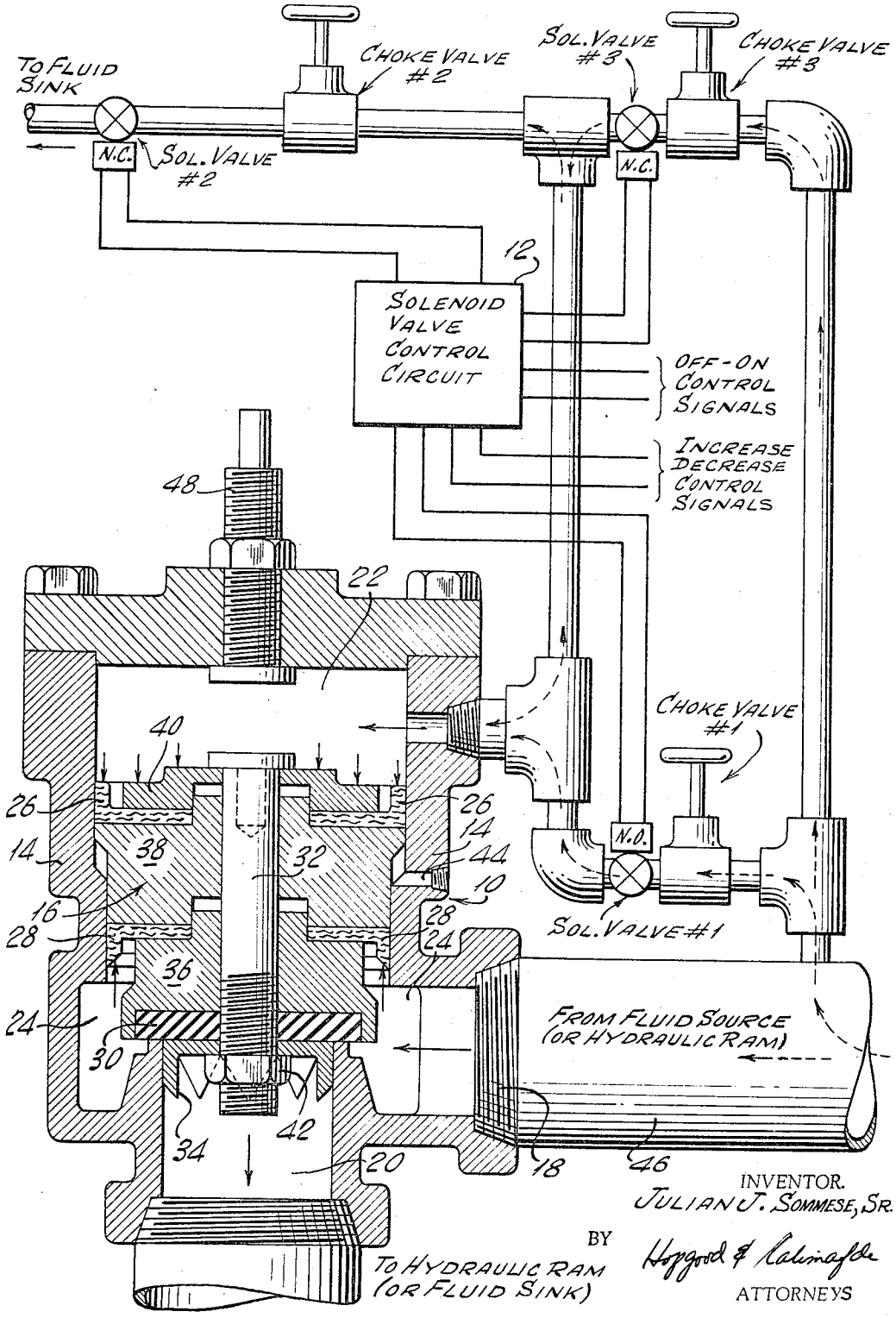
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HYDRAULIC VALVE AND CONTROL MEANS THEREFOR

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HYDRAULIC VALVE AND CONTROL MEANS THEREFOR

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This invention relates generally to hydraulic valves and more particularly to hydraulic valves for controlling the operation of hydarulic elevators and the like.

In hydraulic elevator systems, the position of an elevator cab is varied by pumping hydraulic fluid into or draining hydraluic fluid out of a hydraulic ram which supports the elevator cab. The fluid input and output of the hydraulic ram are controlled by a hydraulic valve, which in turn is controlled by manual or automatic valve control means. Since the speed of the elevator cab depends on the rate of fluid flow at the input or output of the hydraulic ram, the hydraulic valve must be capable of continuous adjustment for differing rates of flow. In addition, it must be capable of being securely locked at any given flow rate, and it must be quick acting in the sense that its flow rate can be quickly and smoothly changed from a relatively high rate to a relatively low rate or vice versa. Furthermore, it should be adapted to be controlled by simple and reliable valve control means, and the control means should be easily adjustable to adapt the valve and the control means to different elevator installations.

