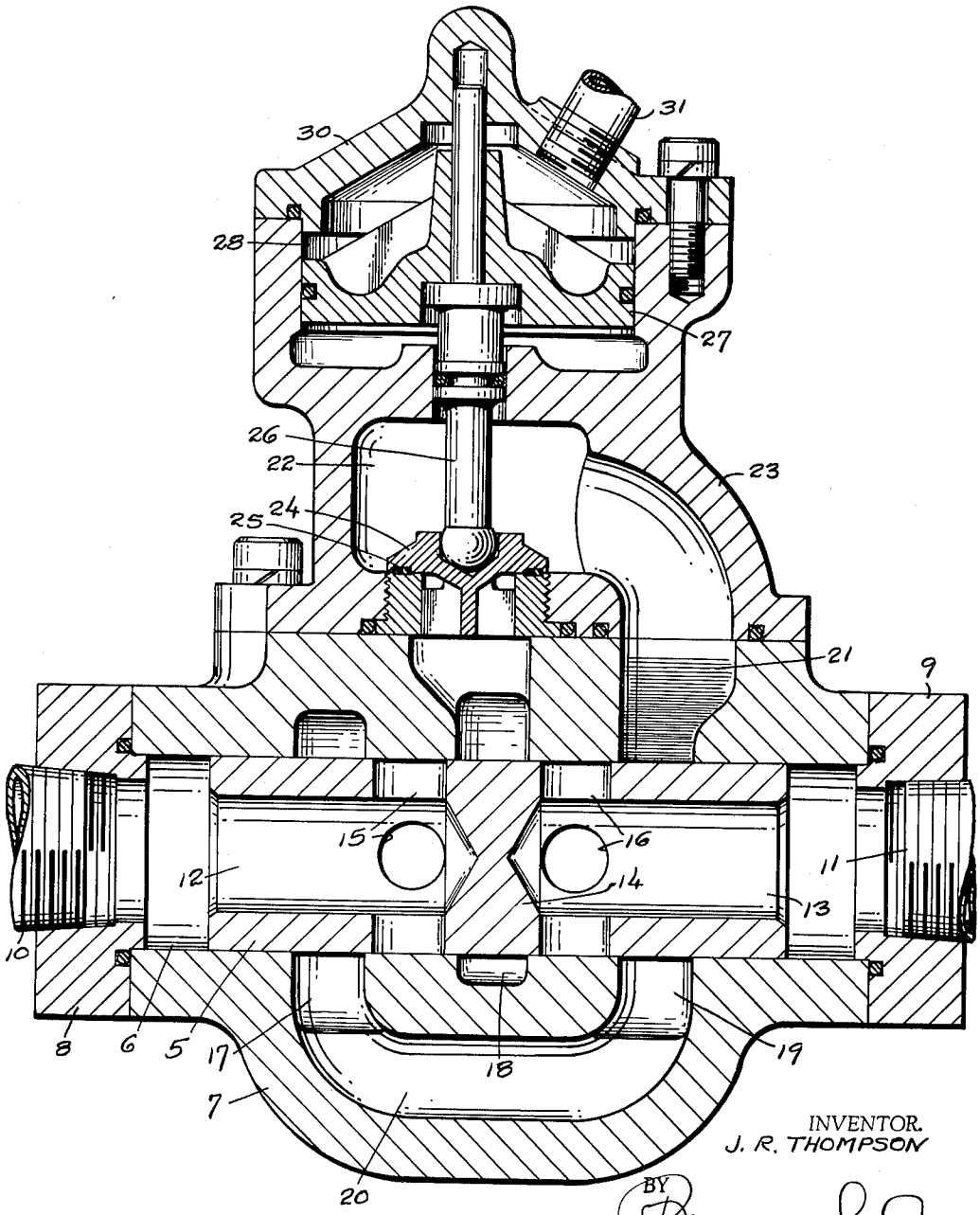
June 28, 1966 J. R. THOMPSON 3,258,022

HYDRAULICALLY POWERED DRIVE SYSTEM WITH PNEUMATIC CONTROL CIRCUIT

Filed July 11, 1962 2 Sheets-Sheet 1

FIG. 1



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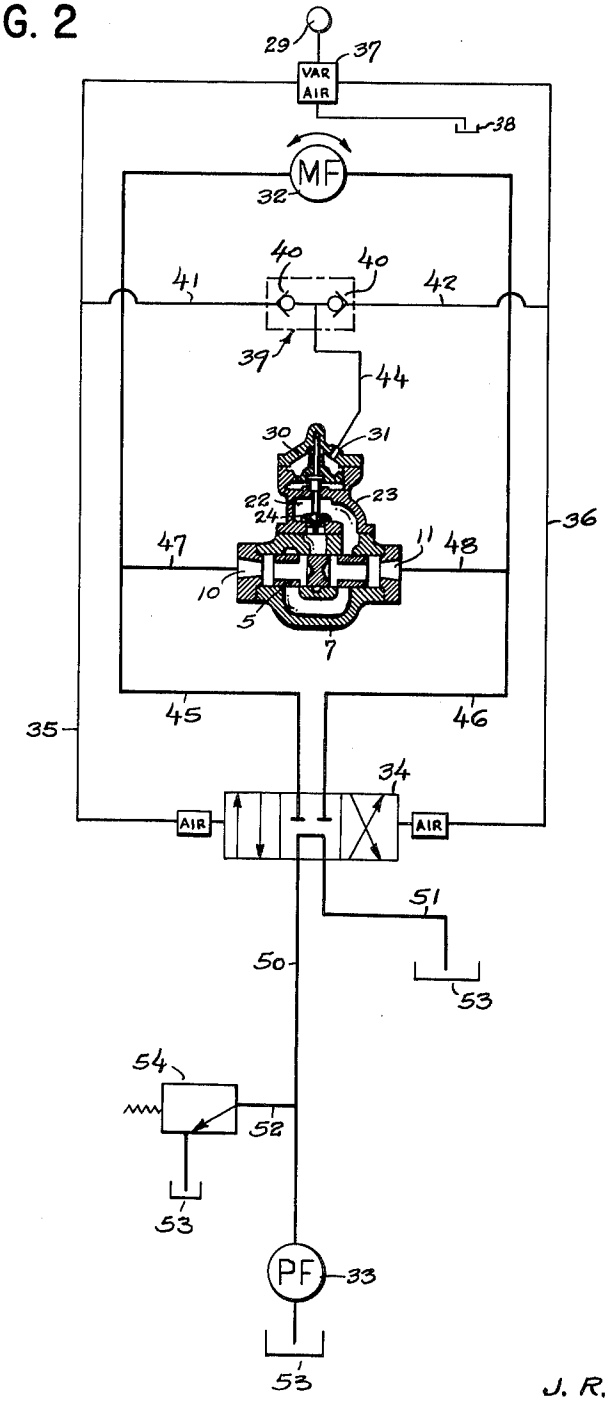
BY Parmelee & Seed
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Filed July 11, 1962 2 Sheets-Sheet 2

FIG. 2



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United States Patent Office 3,258,022 Patented June 28, 1966

3,258,022

HYDRAULICALLY POWERED DRIVE SYSTEM WITH PNEUMATIC CONTROL CIRCUIT

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Filed July 11, 1962, Ser. No. 209,192
10 Claims. (Cl. 137—18)

This invention relates to drive systems employing a hydraulically powered motor as a prime mover, and for its primary object aims to provide a system by which the fluid which powers said motor, while drawn from a fixed-pressure source, is delivered to the motor at selectively variable pressures so that the operator is enabled to control the speed at which the motor is driven.

It is a further and particular object to provide a system of the described nature in which the concerned motor is reversible.

As a further object still the invention aims to provide a hydraulically powered drive system in which the source pressure is of high intensity, and having a separate low-pressure fluid circuit entirely independent of the motor-powering fluid circuit for governing the pressure at which the hydraulic fluid is delivered to the motor.

The invention further proposes to provide a system employing said low-pressure fluid to control the directional course of the delivered hydraulic fluid as well as the pressure at which said fluid is delivered, and having a single manually-operated control for performing the two functions simultaneously.

The invention has the still further and particular object of providing a system of the described character employing air as the low-pressure fluid.

Yet additional objects and advantages in view will, with the foregoing, appear and be understood in the course of the following description and claims, the invention consisting in the novel construction and in the adaptation and combination of parts hereinafter described and claimed.

In the accompanying drawings:

FIGURE 1 is a cross-sectional view illustrating a valve expressly designed to correlate the one to the other of said two fluid circuits in the composite system of the of the present invention; and

FIG. 2 is a diagrammatic view of the system.

