to region 36 of valve assembly 31 and simultaneously to inlet 49 of direction control valve 48. The reaction of the system at this point is dependent upon whether or not control signal conduit 61 of direction control valve 48 is pressurized or unpressurized. If the control signal conduit 61 is unpressurized, spring 56 holds spool 54 in the position illustrated in FIG. 1 to condition the system for operating the motor 11 in the forward direction. In particular, pressurized fluid at inlet 49 of direction valve 48 is transmitted to outlet conduit 52 while conduit 51 is vented to reservoir 16'. Through conduit 52 the fluid pressure is applied to the end regions of bores 33 and 34 behind valve members 39 and 43 of valve assembly 31 while the end regions behind valve members 41 and 42 are vented to reservoir 16'. Accordingly, valve members 39 and 43 are held closed by fluid pressure while valve member 42 may be opened by the pressurized fluid in region 36. Upon opening of valve member 42 in this manner, pressurized fluid is transmitted through passage 46 to fluid port 12 of motor 11 to produce motor operation in the forward direction. Fluid discharged from the motor 11 at this time enters passage 47 of valve assembly 31 and acts against a shoulder 66 on valve member 41 which opens inasmuch as the region on the opposite side of the valve member 41 is vented to reservoir 16' through conduit 51. Opening valve member 41 enables the discharge fluid to enter region 37 and be exhausted to reservoir 16'.

If the control signal conduit 61 to direction control valve 48 is pressurized at the time fluid is supplied to conduit 27 by operation of actuator valve 19, then an opposite action occurs within valve assembly 31. The control pressure admitted to valve 48 through conduit 61 shifts spool 54 whereby pres-

surized fluid is admitted to outlet conduit 51 while outlet conduit 52 is vented to reservoir 16'. The presence of pressurized fluid in conduit 51 holds valve members 41 and 42 against the associated valve seats 38 while the fluid pressure behind valve members 39 and 43 is relieved. Accordingly, pressurized fluid entering region 36 unseats valve member 39 and passes to the reverse drive fluid port 13 of motor 11 through passage 47. Discharge fluid in motor port 12 acts against a shoulder 67 on valve member 43 to unseat the valve member whereby the returned fluid is transmitted to reservoir 16' through region 37.

Accordingly, motor 11 may be started and stopped and the direction of motor operation controlled by manipulating the spools 23 and 54 of actuator valve 19 and direction control valve 48 respectively. The described valve system further functions both as a makeup valve and as a lock valve. If, for example, the motor 11 is being operated in the forward direction, driving fluid is being transmitted to motor port 12 as described above. If incipient cavitation should occur, due to a load force on motor 11 which tends to drive the motor faster than is provided for the rate at which fluid is received at port 12, a fluid pressure reduction occurs in passage 46 of valve assembly 31. Valve member 43 is transpierced by orifices 68 which transmit such a pressure reduction to the region of the adjacent spring 44 enabling the fluid being discharged from the motor, which is passing through region 37 and which experiences a pressure rise at this time, to open the valve 43 against the action of the spring. This results in a direct return of a portion of the discharging fluid to the intake side of the motor at port 12 thereby preventing cavitation, the ultimate effect of such action being similar to that of a conventional makeup valve.

Valve member 41 is transpierced by similar orifices 68' so that a similar makeup action occurs to provide for the return of discharging fluid from port 12 to port 13 in the event of incipient cavitation while the motor 11 is operating in reverse.

Considering now the locking action of the above described structure, the system also functions to resist reverse turning of the motor 11 by an external load force against the action of the driving fluid or when the actuator valve 19 is shifted to the neutral (closed) position. During reversed turning of motor 11 by the driven load, fluid port 12 tends to be pressurized and such pressure is transmitted to passage 46 of valve assembly 31 and acts against the shoulders 67 of valve members 42 and 43 in a direction tending to open the valve members. Opening of either valve member 42 or 43 would allow rotation of the motor 11 by providing a discharge path for the fluid in port 12. Such action is resisted in the case of valve members 42 by the associated spring 44 which exerts sufficient force to block motor movement by ordinary loads. While the spring 44 acting on valve member 43 is lighter any such pressure increase in passage 46 cannot open the valve member 43 inasmuch as the check valve 63 of valve 48 blocks such movement.

Means by which an operator may shift actuator valve 19 and direction control valve 48 are shown in FIGS. 2 and 3. A control lever housing 69 supports a pivotable actuator lever 71 and a pivotable direction selector lever 72. Actuator lever 71 extends radially from a shaft 73 journaled in housing 69 while directional lever 72 extends radially from a shaft 74 journaled in a bracket 76 secured to the top of housing 69, the center line of the shaft 74 being in a plane which is normal to the plane of the center line of shaft 73 whereby the pivoting movements of the two levers are essentially at right angles to each other.

