Oct. 23, 1945. A. R. STONE 2,387,307

SELF-LOCKING HYDRAULIC LINKAGE

Filed June 16, 1942

Fig. 1.

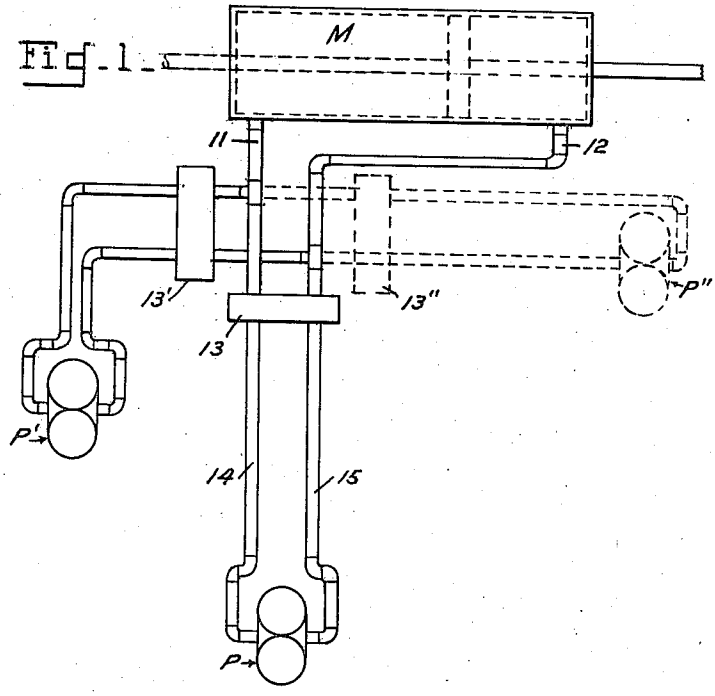
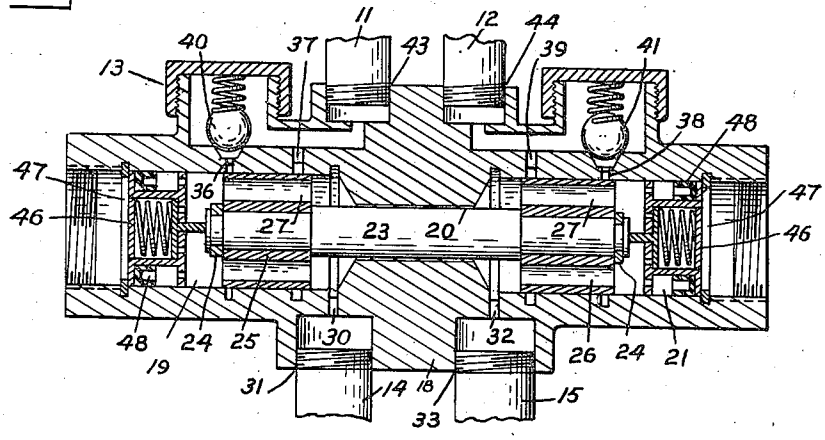


Fig. 2.



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SELF-LOCKING HYDRAULIC LINKAGE

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4 Claims. (Cl. 60—52)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to hydraulic systems and is particularly concerned with a pump-motor circuit wherein the pump may be rotated in either direction to cause movement of the motor in a corresponding direction.

An object of the invention is to provide an irreversible apparatus by which, when the pump is not operating, the motor is held immovable against possible reactive forces thereon. A further object of the invention is to provide a novel valving system which is operated in response to intentional actuation of a hydraulic pump but which may not be operated by reactive forces upon a hydraulic motor. Still another object of the invention is to provide a check valve system in a hydraulic circuit and to provide fluid pressure responsive means to operate the check valves under certain operating conditions of the system.

The details of the invention may be better understood by referring to the detailed description below in connection with the drawing in which:

Fig. 1 is a diagrammatic elevation showing a hydraulic system, and

Fig. 2 is an enlarged section of a hydraulic valve unit which is the essence of the invention.

