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FLUID SYSTEM FOR INDEPENDENT OPERATION OF TWO FLUID MOTORS

Filed Aug. 24, 1966

2 Sheets-Sheet 1

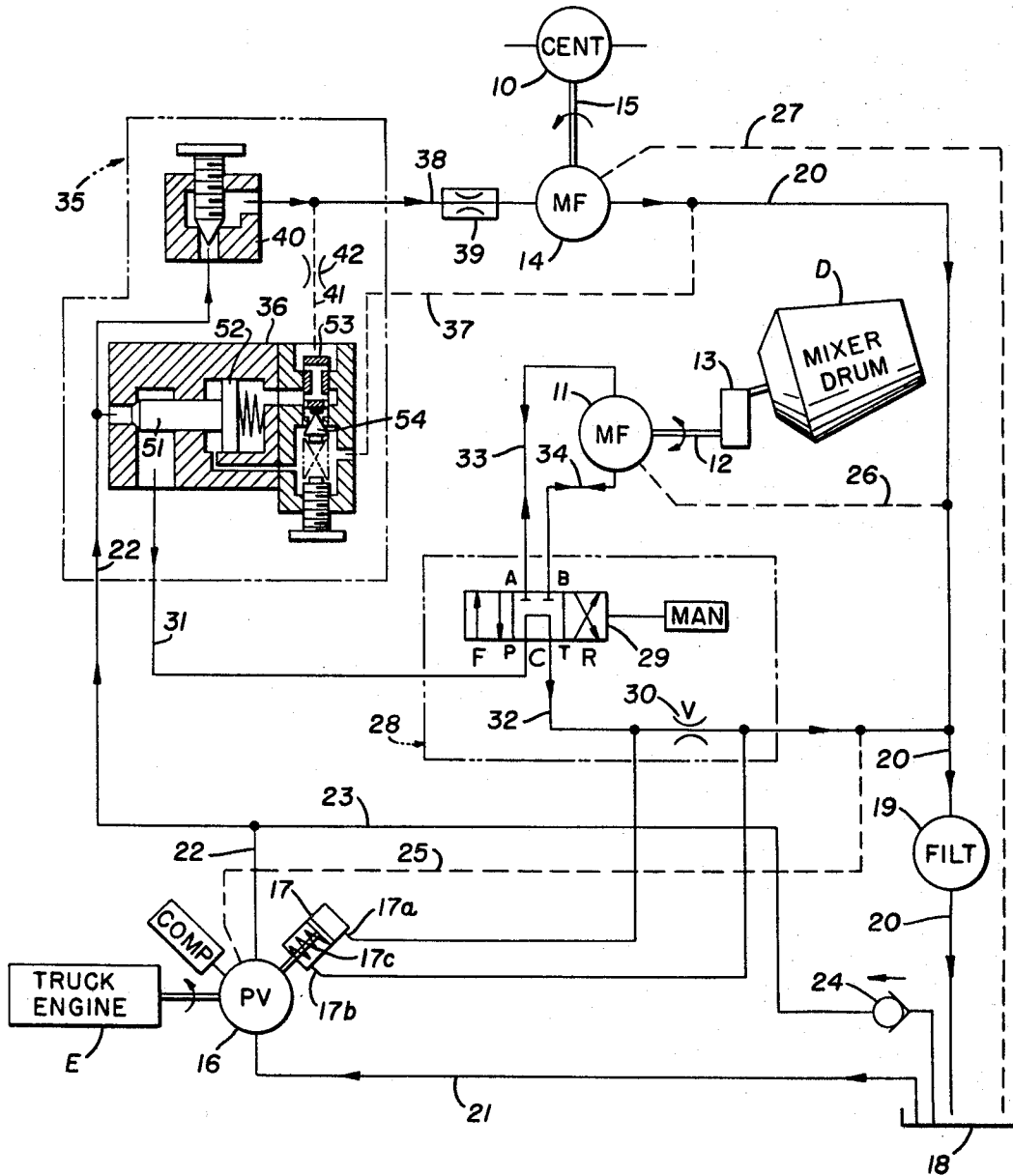


Fig. 1

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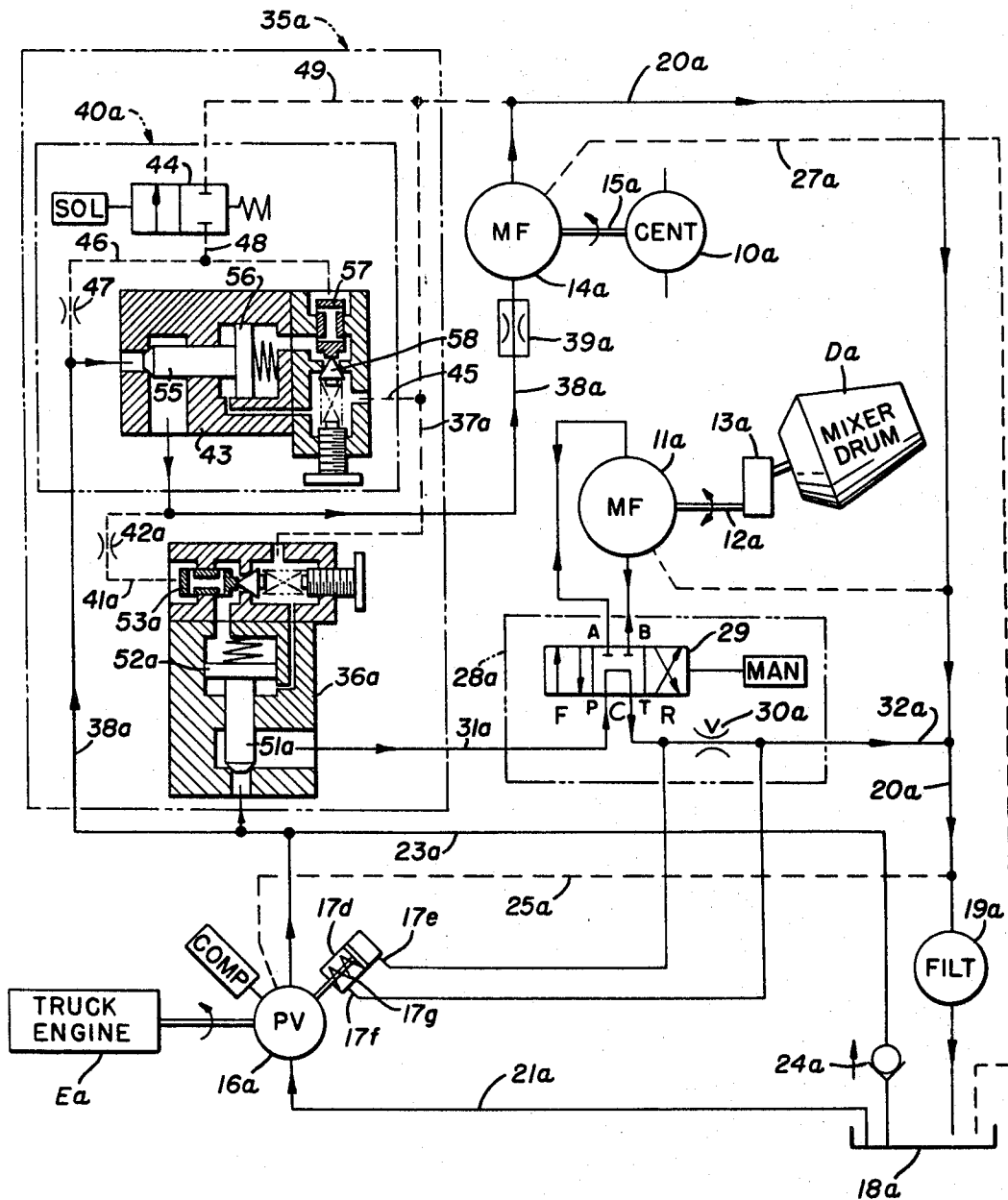


Fig. 2

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FLUID SYSTEM FOR INDEPENDENT OPERATION OF TWO FLUID MOTORS

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ABSTRACT OF THE DISCLOSURE

Selective and independent control of two fluid motors is effected through a fluid control system which permits their concurrent operation by a single fluid pump. The fluid control system includes valve means connected in circuit with the fluid motors and operative in response to fluid flow of one motor to the other motor when the pump is not operating to fully satisfy requirements of both motors. The fluid pump is of the variable volume type responsive to fluid flow requirements of the latter motor to provide pressurized fluid adequate for the system requirements.

General description of the fluid system

The fluid control system described herein is directed primarily to an application such as is encountered in vehicle-mounted, mobile concrete mixers but the application of this system is not limited to this specific application. In the application described herein, the system is applied to an apparatus having a single fluid pump driven by the vehicle engine to supply the necessary fluid for operation of the apparatus which includes, primarily, a concrete mixer drum which may be intermittently driven at a predetermined speed with varied loads. The driving means for the mixer drum comprises a fluid motor which is drivingly connected to the