

Filed July 6, 1965

CAVITATION MINIMIZER

2 Sheets-Sheet 1



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Jan. 31, 1967

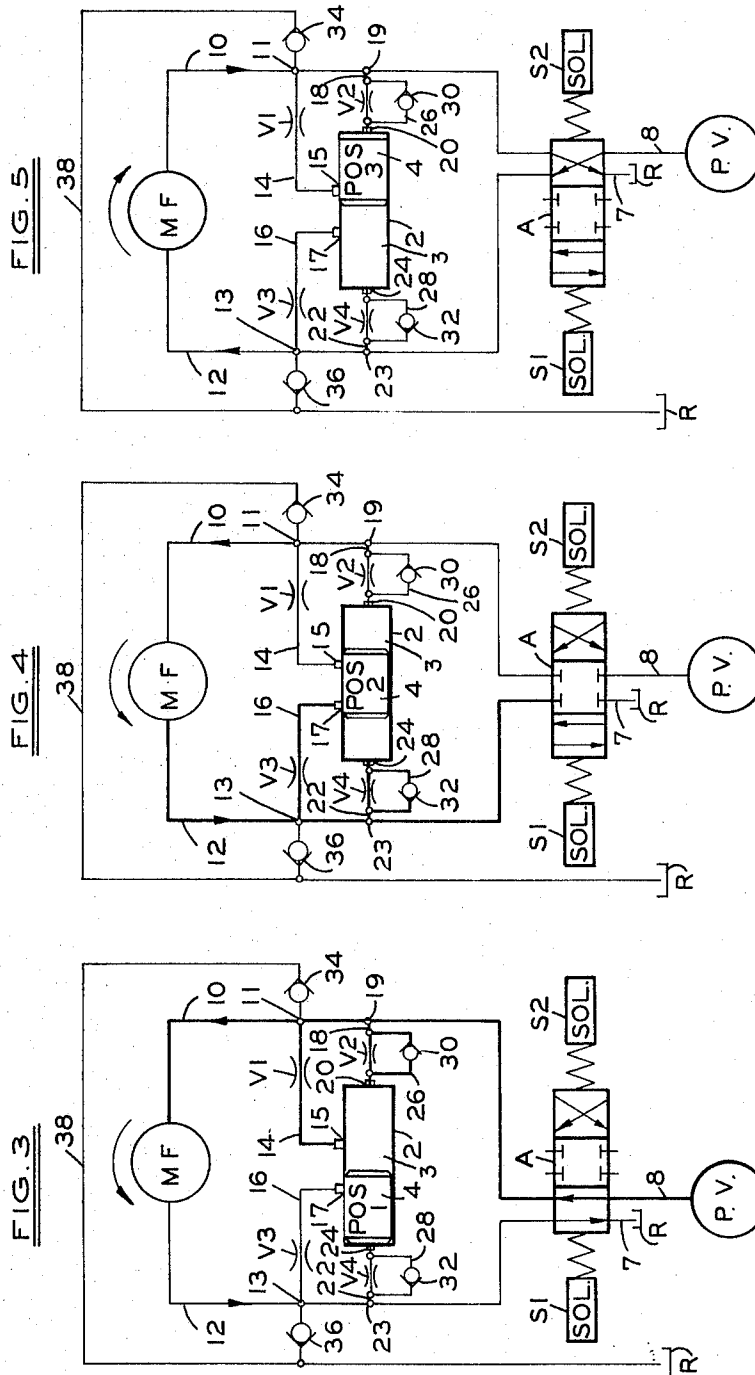
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CAVITATION MINIMIZER

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Filed July 6, 1965, Ser. No. 469,524

8 Claims. (Cl. 60—52)

This invention relates to a system for controlling the flow of fluid to and from a double acting hydraulic motor.

The invention is particularly adapted to control a double acting hydraulic motor used to control sliding movement of a fixture on a machine. Under such conditions the sliding movement of a fixture builds up a very considerable inertia force. If the rapid movement is stopped abruptly by the blocking of fluid flow both to and from opposite sides of the hydraulic motor, inertia forces cause excessive pressure to build up in that side of the motor which normally returns to the reservoir, and simultaneously causes a marked decrease in the pressure in the other side, or inlet side, of the hydraulic motor. Since there is a marked decrease in pressure in the inlet side of the hydraulic motor cavitation occurs which results in marked inefficiency of the motor operation.

Accordingly, it is an object of this invention to provide means for minimizing the cavitation in a hydraulic system and provide for a cushioned stop.

Accordingly, it is a further important object to prevent cavitation by providing a flow of auxiliary fluid to the side of the hydraulic motor in which the pressure drops below a specified operating pressure after the hydraulic motor has been stopped by preventing the flow of fluid to the motor.