Referring to the drawing, in Fig. 1 I show the hydraulic motor M of the piston-cylinder type to the ends of which conduits 11 and 12 are connected. By feeding liquid to the conduit 11, the piston is moved to the right and by feeding liquid to the conduit 12, the piston is moved to the left. Low pressure fluid is exhausted from the other conduits in either of the above cases. These conduits connect through a valve unit 13 through conduits 14 and 15 leading to a reversible pump P which may be driven by any suitable means. Obviously, by turning the pump in one direction the motor is operated in one direction, while turning the pump in the other direction operates the motor in the other direction. The valve unit 13 is so arranged that pressure fluid may flow from the pump to the motor when the pump is operated intentionally; otherwise, the motor is hydraulically locked by the valve so that external forces applied thereto will not operate the pump.

I also contemplate using a plurality of pumps such as P' and P'', with valves 13' and 13'' between them and the motor conduits 11 and 12 so that the motor may be operated from any one of the several pumps. When any one pump ceases operation the hydraulic motor is locked in the adjusted position. Further movement of the motor in either direction, however, may be secured by operating any other of the several pumps.

The valve 13 (as well as 13' and 13'') serves to allow the above selective pump operation and serves the further function of isolating the motor system should any one of the pumps and their associated conduits 14 and 15 become inoperative for any cause. For instance, if the hydraulic system of Fig. 1 was applied to a combat vehicle or military aircraft for operation of accessories, so long as the closely associated motor and valves 13 are intact, the system will not be wholly bled of hydraulic fluid should any one of the pumps or lines 14 and 15 be shot away.

Referring to Fig. 2, a valve body 18 has formed therein coaxial bores 19, 20, and 21, the bore 20 being of smaller diameter than the end bores 19 and 21. Through the bore 20, a piston rod 23 passes in rather closely fitted relationship. To each end of the piston rod 23 is secured, as by a snap ring 24, pistons 25 and 26 which are fitted closely to the bores 19 and 21 respectively. These pistons have formed therein axial passages 27 to permit free flow of fluid between the piston ends.

At the right hand end of the bore 19 is a port 30 communicating with an opening 31 to which one of the pump conduits such as 14 is connected. At the left hand end of the bore 21 is a port 32 communicating with an opening 33 to which the other pump conduit such as 15 is connected. Covered, at times, by the pistons 25 and 26, are ports 36, 37 and 38, 39 respectively. The ports 36 and 38 are closed by ball check valves 40 and 41 respectively. The ports 36 and 37 communicate with an opening 43 to which one of the motor lines such as 11 is connected, while the ports 38 and 39 communicate with an opening 44 to which the other motor conduit such as 12 is connected.

At the outer ends of the bores 19 and 21, centering spring assemblies 46 are secured as by snap rings 47. The spring assemblies 46 form closures for their bores and include ring packings 48 to seal them in the bores. The centering springs serve to hold the piston assembly 23, 25, and 26 in a normally central position where the piston 25 covers both ports 36 and 37 and where the piston 26 covers both ports 38 and 39.

The operation of the valve unit is as follows:

If fluid under pressure is admitted to the port 30 by pump operation, the pressure fluid will act

upon the left hand end of the piston rod 20 and will move the rod to the right, carrying the pistons 25 and 26 with it and compressing the right hand spring unit 46. Thus, the port 36 will be opened to the port 30 and pressure fluid may flow past the check valve 40 to operate the motor. Likewise the piston 26 will uncover the port 39 to permit free flow of low pressure fluid from the motor to the pump intake through the port 32. In this situation, should a large reactive force be imposed upon the fluid motor tending to prevent pump operation or to reverse the pump, the check valve 40 will close preventing the transmission of the fluid force to the pump, at least until such time as the fluid pressure of the pump exceeds that existing in the opening 43 of the valve.

If the pump is reversed, the piston rod 20 with its associated parts will move to the left, opening the port 32 to the port 38 and the port 30 to the port 37, thereby allowing reverse motor operation while maintaining the safety features above outlined. At any time when pump operation ceases, the centering spring units 46 will centralize the piston assembly, by virtue of slight leakage between the piston 23 and the bore 20 closing the ports 36, 37, 38 and 39, locking the hydraulic motor M from movement, and furthermore, locking the hydraulic fluid in the motor conduits in such a way that failure of the pump P will not bleed the motor system of fluid and allow it to collapse. The use of a plurality of valve units and pumps allows operation of the motor from a plurality of distant points and the motors may be operated individually or jointly and will always be divorced from the motor system as soon as pump operation ceases.