drum and receives fluid for operation from the fluid pump. Suitable fluid control means are interposed between the fluid pump and the fluid motor for effecting the necessary control over operation of the motor in driving the mixer drum. This control means includes, for example, a four-way valve permitting operation of the fluid motor in either of the selected directions or permitting the motor to remain stationary and incorporates additional auxiliary control means for controlling the operation of the fluid pump in delivering the necessary quantity of fluid at the required pressure for proper operation of the mixer drum.

It is often desirable or necessary, during operation of a mobile type concrete mixer, to supply water for mixing of the concrete or for cleaning of the mixer drum. Accordingly, the mobile concrete mixers are provided with a water supply tank and pump means for supplying the water as needed under a suitable fluid pressure. Driving of the water pump is effected by a second fluid motor which is designed to be driven by the fluid supplied under pressure by the fluid pump also operating the mixer drum. In accordance with the prior art, the second fluid motor is provided with a separate, independently-operated, control system but because of the dissimilar operating conditions of the two fluid motors and their respective driven loads, the fluid circuits of the prior art apparatus are of a type which prevent simultaneous operation of the water pump and the mixer drum. There are many instances in which it is desirable to permit simultaneous operation of both the mixer drum and the water pump, such as in supplying water under pressure for cleaning of the drum or for adding water to concrete during the mixing operation.