With these and other objects in view, the invention consists of certain novel features of construction, as will be more fully described and particularly pointed out in the appended claims.

FIG. 1 and FIG. 2 show a typical circuit without a cavitation minimizer.

FIG. 3, FIG. 4 and FIG. 5 show a hydraulic circuit with a cavitation minimizer included.

FIG. 6 is a detail of valve A.

FIG. 1 and FIG. 2 show a typical hydraulic circuit without a cavitation minimizer. A volumetric pump PV delivers hydraulic fluid to the fluid motor MF by way of line 8, valve A, and line 10. The return of hydraulic fluid to the reservoir R from the fluid motor MF is by way of line 12 and valve A, and line 7. Valve A is controlled by a solenoid which allows or restricts the flow of hydraulic fluid to the fluid motor. As shown in FIG. 1 fluid is pumped by volumetric pump PV when solenoid SOL S1 is energized allowing fluid to enter line 10 through fluid motor MF to turn in the direction shown, and returning to reservoir R by way of lines 12 and 7. When solenoid SOL S1 is de-energized, as shown in FIG. 2, the flow is stopped. However, due to the high inertia momentum of the driven parts the motor MF maintains its rotation thereby providing an excessive pressure in line 12 and a simultaneous decrease of pressure in line 10. This decrease of pressure in line 10 causes a cavitation condition which is very detrimental to the motor.

Normally, a relief valve is inserted between the inlet and exhaust lines to allow the fluid to enter the line having the decreased fluid pressure. The drawback to the relief valve is that it is actuated when the pressure reaches a predetermined pressure, and often times reacts too late to prevent cavitation effects to the inlet side of the system.

In other words, there is a certain interval when fluid should be bypassed into the inlet side of the motor to overcome the cavitation effects, but because of the comparatively slow action of the relief valve cavitation effects originate in the inlet side before the relief valve can supply enough fluid to it.

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To overcome the inadequacy of a relief valve inserted between the inlet and exhaust a cavitation minimizer is inserted between the exhaust and inlet side of the fluid motor. As shown in FIGS. 3, 4, and 5, the cavitation minimizer consists of a cylinder 2 having a slidably movable piston 4 adapted to slide from one end position of the chamber 3 of the cylinder to the other end. A line 14 is connected at 11 to line 10 and is connected to port 15 of cylinder 2. Another line 16 is connected at 13 to line 12 and is connected to port 17 of cylinder 2. The lines 14 and 16 include restriction valves V1 and V3 respectively to provide regulatory flow to and from the chamber 3 of cylinder 2. Also connected to the line 10 at 19 is another line 18. Line 18 is connected to the end port 20 of cylinder 2. The line 18 includes a restriction valve V2 to allow for restrictive flow between the line 10 and cylinder 2. A line 26 is connected to line 18 for the purpose of by-passing valve V2 and includes a relief check valve 30.

Similarly line 22 is connected at 23 between line 12 and end port 24 of cylinder 2 and includes a restriction valve V4 to allow for restrictive flow between the lines 12 and cylinder 2. A by-pass line 28 is connected to line 22 for by-passing valve V4 and includes a relief check valve 32.

Check valves 30 and 32 are unidirectional flow valves and allow fluid to flow only in one direction.

Restriction valves V1, V2, V3, and V4 are regulatory valves and are adapted to be adjusted to provide for fluid to be regulated properly to allow for the piston 4 to travel in the chamber 3 of cylinder 2 from one end position to the other at a predetermined rate of speed.

A line 38 is connected to lines 10 and 12 at 11 and 13 respectively and is connected to the reservoir R. However, a check valve 34 is placed near the connection 11, and a check valve 36 is placed near the connection 13. The check valves 34 and 36 allow for prevention of fluid flow to the reservoir when the fluid motor MF is being driven in one direction. However, at the time of stopping the rotation of motor MF, the valve connected to the line having the decreased pressure allows fluid from the reservoir to flow into the line decreasing the cavitation effects.

The device operates in the following manner:

(I) When solenoid SOL S1 is energized, the valve A allows flow of hydraulic fluid from pump PV to the inlet side of fluid motor MF by means of lines 8 and 10. The flow of fluid in line 10 passes through lines 14 and 18 through restriction valves V1 and V2 and through check valve 30 without restriction to slidably move free floating piston 4 in chamber 3 of cylinder 2 to a position shown in FIG. 3. The fluid motor MF is thereby adapted to rotate in a direction shown in FIG. 3. At this time flow of fluid from the lines 10 and 12 is restricted from entering the reservoir by means of check valves 34 and 36 since the pressure is greater in lines 10 and 12 than line 38.