The previously described actuator valve 19 is secured to housing 69 and a crank arm 77 on shaft 73 engages the spool 23 of valve 19 whereby pivoting movement of the actuator lever 71 shifts actuator valve 19 between the three previously described positions thereof. A link 82 having one end eccentrically fastened to the directional lever pivot shaft 74 operates an air valve 83 situated between directional signal conduit 61 and a source 84 of air under pressure as shown in FIG. 1. At the reverse position of lever 72 valve 83 commu-

nicates the directional signal line 61 with air source 84 and vents the signal conduit 61 when the lever is at the forward position to condition the direction selector valve 48 as hereinbefore described.

In many systems driven by a fluid motor 11, such as the earthmoving scraper elevator drive hereinbefore discussed, a reversal of the motor while in operation may cause damage to the driven mechanism. Referring again to FIGS. 2 and 3, to prevent such damage, a cam 86 extends radially from the pivot shaft 74 of direction selector lever 72 and an arcuate member 87 is secured to actuator lever 71 in position to be abutted by the cam 86 during any attempted move of direction lever 72 between the two positions thereof when the actuator lever is at either the Slow or Fast position. When actuator lever 71 is at the Neutral position at which the motor 11 is stopped, member 87 no longer transacts the plane of cam 86 and movement of the direction selector lever between the forward and reverse positions may be effected.

What is claimed is:

1. In a control system for a motor which is driven by pressurized fluid received through an actuator valve having open and closed positions, said motor having a pair of fluid ports wherein fluid may be directed to a forward drive one of said ports to produce motor operation in a forward direction and to a reverse drive one of said ports to produce motor operation in a reverse direction and wherein fluid directed to one of said ports is transmitted to drain means through the other port during motor operation, the combination comprising:

- valve body means having a fluid inlet receiving fluid from said actuator valve and having a forward drive passage for transmitting fluid from said inlet to said forward drive port of said motor, said valve body further having a reverse drive passage for transmitting fluid from said inlet to said reverse drive port of said motor,
- a first pair of valve members each being situated in a separate one of said passages of said valve body means and each having an open position and a closed position,
- a second pair of valve members each being situated between a separate one of said passages of said valve body means and said drain means and each having an open position and a closed position,
- a motor direction control valve having an inlet communicated with said actuator valve for receiving a portion of said pressurized fluid therefrom and having a forward drive position at which said fluid is transmitted to the one of said first pair of valve members that is situated in said forward drive passage and the one of said second pair of valve members that is situated in said reverse drive passage to hold said ones of said valve members in the closed positions thereof, said motor direction control valve having a reverse drive position at which said fluid is directed to the others of said first and second valve members to hold said other valve members closed, and
- means for blocking a shift of said motor direction control valve between said positions thereof while said actuator valve is opened.

2. In a control system for a motor which is driven by pressurized fluid received through an actuator valve having open and closed positions, said motor having a pair of fluid ports wherein fluid may be directed to a forward drive one of said ports to produce motor operation in a forward direction and to a reverse drive one of said ports to produce motor operation in a reverse direction and wherein fluid directed to one of said ports is transmitted to drain means through the other port during motor operation, the combination comprising:

- valve body means having a fluid inlet receiving fluid from said actuator valve and having a forward drive passage for transmitting fluid from said inlet to said forward drive port of said motor, said valve body further having a reverse drive passage for transmitting fluid from said inlet to said reverse drive port of said motor,
- a first pair of valve members each being situated in a separate one of said passages of said valve body means and each having an open position and a closed position,
- a second pair of valve members each being situated between a separate one of said passages of said valve body means and said drain means and each having an open position and a closed position,
- a motor direction control valve having an inlet communicated with said actuator valve for receiving a portion of said pressurized fluid therefrom and having a forward drive position at which said fluid is transmitted to the one of said first pair of valve members that is situated in said forward drive passage and the one of said second pair of valve members that is situated in said reverse drive passage to hold said ones of said valve members in the closed positions thereof, said motor direction control valve having a reverse drive position at which said fluid is directed to the others of said first and second valve members to hold said other valve members closed,
- an actuator lever coupled to said actuator valve and movable to shift and actuator valve between said open and closed positions thereof, and a direction selector lever movable between forward and reverse positions for shifting said motor direction control valve between said forward and reverse positions thereof, and means coupled to said actuator lever and movable therewith for blocking said movement of said direction selector lever when said actuator lever is positioned to open said actuator valve.

3. The combination defined in claim 2 wherein said actuator lever is pivoted for motion within a first plane and said direction selector lever is pivoted for motion within a plane normal to said first plane, further comprising a cam coupled to said direction selector lever to turn about the pivot axis thereof when said direction selector lever is moved, and wherein said means for blocking movement of said direction selector lever when said actuator lever is positioned to open said actuator valve comprises a member secured to said actuator lever and extending therefrom in position to be abutted by said cam upon attempted pivoting of said direction selector lever while said actuator lever is positioned to hold said actuator valve open.

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