Many hydraulic valves and valve control means have been devised in the past to control hydraulic elevators and the like, as exemplified by the valve and valve control means disclosed in U.S. Patent 2,913,070, which was issued on November 17, 1959, to M. N. Nyberg for an "Automatic Elevator Control." These prior art valves were adequate in the flow rate. In addition, they were difficult to control for slow, continuous variations in the flow rate, such as required when the elevator cab is accelerated from a stop to full speed or decelerated from full speed to a stop. Improved control means have been devised to smooth the operation of these prior art hydraulic valves, as disclosed in copending patent application Serial Number 136,276, which was filed on September 6, 1961, by James F. MacNair et al. for a "Hydraulic Elevator Control," but although these improved control means were very helpful, they did not fully remedy the lack of smoothness for small variations in the flow rate or slow, continuous variations in the flow rate.

Accordingly, one object of this invention is to provide a hydraulic valve which is capable of continuous adjustments for differing rates of flow.

Another object of this invention is to provide a hydraulic valve which is capable of being securely locked at any given flow rate and which is capable of being quickly and smoothly changed from one flow rate to another.

A further object of this invention is to provide a hydraulic valve which is easly to adjust for small variations in the flow rate thereof.

An additional object of this invention is to provide a simple and reliable control means for a hydraulic valve of the above described type.

Another object of this invention is to provide a control means which is easily adjustable to provide differing rates of change in the flow rate of a hydraluic valve controlled thereby.

Another object of this invention is to provide a control means which is capable of continuously and smoothly varying the flow rate in a hydraulic valve controlled thereby.

Another object of this invention is to provide a control means which is capable of producing small variations in the flow rate of a hydraulic valve controlled thereby.

Another object of this invention is to provide a control means which is capable of securely locking a hydraulic valve controlled thereby at any given flow rate and which is capable of quickly and smoothly changing the flow rate to a different level.

Another object of this invention is to provide a control means of the above described type which is easy to adjust to meet the requirements of different applications thereof.

Another object of this invention is to provide a hydraulic valve and hydraulic control means which is simple, reliable, and relatively inexpensive.

Other objects and advantages of the invention will become apparent to those skilled in the art from the following description of one specific embodiment thereof, as illustrated in the attached drawing, which shows one specific hydraulic valve and valve control means of this invention.

Referring to the figure, one embodiment of this invention comprises a main hydraulic valve, which is generally indicated by the numeral **10**, and a valve control means which includes solenoid valves #1 . . . #3, choke valves #1 . . . #3, and a solenoid valve control circuit **12**. Main hydraluic valve **10** is similar in construction to the prior art solenoid operated valves, but it differs importantly in that it contains no needle valve or needle valve orifice. The elimination of these parts adapt the valve for continuous variation of fluid flow rather than off-on operation and also allows the fluid inlet and outlet ports to be used interchangably. Valve **10** comprises a body member **14**, a piston assembly generally designated by the numeral **16** sildably mounted within body member **14**, a fluid inlet port **18**, and a fluid outlet port **20**. Piston assembly **16** is adapted to vary the fluid flow rate between the inlet and outlet ports in accordance with its position. In the position shown in the figure, the flow is completely shut off. As piston assembly **16** rises, however, fluid flow will begin and its rate will increase as the piston assembly rises.

Piston assembly **16** contains two leather packings which act as fluid seals to divide the interior of body member **14** into an upper fluid chamber **22** and a lower fluid chamber **24**. Leather packing **26** seals off upper chamber **22**, and leather packing **28** seals off lower chamber **24**. A neoprene valve seat **30** seals off the fluid outlet port **20** when the valve is in its closed position. The leather packings and neoprene valve seat are securely fastened to the valve stem **32** by being sandwiched between the other members of the piston assembly, which include a serrated fluid shield **34** that extends into outlet port **20**, a piston member **36**, which is recessed to receive valve seat **30**, a packing spacer **38**, which separates leather packings **26** and **28**, and a packing follower **40**, which holds leather packing **26** in place. The top of valve stem **32** is enlarged to hold packing follower **40** in place, and the bottom of valve stem **32** is threaded to receive a nut **42** which holds the entire piston assembly together.

It should be noted that packing spacer **38** has a larger diameter at its top than it does at its bottom. This differential of diameter is provided so that the piston assembly will be driven to its closed position when the pressure in upper chamber **22** is equal to the pressure in lower chamber **24**. This follows from the well known principle that the force exerted by a fluid under pressure is equal to the pressure multiplied by the area against which the pressure is exerted. The open space between packing spacer **38** and the wall of the valve body **14** is drained by means of a vent opening **44** which is drilled through the valve body. This prevents any locking of the piston due to trappage of air or hydraulic fluid in the open space. It should also be noted that serrated fluid shield **34** provides a smoothly variable increase in the fluid flow rate when it is withdrawn from outlet port **20**

and a smoothly variable decrease in the fluid flow rate when it is inserted back into outlet port **20**. This smooth increase or decrease depends, however, on the smoothness with which the position of the piston is varied. Valves of the above described type have been known in the past, but they have never realized the full potential of their inherent smoothness due to shortcomings in the prior art means for varying the position of the piston.