It is, therefore, the primary object of this invention to provide a fluid control system which permits the simul-

taneous and independent operation of two fluid motors which are supplied by a single fluid pump.

It is another object of this invention to provide a fluid control system for dual operation of fluid motors supplied by a single fluid pump which will permit starting of either fluid motor for independent operation or permit starting of either fluid motor while the other motor is operating.

It is a further object of this invention to provide a fluid control system for operation of two fluid motors having dissimilar operating conditions and which substantially prevents excessive fluid pressure surges when starting or stopping either of the fluid motors.

It is also an object of this invention to provide a fluid control system of the type described which is efficient in operation and prevents excessive power loss through generation of heat in the operation of the several elements of the system.

These and other objects and advantages of this invention will be readily apparent from the following detailed description and the accompanying drawings.

In the drawings:

FIGURE 1 is a schematic diagram of a fluid control system embodying this invention and which incorporates a manual control mechanism.

FIGURE 2 is a schematic diagram of a modification of the fluid control system which incorporates an automatic control mechanism.

Having reference to FIGURE 1 of the drawings, a basic fluid control system, which is manually operated, is shown as applied to a mobile concrete mixer in which the mixer drum is mounted on a vehicle of the self-propelled type having an engine E. In this type of installation, the vehicle engine E is utilized to provide the necessary power for operation of the components of the system. Carried by the truck is a mixer drum D which is adapted to be charged with the concrete-forming materials and transported by the truck. Also carried by the truck is a water supply system which includes a suitable water pump 10 which may be of the centrifugal type. Only the pump 10 of the water supply system is shown diagrammatically in FIGURE 1 as the remainder of the water supply system is of well known construction and the details of this system do not form a part of this invention. The mixer drum D is also only shown diagrammatically as its structure and mounting is of well known construction. Revolving of the mixer drum D is effected by a fluid motor 11 which may be of the fixed displacement, reversible type supplying the necessary rotary motion to a drive shaft 12 and which shaft is drivingly connected with the mixer drum D by a suitable gear box and transmission 13. Rotary motion is also supplied to the water pump 10 by a fluid motor 14 which may be of the fixed displacement type and may be directly connected to the pump 10 by a drive shaft 15.

The necessary pressurized fluid supply for operation of the drum motor 11 and the water pump motor 10 is provided by a fluid pump 16 which is drivingly connected to the truck engine E. The truck engine is also adapted to provide the necessary motive force for the vehicle through a power train of the well known type including a transmission and clutch mechanism (not shown). However, the pump 16 is preferably directly connected to the truck engine E for continuous operation as long as the truck engine remains operating. The pump 16, which is of the pressure compensated, variable displacement type to accommodate variations in fluid flow required for operation of the fluid drive motors 11 and 14 under varied load conditions, also includes a control mechanism 17 for automatically effecting a change in the displacement of the pump to accommodate variations in fluid flow required by the system. This control mechanism 17 may be of the

type comprising a movable member within the pump controlling the displacement and an actuating member comprising a piston and cylinder unit. This piston and cylinder unit is diagrammatically shown in FIGURE 1 and is provided with fluid connection ports 17a and 17b which communicate with the cylinder at opposite sides of the piston. Also included in the piston and cylinder unit 17 is a spring 17c which normally biases the movable displacement control member of the pump 16 to a fixed, maximum flow position. Operation of this control mechanism 17 is such that the application of a relatively greater fluid pressure at port 17a will overcome the biasing force of the spring 17c and a relatively lower fluid pressure at port 17b will displace the movable control element or member of the pump 16 to a decreased fluid flow position. The specific flow position of the movable member of the pump 16 is dependent on the relative differential operating on the piston of the control mechanism 17 and is compensated by the spring 17c.

Other components of the fluid system include a fluid supply reservoir 18 having a capacity to adequately meet the requirements of the fluid system. A fluid filter 19 is also connected in a main return line 20 to the reservoir 18. Connecting the fluid reservoir 18 to an inlet port of the pump 16 is a suction line 21. Connected to the outlet port of the pump 16 is the main pressurized fluid supply line 22. An auxiliary suction line 23 connected to the main pressure supply line 22 connects the outlet port of the pump 16 to the reservoir 18 through a check valve 24 which is connected in this line to permit relatively free fluid flow from the reservoir to the pump. The purpose of the auxiliary suction 23 is to provide a fluid supply in the event that the pump 16 is momentarily driven in a reverse direction as may happen in the case when the truck engine E is stopped. During normal operation of the fluid system, the auxiliary supply line 23 is of no effect as the check valve 24 prevents fluid flow from the high pressure outlet port of the pump 16 to the reservoir 18.

The fluid pump 16 and each of the fluid motors 11 and 14 are of a type provided with external drain connections with the drains of the pump 16 and the motor 11 being connected by the respective drain lines 25 and 26 to the fluid return line 20 at the inlet side of the filter 19. The external drain of the motor 14 is connected by an independent drain line 27 directly to the reservoir 18. In the present embodiment, the independent drain line 27 for the motor 14 is required as this motor is of a type having a relatively low pressure type seal and the direct return prevents loss of seal as this line is at an effective zero pressure whereas the drain lines connected to the filter are at a specific fluid pressure which may be within the range of 25 to 50 p.s.i.