(II) When solenoid SOL S1 is de-energized, the valve A prevents the flow of fluid from pump PV to the fluid motor MF. Due to the inertia force of the fluid and motor, the motor MF continues to maintain its rotational direction (see FIG. 4) thereby causing excessive pressure in line 12 and simultaneously causing a decrease in pressure in line 10. The simultaneous decrease in pressure in line 10, which causes a partial vacuum, and the increase in pressure in line 12 forces piston 4 to immediately move in the chamber of cylinder 2 to a position shown in FIG. 4. That is the fluid flows from line 12 through connection 23, into line 22, through relief check valve 32 and restriction valve V4 into cylinder 2 by means of end port 24.

The force of fluid flow moves the piston toward the right, as shown in FIG. 4, causing the fluid that was in the chamber 3 of cylinder 2 to exhaust into the line 10 by means of lines 14 and 18. Line 14 receives most of the primary fluid through port 15 and is adapted to replenish line 10.

In the position shown in FIG. 4, the port 15 is shut off from further fluid flow, however, fluid continues to flow into line 10 through line 18 by means of end port 20. Additional fluid is allowed to enter line 10, if necessary by means of check valve 34 which accumulatively prevents cavitation effects in line 10.

(III) When solenoid SOL S2 is energized, fluid from pump PV enters line 12, thereby causing fluid motor MF to then reverse direction. The flow of fluid in line 12 concurrently enters line 22, and enters cylinder 2 by means of end port 24, to move piston 4 toward the extreme end position of chamber 3 as shown in FIG. 5. After the piston 4 moves past the port 17, additional fluid is allowed to enter the chamber of cylinder 2 by means of line 16.

As disclosed hereinabove, the fluid motor MF is adapted to be stopped and rotated in opposite directions without cavitation effects in the inlet sides of the system.

FIG. 6 shows a modification of the cylinder thus far described with the arrangement similar to the parts of the embodiment of FIGS. 3 through 5, and marked with the same reference numerals followed by the small letter *b*. Included in the cylinder 2*b* are a plurality of ringed annular recesses or chambers, such as shown, at each end of the cylinder. The ringed annular recess 40 is connected directly to port 17*b*, as is ringed annular recess 46 connected to port 15*b*, for the purpose as described hereinabove in the preferred embodiment. The ports 15*b*, 17*b* are located inwardly from each end of the cylinder substantially near the midpoint thereof. However, ringed annular recesses 42 and 44 are connected to the port 17*b* by means of a threaded bore 41. Similarly ringed annular recesses 48 and 50 allow fluid to flow to port 15*b* through bore 47. Plugs 43, 45, 49 and 51 secure the openings that lead to the ringed annular recesses 42, 44, 48 and 50 respectively. The adjustable screws 52 and 54 allow for a differential rate of flow from the chamber 3*b* of cylinder 2*b* by means of adjusting the screws to accommodate for a greater amount of fluid flow to lines 10*b* and 12*b*, respectively. The threaded bores 41 and 47 are in close engagement with the threaded screws 54 and 52 respectively, so that the screws are adjustable to prevent the flow of fluid. The threaded hole is tapped through the ringed annular recesses or chambers, and consequently, if the screw is backed off so that it does not enter any of the chambers or ringed annular recesses the ports 17*b*, 15*b* receive all the fluid from the chamber. If the screw is adjusted so that it passes the ringed annular recess 44 and enters the threaded portion between ringed annular recesses 44 and 42, the annular recess 44 is cut off from connection with annular recess 42. Likewise, as the screw is turned until it encroaches on ringed annular recess 42 and enters the threaded portion between 42 and 40, it effectively eliminates annular recess 42 as one of the passages for the fluid and leaves only annular recess 40 to handle the fluid flow. In other words, as the screw is adjusted inwardly there is a shortening of the length of the cylinder through which the piston travels before cutting off the outlet at 17*b*. Beyond this point, the fluid must flow out of 24*b* alone at a much reduced rate of flow due to restriction valve V4*b*. The reason for the greater flow is quite evident, in that at the instant the fluid flow is blocked by the valve, inertia forces cause an increase in pressure in the outlet side of the fluid motor, thereby causing the piston 4*b* to slidably move toward the other end of the chamber of the cylinder. Depending upon the adjustment of the screws 52, 54, a quantity of fluid

is delivered to the inlet side of the fluid motor system causing an immediate decrease in cavitation effects. As the piston slides further toward the end position in the chamber of the cylinder, fluid flow is progressively reduced until piston 4*b* moves past the ringed annular recesses thereby closing off all flow of fluid through the ports 15*b* or 17*b*. Thereafter, the flow of fluid is forced through line 18*b* or 22*b*. The rate of flow must be decreased progressively in steps, otherwise the fluid motor will continue rotating in the same direction for too long a period of time, and stopping the rotation will not be accomplished properly. In other words, if the cavitation minimizer replenishes the inlet side of the line to the motor at too rapid a speed, although the cavitation effects will be dissipated, the motor will continue to rotate in the same direction as originated, and will not slow down as intended. Therefore, a combination of allowing enough fluid to prevent cavitation and to decrease the rotation of the motor in progressive steps in as short a time as necessary is needed. This is accomplished by the aforesaid description.