In accordance with this invention, the position of piston assembly **16** is controlled by a novel valve control means for pumping fluid into or draining fluid out of upper chamber **22** of valve **10**. The particular valve control means shown in the figures contains three solenoid operated valves #1 . . . #3, three choke valves #1 . . . #3, and a solenoid valve control circuit **12** which receives input signals signifying a desired condition in the main valve **10** and which operates the solenoid valves in such a way as to produce the desired condition. In this particular embodiment four input signals are applied to solenoid valve control circuit **12**, (1) a signal signifying the full open condition of main valve **10**, (2) a signal signifying the full closed position of main valve **10**, (3) a signal signifying an increase in the fluid flow rate through main valve **10**, and (4) a signal signifying a decrease in the fluid flow rate through main valve **10**. The operation of the control means can be best explained by tracing the sequence of events that occur in response to these signals.

In the absence of any signal input to the solenoid valve control, fluid entering pipe **46** from the fluid source is applied directly to lower chamber **24** of main valve **10** and also to upper chamber **22** via choke valve #1 and normally open solenoid valve #1. This produces equal pressure in upper chamber **22** and lower chamber **24**, which forces piston assembly **16** downward due to the unequal areas of the top and bottom of the piston, as explained previously, thereby fully closing main valve **10**. When an "on" control signal is applied to circuit **12**, normally open solenoid valve #1 and normally closed solenoid valve #2 are energized. This couples upper fluid chamber **22** to the fluid sink via choke valve #2 and solenoid valve #2 and allows the pressure in lower chamber **24** to drive piston assembly **16** to the full limit of its upward travel, which is defined by an adjustable stop screw **48** in the top of valve body member **14**. The fluid in upper chamber **22**, of course, is driven into the fluid sink as the piston assembly **16** rises. An "off" signal applied to circuit **12** de-energizes solenoid valves #1 and #2, thereby returning main valve **10** to its full closed position. It should be noted that the control circuit is fail-safe in the sense that the main valve **10** will shut itself off in the event of a power failure. When the main valve is used to drive a hydraulic elevator, this means that the elevator will automatically stop in the event of a power failure instead of running wild.

In response to a "decrease" input signal, control circuit **12** energizes normally open solenoid valve #1 and normally closed solenoid valve #3, which applies fluid to chamber **22** at a rate controlled by the setting of choke valve #3. When the flow rate of main valve **10** reaches the desired level, as indicated by some follow-up means such as a tachometer coupled to the hydraulic ram, solenoid valve #3 is de-energized while normally open solenoid valve #1 remains energized. This seals the fluid in upper chamber **22** and securely locks the piston assembly in place. In response to an "increase" input signal, normally closed solenoid valve #2 is energized while normally open solenoid valve #1 remains energized . This allows fluid to drain from upper chamber **22** at a rate controlled by the setting of choke valve #2. When the flow rate of main valve **10** reaches the desired level, the piston assembly **16** is securely locked in place by de-energizing solenoid valve #2 and holding solenoid valve #1 energized. It will be noted that solenoid valve #1 is energized by either the "increase" or the "decrease" signal and that it remains energized after these signals have terminated. This is done by means of an electrical latch back circuit in control circuit **12**, as will be readily understood by those skilled in the art. After the latch back circuit has been energized, solenoid valve #1 will remain closed until the latch back circuit is broken by either a power failure or the receipt of an "off" input signal.

The switching speed, i.e. the rate of change in the flow rate of main valve **10** during the foregoing operations, can be conveniently adjusted to meet the requirements of differing applications by means of choke valves #1, #2, and #3. The setting of choke valve #1 controls the switching speed when the main valve **10** is moved to the full off position by an "off" input signal or by a power failure. The setting of choke valve #3 controls the switching speed when the flow rate through the main valve **10** is decreased in response to a "decrease" input signal, and the setting of choke valve #2 controls the switching speed when the flow rate through the main valve **10** is increased in response to an "increase" input signal or when it is moved to the full "on" position in response to an "on" input signal.

The component parts of the above described control means can be any suitable prior art valves, pipes, and couplings which are suited to the particular application of the invention, the type of hydraulic fluid used, and the pressures involved. The solenoid valve control circuit **12** can be any suitable prior art switching circuit which is adapted to receive the input signals used in a particular application of the invention and to switch the solenoid valves in accordance with the above described operating logic. For example, a relay logic circuit might be used, or a solid state logic circuit, or, in the case where the input signals are mechanical variables rather than electrical variables, a mechanical switch might be used.