Control of the fluid motor 11 driving the mixer drum is effected by a control means indicated generally at 28 and including a three-position, spool-type valve 29 and a variable restriction valve 30. The spool-type valve 29 may be of the manually operated type having detents for maintaining the spool in the desired position. In the illustrated center position of the spool, the inlet port P is connected to the fluid supply line 22 and the tank port T is connected to the main return line 20 through the restriction valve 30 with the ports P and T being interconnected by the spool for fluid flow through the valve. The outlet ports A and B of the valve, which are blocked in the center position, are connected to the inlet and outlet ports of the fluid motor 11 as determined by the direction of rotation. Manually actuating the valve 29 to place the spool in position where the section F is connected with the ports of the valve housing, the fluid will flow through the valve in the indicated direction for driving the motor 11 in a forward direction. Actuating the valve 29 to place the section R in fluid flow relationship to the ports of the valve will direct fluid flow to the motor 11 in the opposite direction to result in a reversal in its direction of operation. The center position C of the

spool of valve 29 is formed to block both ports A and B and to prevent rotation of the motor 11. The pressure and tank ports are interconnected in this center position to permit fluid flow through the valve and through the restrictor valve 30.

This variable restriction valve 30 may also be of the manually operated type and is utilized in conjunction with the manually operated valve 29 to control the operation of the main drive motor 11 as to the speed of rotation of the mixer drum D. This restriction valve 30 is also designed to provide a relatively constant, minimum pressure differential across the inlet and outlet ports of the valve in any selected fluid flow position. This pressure differential which may be of the order of 200 p.s.i. is utilized for operation of the control mechanism 17 in varying the fluid displacement of the pump 16 in order that the fluid volume demands of the system may be met at all times. The pressure differential appearing across the restriction valve 30 will remain substantially constant for a predetermined minimum volume at any particular orifice setting. A decrease in fluid flow through the restriction valve 30 resulting from a specific operating condition of either the mixer drum D or the water pump 10 will result in a decreased fluid pressure differential which will be sensed by the control mechanism 17 and effect an increase in the volumetric output of the pump 16. Similarly, an increase in fluid flow through the restriction valve 30 at a specific setting of the orifice will result in an increase in the pressure differential across the valve and cause operation of the control mechanism 17 to decrease the volumetric output of the pump 16.

Further control of the operation of the motors 11 and 14, which respectively drive the mixer drum D and the water pump 10, is effected by fluid control circuit means, indicated generally at 35. First fluid flow control means incorporated in the circuit 35 effects control of fluid flow through a line 31 connecting with the pressure port P of the valve 29. This control means comprises a sequence valve 36 having an inlet port connected to the main pressurized fluid supply line 22 and an outlet port which is connected to the line 31. The sequence valve 36 is set at a predetermined pressure, such as 1800 p.s.i. in the present embodiment, and will maintain that pressure in lines 22 and 38 until the requirements of the motor 11 require a greater pressure. An external drain is also provided for the sequence valve 36 and is connected by a drain line 37 to an extension of the main return line 20. Also connected to the main pressurized fluid supply line 22 at the inlet port side of the sequence valve 36 is a branch fluid supply line 38 which is connected with the motor 14 driving the water pump 10. The branch supply line 38 connects with the inlet port of the motor 14 while the outlet port of this motor is connected to the main return line 20. Interposed in this branch supply line 38 is a pressure compensated, flow control valve 39 which is interposed between the fluid control circuit means 35 and the inlet port of the motor 14 and which is operable to effect control over the speed of operation of the motor. The flow control valve 39 is normally preset to a predetermined value or setting to limit the maximum speed of the motor 14 to prevent overspeed of the water supply components, such as the water pump 10 and, in the present embodiment, is set to limit fluid flow through the motor 14 to a maximum of seven gallons per minute irrespective of the fluid pressure. A second fluid flow control means 40 is also incorporated in the circuit means 35 for effecting the selective operation of the motor 14. In the embodiment of the fluid control system illustrated in FIGURE 1, the second flow control means 40 comprises a manually operated, shut-off valve which may be of the needle valve type. A control line 41 connected to the branch pressure supply line 38 at the outlet side of the valve 40 also connects with a control port of the sequence valve 36. Interposed in the control line 41 is a choke-type restriction 42.