It will be apparent from the above description that the objects of the invention are met and that the valve unit described provides automatic and positive isolation of a hydraulic motor system from a pump under all conditions except when the pump is operated intentionally.

While I have described my invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art, after understanding my invention, that various changes and modifications may be made therein without departing from the spirit or scope thereof. I aim in the appended claims to cover all such modifications and changes.

I claim:

1. A control valve for use in a pair of pressure conduits connecting a reversible pump and a reversible hydraulic motor, said control valve comprising a housing, said housing having a bore extending axially therethrough, a piston slidably reciprocable in said bore, said piston and said bore being of such relative sizes that cavities are provided at the opposite ends of said bore and said piston blocks any passage of fluid through said bore between said cavities, one cavity having a port connecting it to the pump-side of one pressure conduit, the other cavity having a port connecting it to the pump-side of the other pressure conduit, a passage-way in said housing connected to the motor-side of one pressure conduit, a second passageway connected to the motor-side of the other pressure conduit, a pair of ports connecting one cavity to one passageway, a second pair of ports connecting the second cavity to the second passageway, plug means closing the outer end of each cavity, yieldable means urging said piston to a middle position, a sleeve valve in each said cavities at each end of and connected to said piston, each said sleeve valve closing both motor-side ports when said piston is in said middle position, said piston sleeve valve being limited in its reciprocation to open either but not both of each pair of motor-side ports, said pump-side cavity ports being always open, a one-way cavity-exit-valve on one port of each pair of passageway ports, said sleeve valves permitting communication through only one cavity-exit-valve port and simultaneously through the other motor-side port of the second cavity at one time, whereby high pressure fluid from the pump-side of one of the pump pressure conduits holds the piston and sleeve in communication-permitting-position through the cavity-exit-valve port to permit flow of high pressure fluid therethrough to one motor-side passageway and simultaneously low pressure fluid to flow from the other motor-side passageway back to the to the other pressure pump conduit, and whereby reverse flow on the motor-side of the passageway receiving high pressure from said pump causes said one-way cavity-exit-valve to close and permit said yieldable means to reciprocate said piston sleeve to low pressure port-blocking position while the cavity-exit-port valve closes the high pressure port of the same cavity, thereby only permitting passage of high pressure from the pump-side to the motor-side and locking off passage of high pressure from the motor-side to the pump-side.

2. A control valve for use in a pair of pressure conduits connecting a reversible pump and a reversible hydraulic motor, said control valve comprising a housing, said housing having a bore extending axially therethrough, a piston slidably reciprocable in said bore, said piston and said bore being of such relative sizes that cavities are provided at the opposite ends of said bore and said piston blocks any passage of fluid through said bore between said cavities, one cavity having a port connecting it to the pump-side of one pressure conduit, the other cavity having a port connecting it to the pump-side of the other pressure conduit, a passageway in said housing connected to the motor-side of one pressure conduit, a second passageway connected to the motor-side of the other pressure conduit, a pair of ports connecting one cavity to one passageway, a second pair of ports connecting the second cavity to the second passageway, plug means closing the outer end of each cavity, yieldable means urging said piston to a middle position, a sleeve valve in each said cavities at each end of and connected to said piston, each said sleeve valve closing both motor-side ports when said piston is in said middle position, said piston sleeve valve being limited in its reciprocation to open either but not both of each pair of motor-side ports, said pump-side cavity ports being always open, a one-way cavity-exit-valve on one port of each pair of passageway ports, said sleeve valves permitting communication through only one cavity-exit-valve port and simultaneously through the other motor-side port of the second cavity at one time, whereby high pressure fluid from the pump-side of one of the pump pressure conduits holds the piston and sleeve in communication-permitting-position through the cavity-exit-valve port to permit flow of high pressure fluid therethrough to one motor-side passageway and simultaneously low pressure fluid to flow from the other motor-side passageway back to the other pressure pump conduit, and vice versa, and whereby

reverse flow on the motor-side of the passageway receiving high pressure from said pump causes said one-way cavity-exit-valve to close and permit said yieldable means to reciprocate said piston sleeve to low pressure port-blocking position while the cavity-exit-port valve closes the high pressure port of the same cavity, thereby only permitting passage of high pressure from the pump-side to the motor-side and locking off passage of high pressure from the motor-side to the pump-side.