While in the foregoing description the invention was explained in connection with one possible form or embodiment thereof wherefore certain specific terminology and language have been used herein, it is to be understood that the present disclosure is illustrative rather than restrictive and that changes and modifications may be resorted to without departing from the spirit of the invention as defined by the claims which follow.

What is claimed is:

1. A system for controlling the operation of a fluid actuated motor comprising;
 - a fluid actuated motor;
 - a fluid reservoir;
 - a volumetric pump;
 - a fluid supply line and a fluid return line connecting said reservoir, said pump and said motor;
 - valve means connected between said motor and said pump and reservoir for controlling the flow of fluid to and from said motor;
 - a fluid cylinder connected between said fluid supply line and said fluid return line, said fluid cylinder including;
 - a chamber;
 - a free floating slidably movable piston in said chamber;
 - a plurality of port means on said cylinder connecting said chamber of said cylinder and said fluid supply line and said fluid return line, respectively; whereby fluid in said chamber on one side of said piston is forced into said fluid supply line to control cavitation defects when said controlling valve means prevents flow of fluid to said motor.
2. A system as defined in claim 1, wherein said cylinder comprises;
 - a plurality of ringed annular recesses, each of said ringed annular recesses having a diameter larger than the diameter of said bore of said cylinder;
 - and an adjusting means for controlling the flow of said fluid through said ringed annular recesses through said porting means to either said fluid supply line or said fluid return line when said valve means for controlling said flow of fluid to said motor is discontinued thereby minimizing cavitation.
3. A system as defined in claim 1 wherein said cylinder comprises a plurality of ringed annular recesses, each of said ringed annular recesses having larger diameters than the diameter of said bore, at least one of said ringed annular recesses connected to a means for porting said fluid, and an adjusting means for controlling the flow of said fluid through said ringed annular recesses through said porting means to said fluid supply and said fluid return lines.
4. A system as defined in claim 3 wherein said adjusting means comprises a screw adapted to control fluid

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flow from said cylinder to said fluid supply and said fluid return lines.

5. A system for controlling the operation of a fluid actuated motor comprising; a fluid motor, a fluid reservoir, a volumetric pump, a fluid supply line and a fluid return line connecting said fluid motor and said fluid reservoir, means for controlling the flow of fluid to and from said fluid motor, an hydraulic cylinder, said cylinder having a chamber therein, a free floating piston slidably movable in said chamber of said cylinder, a plurality of cylinder port means connected to said cylinder substantially near the midpoint thereof, a first line connecting said fluid supply line to one of said plurality of cylinder port means, a second line connecting said fluid return line to the other of said plurality of cylinder port means, whereby movement of said piston is adapted to force fluid from the chamber of said cylinder into said fluid supply line when said controlling means prevents further flow of fluid.

6. A system as defined in claim 5 further including a line connecting said fluid supply line and said fluid return line to said fluid reservoir, said line having a valve controlling the flow of fluid near each connection of said line to said fluid supply line and said fluid return line.

7. A system as defined in claim 4 further comprising a threaded bore adjacent said ringed recesses and said port means, whereby said adjusting screw is adapted to be threadedly movable within said threaded bore to provide for adjustment of fluid flow from said cylinder.

8. A cylinder comprising:

- a stationary housing having a substantially cylindrical bore therethrough defining a chamber therein;
- a first port means on one end of said housing connected to said chamber for admitting pressure fluid into said chamber;

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a second port means on the other end of said housing connected to said chamber for admitting pressure fluid into said chamber;

a piston in said cylindrical bore adapted to be slidably movable within said chamber;

a first set of ringed annular recesses integral with one end of said housing and having its diameter larger than said bore of said chamber;

a second set of ringed annular recesses integral with the other end of said housing and having its diameter larger than said bore of said chamber;

a third port means connected to said cylinder housing near the midpoint thereof and to said first set of said ringed annular recesses;

a fourth port means connected to said cylinder housing near the midpoint thereof and to said second set of said ringed annular recesses;

adjusting means connected to each of said first set and said second set of said annular recesses respectively;

whereby fluid on one side of said piston is adapted to exit from said chamber through said port means at one end of said housing and adjustably through said port means connected to said ringed annular recesses near the midpoint of said cylinder housing.

References Cited by the Examiner

UNITED STATES PATENTS

2,890,683	6/1959	Pilch	60—52	X
3,233,409	2/1966	Reis	60—53	X
3,262,467	7/1966	Stacey.		

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