The fluid control system is operable to selectively control either the main drive motor 11 operating the mixer drum D or the fluid motor 14 driving the water pump 10 or to start or stop either of the motors, 11 or 14, at any time. In addition to the operating condition where both motors 11 and 14 are stopped and it is desired to start either motor, the fluid control system is operative to permit simultaneous operation of the motors. In the operating condition where both motors 11 and 14 are stopped, the spool of valve 29 is positioned to connect port P with port T and block ports A and B as indicated by center section C and the valve 40 will be completely shut off. In this configuration, the valve 29 will permit fluid flow through the center section from the pressure port P to the tank port T and the valve 40 will be effectively blocking fluid flow through the branch supply line 38 to the water pump motor 14. The ports A and B of the valve 29 will be blocked and prevent rotation of the main drive motor 11 holding the mixer drum in a stationary position. With the valve 40 shut off, the portion of a branch supply line 38 connecting with the outlet port of this valve and the inlet port of the motor 14 will be effectively at a zero fluid pressure having a nominal value which is equal to the back pressure produced by the fluid return system including the filter 19 and may be in the range of 25 to 50 p.s.i. With essentially a zero fluid pressure in the control line 41, a movable valve spool 51 in the sequence valve 36 will be displaced from the illustrated inlet-port-blocking position to an open position where there will be free flow from the inlet port connecting to the main supply line 22 to the outlet port connecting with the line 31 permitting fluid flow from the main pump 16 through the valve 36 and the spool valve 29 to the orifice 30 and return to the fluid reservoir. This is a minimum fluid flow configuration which is controlled by the minimum orifice setting of the variable restriction valve 30 and the pressure differential appearing across this valve will operate on the control mechanism 17 to maintain a relatively constant minimum fluid flow through the system. This minimum fluid flow is desired to maintain the pump 16 in operation although requiring a minimum amount of power for its operation.

If it is desired to operate the mixer drum D, the control means 28 is operated to provide fluid flow through the motor 11 in the desired direction and the volume is controlled to obtain the desired drum speed. This is accomplished by displacing the spool of the valve 29 in a desired direction to bring either the F or the R section in fluid flow relationship to the ports of the valve body and cause fluid flow through the motor 11 in the proper direction. Speed of the motor 11 is controlled by operation of the variable restriction valve 30 to provide a particular setting at which the drum D will be revolved at the desired speed and maintain the minimum predetermined pressure differential across the valve. Opening of the valve 30 from its minimum flow condition to increase the fluid flow through the motor 11 and thereby increase its speed will momentarily decrease the pressure differential across the valve and the control mechanism 17 will be caused to operate in increasing the volumetric output of the pump 16. As the flow from the pump 16 and through the motor 11 reaches the volume required for operating the drum D at the desired speed for the particular load condition, the pressure differential across the valve 30 will again return to the desired minimum pressure differential and operate on the control mechanism 17 to maintain the pump 16 in this particular flow condition. The operating pressure of the fluid in the main supply line 22 and to the inlet port of the motor 11 will be determined by the particular load condition of the drum D. Stopping of the mixer drum D is effected by returning the spool of the valve 29 to the illustrated center position and returning the restriction valve 30 to its minimum flow configuration. The pressure differential change sensed by the control mechanism 17 will return the pump 16 to its minimum

volumetric flow capacity. During the starting and stopping operations of the mixer drum D, the valve 36 will be maintained in its free flow configuration as long as the valve 40 is maintained closed.

If it is desired to operate the motor 14 in driving the water pump 10 while the motor 11 remains stationary with the valve 29 placed in the center, illustrated position, it is only necessary to open the valve 40 to permit fluid flow through the branch supply line 38 and through the motor 14. As the valve 40 is opened, the fluid pressure in the branch supply line 38 will be increased and the pressure in the control line 41 will approach that of the main supply line 22. This fluid pressure in the control line 41 is applied to the piston end 32 of the movable spool 51 of the sequence valve 36 through a spool-piston 53 in opposition to the fluid pressure applied to the opposite end of the spool at the inlet port of the sequence valve and will effect closing of the sequence valve due to the difference in area. Due to the choke restriction 42 in the control line 41, the fluid pressure is increased at a relatively slow rate and the sequence valve 36 will, therefore, operate slowly during the closing cycle. This slow operation of the sequence valve 36 will prevent high pressure surges in the system which could be destructive to the several elements.

With the sequence valve 36 now closed, fluid flow will be from the main supply line 22 through the branch supply line 38 and through the flow control valve 39 and the motor 14. As previously indicated, the flow control valve 39 will have been preset to the predetermined value to maintain the motor 14 at a specific speed. Since the sequence valve 36 will now be closed, there will be no flow through line 31 and line 32 in which the restriction valve 30 is interposed and the pressure differential across this valve will be decreased and initiate operation of the control mechanism 17 of the pump 16 to increase the output volume. The volumetric output of the pump 16 will continue to increase until the demands of the motor 14 are met.