3. A control valve for use in a pair of pressure conduits connecting a reversible pump and a reversible hydraulic motor, said control valve comprising a housing, said housing having a bore extending axially therethrough, a piston slidably reciprocable in said bore, said piston and said bore being of such relative sizes that cavities are provided at the opposite ends of said bore and said piston blocks any passage of fluid through said bore between said cavities, one cavity having a port connecting it to the pump-side of one pressure conduit, the other cavity having a port connecting it to the pump-side of the other pressure conduit, a passageway in said housing connected to the motor-side of one pressure conduit, a second passageway connected to the motor-side of the other pressure conduit, a pair of ports connecting one cavity to one passageway, a second pair of ports connecting the second cavity to the second passageway, plug means closing the outer end of each cavity, spring means based on said plug means urging said piston to a middle position, a sleeve valve in each said cavities at each end of said piston, spider means connecting each said sleeve valve to its end of said piston, each said sleeve valve closing both motor-side ports when said piston is in said middle position, said piston sleeve valve being limited in its reciprocaton to open either but not both of each pair of motor-side ports, said pump-side cavity ports being always open, a one-way cavity-exit-valve on one port of each pair of passageway ports, said sleeve valves permitting communication through only one cavity exit valve port and simultaneously through the other motor-side port of the second cavity at one time, whereby high pressure fluid from the pump-side of one of the pump pressure conduits holds the piston and sleeve in communication-permitting-position through the cavity-exit-valve port to permit flow of high pressure fluid therethrough to one motor-side passageway and simultaneously low pressure fluid to flow from the other motor-side passageway back to the other pressure pump conduit, and whereby reverse flow on the motor-side of the passage receiving high pressure from said pump causes said one-way cavity-exit-valve to close and permit said yieldable means to reciprocate said piston sleeve to low pressure port-blocking position while the cavity-exit-port valve closes the high pressure port of the same cavity, thereby only permitting passage of high pressure from the pump-side to the motor-side and locking off passage of high pressure from the motor-side to the pump-side.

4. A control valve for use in a pair of pressure conduits connecting a reversible pump and a reversible hydraulic motor, said control valve comprising a housing, said housing having a bore having a reduced central neck extending axially therethrough, a piston slidably reciprocable in said bore neck, said piston and said bore being of such relative sizes that cavities are provided at the opposite ends of said bore and said piston blocks any passage of fluid through said bore neck between said cavities, one cavity having a port connecting it to the pump-side of one pressure conduit, the other cavity having a port connecting it to the pump-side of the other pressure conduit, a passageway in said housing connected to the motor-side of one pressure conduit, a second passageway connected to the motor-side of the other pressure conduit, a pair of ports connecting one cavity to one passageway, a second pair of ports connecting the second cavity to the second passageway, plug means closing the outer end of each cavity, yieldable means urging said piston to a middle position, a sleeve valve in each said cavities at each end of and connected to said piston, each said sleeve valve closing both motor-side ports when said piston is in said middle position, said piston sleeve valve being limited in its reciprocation to open either but not both of each pair of motor-side ports, said pump-side cavity ports being always open, a one-way cavity-exit-valve on one port of each pair of passageway ports, said sleeve valves permitting communication through only one cavity-exit-valve port and simultaneously through the other motor-side port of the second cavity at one time, whereby high pressure fluid from the pump-side of one of the pump pressure conduits holds the piston and sleeve in communication-permitting-position through the cavity-exit-valve port to permit flow of high pressure fluid therethrough to one motor-side passageway and simultaneously low pressure fluid to flow from the other motor-side passageway back to the other pressure pump conduit, and whereby high pressure on the motor-side of the passageway receiving reverse flow from said pump causes said one-way cavity-exit-valve to close and permit said yieldable means to reciprocate said piston sleeve to low pressure port blocking position while the cavity-exit-port valve closes the high pressure port of the same cavity, thereby only permitting passage of high pressure from the pump-side to the motor-side and locking off passage of high pressure from the motor-side to the pump-side.

ALBERT RIVINGTON STONE.