The above disclosed embodiment of the invention can be applied to hydraulic elevator control systems such as described in the above noted U.S. Patent No. 2,913,070 by simply coupling the main valve of the invention in parallel with the main valve used to control the fluid input and output of the hydraulic ram. This application requires two main valves and control systems as described above, one coupled between the fluid source and the hydraulic ram, and the other coupled between the hydraulic ram and the fluid sink. In this case, the first mentioned valve would influence the rate of the elevator cab's ascent, and the other would influence the rate of the elevator cab's descent. In this application, a two inch size for the main valve of this invention has been found appropriate in connection with a six inch main valve in the existing elevator control system. The main valve of this invention could also be used as a replacement for the main valve of an existing elevator control system, but this, of course, would require a six inch valve rather than a two inch valve.

From the foregoing description, it will be apparent that this invention provides a hydraulic valve and valve control which fulfills the objectives set forth in the opening paragraphs of this document. It will be equally apparent that this invention is by no means limited to the specific edmodiment disclosed herein, since many modifications can be made in the disclosed structure without departing from the basic teaching of this patent application. For example, the fluid input to the valve control means could be derived from an independent source if desired rather than being tapped from fluid whose flow is being controlled. This would allow the invention to be used to control the flow of air without the bouncing or overshoot that would result from the use of compressed air in the embodiment disclosed. The leather packings in the disclosed embodiment could be replaced by piston rings if desired, and many other piston assemblies could be used in place of the particular piston assembly described above. These and many other modifications of the in-

vention will be apparent to those skilled in the art, and this invention includes all modifications falling within the scope of the following claims.

I claim:

1. A hydraulic valve and control means therefor comprising a valve body having a piston member slideably mounted therewithin and movable between first and second limiting positions, a first fluid chamber within said valve body in fluid communcation with one end of said piston member, a second fluid chamber within said valve body in fluid communication with the opposite end of said piston member, a fluid inlet port and a fluid outlet port communicating into said second fluid chamber, means coupled to said piston member for variably obstructing the passage of fluid between said inlet and outlet ports in accordance with the position of said piston member, a third port communicating into said first fluid chamber, and means for forcing fluid into and out of said first fluid chamber via said third port and sealing said fluid to position said piston at any desired position between said first and second limiting positions, thereby producing any desired rate of fluid flow between said inlet and said outlet ports between a minimum rate defined by one of said limiting positons of said piston and a maximum rate defined by the other limiting position thereof, the area of one end of said piston is larger than the area of the other end thereof, whereby equal pressures in said first and second fluid chambers produce differing forces on opposite ends of said piston member, said larger area of said piston comprising the end thereof in fluid communication with said first fluid chamber, whereby equal pressures in said first and second fluid chambers produces a force differential urging said piston member away from said first fluid chamber and toward said second fluid chamber; and means for forcing fluid into and out of said first fluid chamber comprising a first fluid coupling including a normally open solenoid valve coupled between said third port and one of the other two ports, and a second fluid coupling including a first normally closed solenoid valve coupled between said third port and a fluid sink, means for closing said normally open valve, and means for opening said first normally closed valve, and a third fluid coupling including a second normally-closed solenoid valve coupled between said third port and said one of the other two ports, and means for opening said second normally-closed valve.

2. The combination defined in claim 1 wherein movement of said piston member toward said second fluid chamber increases the obstruction offered by said means coupled to said piston member for variably obstructing the passage of fluid between said inlet and outlet ports, whereby movement of said piston member toward said second fluid chamber decreases the rate of fluid flow between said inlet and outlet ports, and movement of said piston member toward said first fluid chamber increases the rate of fluid flow between said inlet and said outlet ports.

3. The combination defined in claim 2 wherein said normally open and normally closed valves are solenoid operated valves, and also including a valve control circuit for energizing and de-energizing said solenoid valves in response to input signals signifying a desired fluid flow rate between the inlet and outlet ports of said hydraulic valve.

4. The combination defined in claim 3 wherein said valve control circuit is adapted to receive "off," "on," "increase," and "decrease" signals, said valve control circuit being operable to de-energize all of said solenoid valves in response to said "off" signal, and being operable to energize said normally open valve and said first normally closed valve in response to said "on" signal, and being operable to energize said normally open valve and said second normally closed valve in response to said "decrease" signal, and being operable to energize said normally open valve and said first normally closed valve in response to said "increase" signal, and said valve control signal being operable to hold said normally open valve energized following the application of an "increase" or "decrease" signal until an "off" signal is applied thereto.

5. The combination defined in claim 1 and also including first, second, and third choke valves coupled in a corresponding one of said first, second, and third fluid couplings.

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