When the motor 14 reaches its maximum desired speed, as determined by the valve 39 and the load on the pump 10, the continued increase of fluid flow from the pump 16 will serve to increase the fluid pressure in the supply lines and, in particular, at that portion of the branch supply line 38 to which the control line 41 is connected. When the fluid pressure exceeds the predetermined pressure setting of the sequence valve, the spool piston 53 is displaced against a spring-biased needle valve 54 which is also displaced and thereby relieves fluid pressure previously applied to the piston-end 52 of the spool 51 through the drain 37. Displacement of the spool-piston 53 simultaneously blocks the internal passages thereof and prevents further fluid flow into the sequence valve through the control port connected with line 41. This increased fluid pressure also appears at the inlet port to the sequence valve which is connected to line 22 and will displace the spool 51 since the pressure has been removed from the opposed piston-end 52 and thus returns the spool to an open position when the fluid pressure in the supply line 22 exceeds the pressure setting of the sequence valve as determined by the spring-biased needle valve 54. Fluid will again flow through the sequence valve 36 and through the variable restriction valve 30. The pressure differential appearing across the valve 30 will return to its normal minimum value and this change will be sensed by the control mechanism 17 and maintain the pump 16 at the desired volume setting for operation of the motor 14. Variations in fluid flow requirements of the motor 14 will be sensed by the control mechanism 17 through the valve 30 as any flow change through the motor 14 will also momentarily affect the fluid flow through the valve 30 and thereby affect the pressure differential. Once the sequence valve 36 has been reopened after starting of the motor 14, the valve will remain in an open condition.

When it is desired to stop the operation of the motor 14 in driving the water pump 10, it is only necessary to close the valve 40. Closing of the valve 40 will prevent further fluid flow through the branch supply line 38 and the pressure in this line at the connection point of the control line 41 will again return to its minimum value as determined by back pressure in the return system. This will not affect the operation of the sequence valve 36 since the spool 51 would previously have been displaced to an open position and will only serve to reduce the pressure in the control line 41. Stopping the flow of fluid through the motor 14 by closing the valve 40 would result in forcing the fluid flow through the lines 31 and 32 and through the variable restriction valve 30. The increased flow through the valve 30 will produce an increased pressure differential causing the control mechanism 17 to react and reduce the volumetric output of the pump 16 to return the system to its minimum flow configuration. In stopping the operation of the motor 14, it is desirable that the valve 40 be slowly closed to prevent a build-up of excessive pressure in the line as would be caused by sudden closing or stopping fluid flow in the branch line 38. It is for this reason that the valve 40 is preferably of the needle valve type which will prevent rapid manual operation due to the larger number of turns of the valve stem required for complete closing of the valve.

This fluid control system is also operative to permit operation of both fluid motors 11 and 14 simultaneously as well as permit starting of the fluid motor 14 for driving the water pump 10 during any time that the main drive motor 11 is operating to revolve the mixer drum D. In the situation where the mixer drum D is operating and it is desired to initiate operation of the water system through starting of the motor 14 to drive the water pump 10, the valve 29 would have been placed in the desired position and the variable restriction valve 30 appropriately adjusted to obtain the desired drum speed. The valve 40 would initially be closed and preventing operation of the motor 14. The pump 16 will then be supplying fluid at a volume which is adequate for operating the mixer drum at this speed. Opening of the valve 40 at this time will produce the same effect as previously described and initiate operation of the motor 14 while momentarily attempting to close the inlet port of the sequence valve 36 which is connected to supply line 22. The valve 36 being closed will prevent fluid flow through the motor 11 and will result in slowing down of the drum D or complete stoppage of the drum depending upon its initial operating speed at the time that the valve 40 is opened. The duration of this transient effect on the mixer drum operation is dependent on the speed of the drum and is of a relatively short time interval as the motor 14 driving the water pump 10 will be brought up to its operating speed very quickly.

With both motors 11 and 14 now operating, the fluid control system of this invention permits either motor 11 or 14 to be stopped as may be desired. In the case of stopping the main drive motor 11 connected to the mixer drum D, the valve 29 is actuated to position the spool of this valve to obtain the flow configuration illustrated by the center section C with ports A and B blocked and ports P and T interconnected and reduce the variable restriction valve 30 to its minimum flow condition. This will result in stopping of the motor 11 as the motor ports A and B of the valve 29 will be blocked and a minimum fluid flow through the pressure and tank ports of the valve 29 and the restriction valve 30 will result in a pressure differential change of momentary duration sensed by the control mechanism 17 to reduce the volumetric output of the pump 16 to the value as required for operation of the motor 14 in driving the water pump 10. If so desired, the main drive motor 11 for the mixer drum D may be restarted while the motor 14 for the water system continues in operation by displacing the spool of the valve 29 to the desired position and appropriately adjusting the vari-

able restriction valve 30 to obtain the desired drum speed. This operation will also have no effect on the operation of the motor 14 in driving the water pump 10.

With both the main drive motor 11 and the water pump drive motor 14 simultaneously operating, it is possible to stop the water pump motor 14 through closing of the valve 40. The operation will be as previously described with closing of the valve 40 and the motor 11 stopped. Resultant changes in fluid flow requirements of the system will produce a change in the pressure differential across the restriction valve 30 which is sensed by the control mechanism 17 and, accordingly, alter the volumetric output of the pump 16.

FIGURE 2 of the drawings schematically illustrates a modified fluid control system in which the fluid control circuit means 35a has been modified to permit utilization of an electrically operated solenoid for controlling the operation of the water pump drive motor 14a. Elements of the fluid control system shown in FIGURE 2, which are common to that shown in FIGURE 1, are identified by similar numerals with the suffix a, with the exception of the fluid connection ports and control spring of the control mechanism 17d. These elements are identified by the numeral 17 having the respective suffixes e, f, and g. In this modified circuit, the second fluid control means 40a is seen to comprise a second sequence valve 43 and an electric solenoid-actuated, shut-off valve 44. The shut-off valve 44 is spring biased to a normal position in which both ports are blocked. Energization of the solenoid of this valve will shift the spool to a position in which there will be relatively free fluid flow through the valve. The sequence valve 43 which includes a spool 55 with piston-end 56, a spool-piston 57, and a spring-biased needle valve 58, is connected in the branch supply line 38a with the inlet and outlet ports connected to this line. This sequence valve 43 is set to operate at a predetermined pressure (4,000 p.s.i.) which is substantially greater than the maximum pressure of the pump 16a (3,750 p.s.i.) to prevent inadvertent operation of the fluid motor 14a in driving the pump 10a. An external drain of the sequence valve 43 is connected by a drain line 45 to the drain line 37a and thence to the main return line 20a to the reservoir 18a. The control port of the sequence valve 43 is connected by a line 46 to the inlet port of this valve through a choke restriction 47. A branch control line 48 also connects with the control line 46 at the control port of the sequence valve and to a port of the shut-off valve 44. The opposite port of the shut-off valve 44 is connected by a line 49 to the main return line 20a.

The modified fluid control system shown in FIGURE 2 operates in a similar manner as previously described in conjunction with the fluid control system shown in FIGURE 1. Assuming that the main drive motor 11a is stopped and the system is operating in a minimum flow condition, the sequence valve 36a will be open with the shut-off valve 44 closed. With the shut-off valve 44 closed, the branch control line 48 will be blocked and pressure will be built up in the control line 46 through the choke restriction 47. This pressure in the control line 46 connected to the control port of the sequence valve 43 and applied to the piston-end 56 of the spool 55 will produce a greater force on the spool than the fluid pressure applied to the spool at the inlet port due to the area difference and will result in closing of the valve and preventing fluid flow through the valve. Thus, the motor 14a will be prevented from operating as there will be no fluid flow in the line 38a. The control line 41a connected to the sequence valve 36a is connected to the outlet port of the sequence valve 43 in the same relationship to the branch supply line 38a as in the system shown in FIGURE 1 and the valve 36a will thus be maintained in an open position since the pressure in the line 38a and the control line 41a will be essentially at a minimum or zero pressure.

To start the motor 14a for driving the water pump 10a, the solenoid of the shut-off valve 44 is energized to shift the spool to permit fluid flow through the valve and the control line 46 will then be connected by the branch line 48 and the return line 49 to the low pressure side of the control system. The choke restriction 47 will prevent substantial fluid flow from the branch supply line 38a to the return line and the pressure at the control port of the sequence valve 43 will be essentially reduced to zero. With removal of fluid pressure at the control port, the fluid force applied to the piston-end 56 will be less than the fluid force applied to the opposite end of the spool 55 at the inlet port and the spool of this valve will be shifted to an open position, permitting fluid flow through the valve. Fluid will thus flow through the line 38a and the flow control valve 39a to the motor 14a and initiate operation of the water pump system. During the starting of the motor 14a, the pressure in the line 38a will increase and effect an increase in the pressure in the control line 41a which affects the operation of sequence valve 36a. As the pressure in the control line 41a equals the pressure in the supply lines 22a and the branch supply line 38a, the fluid force applied to the piston-end 52a will be greater than the force applied to the opposite end of the spool 51a at the inlet port connected with line 22a due to the difference in area and the movable spool of the sequence valve 36a will be caused to be displaced to a closed position and prevent fluid flow through the line 31a and the valve 29a. This results in a reduced pressure differential across the restriction valve 30a causing an increase in the volumetric output of the pump 16 as sensed by the control mechanisms 17a.

As the motor 14a comes up to its maximum speed, the pressure in the line 38a will increase resulting in an increase in the pressure at the inlet port to the sequence valve 36a and the control port until the pressure setting of the sequence valve 36a is exceeded thereby displacing the spool-piston 53a against the spring-biased needle valve 54a. The needle valve 54a will also be displaced thereby relieving fluid pressure previously applied to the piston-end 52a of the spool 51a through the drain 37a without further fluid flow through the control line 41a. Thus, the spools 51a of the sequence valve 36a will be displaced to an open position due to this pressure difference and again permit fluid flow through the valve and through the line 31a and thence through the variable restriction valve 30a. Upon stabilization of the fluid flow through the motor 14a and the valve 30a, the volumetric output of the pump 16a will again be stabilized at a value adequate for operation of the motor 14a under the particular load conditions.

At the time that the valve 44 is opened, the sequence valve 43 will also open rapidly; however, the sequence valve 36a will close relatively slowly and thereby prevent excessive fluid pressure surges in the system.

Stopping of the motor 14a is effected by deenergizing the solenoid of the shut-off valve 44 which will permit the return of the spool to the position where the ports are blocked. In this position, the branch control line 48 will be blocked and thus permit fluid pressure to again build up in the control line 46 at the control port of the sequence valve 43. As this pressure reaches the value of the fluid pressure at the inlet port to this valve, the spool will be shifted to a closed position blocking the inlet port connected to line 38a due to the difference in areas of the spool ends. This closing of the sequence valve 43 will be a relatively slow operation due to the presence of the choke restriction 47 and thereby also prevent excessive pressure surges in the system through the operation of stopping the motor 14a.

This operation of the second fluid control means 40a in the modified control system of FIGURE 2 is thus seen to operate in an identical manner as to the system shown in FIGURE 1. The alternate operation of the system as to simultaneous operation of the motors 11a and

14a or to the stopping or starting of either motor while the other is running will follow the same operational sequence as described in conjunction with FIGURE 1 with the substitution of the shut-off valve 44 and the second sequence valve 43. These operations will, therefore, not be further described.

It will thus be readily apparent that the fluid control system of this invention permits the independent operation of two fluid motors connected to dissimilar loads and having a common, pressurized fluid supply line or system. Either of the fluid motors may be operated and controlled as desired for operation of the specific load without affecting the operation of the other motor so long as the pump 16a has sufficient capacity. Either motor may also be started or stopped as desired without regard to the operating condition of the other motor. The system utilizes a single, pressurized supply which is automatically varied to provide the necessary fluid flow for a particular operating condition of either or both motors and is designed to prevent excessive pressure surges in the system due to operation of the control components.

According to the provisions of the patent statutes, the principles of this invention have been explained and have been illustrated and described in what is now considered to represent the best embodiment. However, it is to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

Having thus described this invention, what is claimed is:

1. A fluid system comprising a fluid reservoir, a variable-volume fluid pump having an inlet port communicating with said reservoir and an outlet port and including driving means therefor, a first fluid motor drivingly connected to a first load, a second fluid motor having an outlet port communicating with said reservoir and drivingly connected to a second load, first control means connected in fluid coupled relationship with said fluid pump, reservoir and said first fluid motor and being selectively operable to control operation of said first fluid motor, said first control means including fluid flow responsive means operatively connected with said fluid pump for controlling the volumetric output thereof in response to fluid requirements of said first and second fluid motors, and fluid control circuit means connected in fluid coupled relationship with said first control means and said second fluid motor and being selectively operable to control operation of said second fluid motor, said fluid control circuit means including first fluid flow control means interposed in fluid flow controlling relationship with said first control means and second fluid flow control means interposed in fluid flow controlling relationship with said second fluid motor, said first fluid flow control means normally permitting fluid flow to said first control means and being responsive to fluid flow requirements of said second fluid motor to restrict fluid flow to said first control means when the combined fluid flow through said second fluid motor and said first control means exceeds the volumetric output of said fluid pump.

2. A fluid system according to claim 1 wherein said first load comprises a concrete mixer drum which is to be rotatably driven and said second load comprises a fluid pump in an auxiliary fluid supply system.

3. A fluid system according to claim 1 wherein said first control means includes selectively operable valve means for controlling fluid flow to said first motor, said valve means providing a fluid by-pass to said first fluid motor in a first position and directing fluid flow through said first fluid motor in relatively opposite directions when in either a second or third position.

4. A fluid system according to claim 1 wherein said fluid pump includes actuating means operable to effect control of the volumetric output thereof in response to fluid pressure, said fluid flow responsive means being connected with said actuating means and providing a fluid pressure for operation thereof with said fluid pressure

being related to fluid flow through said first control means.

5 5. A fluid system according to claim 4 wherein said fluid flow responsive means comprises a variable restriction valve which is adapted to maintain a predetermined pressure differential between the inlet and outlet thereof for any specific fluid flow therethrough.

6. A fluid system according to claim 1 which includes a fluid flow limiting valve connected in series circuit with said second fluid motor and operable to limit flow there-
10 through to a predetermined maximum value.

7. A fluid system according to claim 1 wherein said first fluid flow control means comprises a first sequence valve having an inlet port connected with the outlet port of said fluid pump, an outlet port connected with said
15 first control means, and a control port connected in fluid flow relationship through a fluid flow restrictor to the juncture of said second fluid flow control means and said second fluid motor whereby said sequence valve will be responsive to the pressure of the fluid flowing to said
20 second fluid motor, said sequence valve being set to transfer from a closed to an open position at an inlet port pressure substantially less than the maximum fluid operating pressure of said fluid pump.

8. A fluid system according to claim 7 wherein said

second fluid flow control means comprise a manually operated shut-off valve.

9. A fluid system according to claim 7 wherein said second fluid flow control means includes a second sequence valve having an inlet port connected to the inlet port of said first sequence valve, an outlet port connected in fluid flow relationship with said second fluid motor, and a control port connected to the inlet port of said second sequence valve through a fluid flow restrictor, and a normally closed valve connecting with the control port of said second sequence valve at the juncture thereof with said fluid flow restrictor, said normally closed valve being selectively operable to an open position for reducing the fluid pressure at said control port.

10. A fluid system according to claim 9 wherein said normally closed valve is of the electric-solenoid-actuated type which is biased to the closed position.

References Cited

UNITED STATES PATENTS

3,175,354	3/1965	Firth et al.	60—52
3,248,869	5/1966	Kittler	60—53 XR

25 EDGAR W. GEOGHEGAN, *Primary Examiner.*