First describing said valve, with reference being had to said drawings, the numeral 5 designates a 3-position shuttle valve received for reciprocal endwise motion in the cylinder 6 of a valve chest 7. The cylinder is open at both ends, and closing these openings are headers 8 and 9 each tapped to receive a respective pipe fitting, as 10 and 11. The shuttle valve has centerbores 12 and 13 at the two ends separated one from the other by a centrally placed bulkhead 14. Radial ports, as 15 and 16, lead to the perimeter of the suttle valve from the inner end of each center-bore. The spacing between the two sets of ports is moderately greater than the diameter of the ports.

The valve chest presents a center groove 18 and two end grooves 17 and 19 each extending circumferentially about the valve cylinder and formed in each instance to a width corresponding to the diameter of the ports. These grooves are spaced equidistantly from one another distances corresponding to the spacing betwen the two sets of ports. By the abovedescribed placement of said ports and grooves, movement of the shuttle valve to one extreme of its endwise travel brings the ports 15 and 16 into register with the grooves 17 and 18, respectively, while movement to the opposite extreme brings such ports into register with the grooves 18 and 19, respectively. In the centered position of the valve the grooves are lapped by land portions of the valve.

A passageway 20 extends from one to the other of said outer grooves 17 and 19 so that the same are in constant communication, and a passageway 21 leads to these grooves from a relief chamber 22 formed in a body 23 which surmounts the valve chest. The center groove 18 also connects with the relief chamber but normally is isolated therefrom by a guidably mounted relief valve 24 closing upon a sealing gasket 25 against pressure obtaining within such center groove. Yielding thrust to urge said relief valve into closed position is imposed through a piston rod 26 from an air piston 27 working in a cylinder 28 formed in the head end of the body 23. A bonnet 30 bolted to said body complements the cylinder to produce the air chamber for the piston, and threaded in such bonnet is a fitting 31 for supplying pressure air to the chamber. The surface of such piston 27 which is exposed to the air chamber is differentially superior to the surface of the relief valve exposed to the center groove of the valve chest. As here shown, and which I find to be suitable, this superiority is on the order of 10 to 1.

As can be seen from an inspection of FIG. 2, the described valve permits variable pressures to be applied to a reversible hydraulic motor 32 from a fluid pump 33 of fixed displacement. A contol valve 34 having a 3-position spool is applied between said pump and motor. The spool normally occupies a neutral position and is shifted to either of its two end positions, selectively, by air delivered through pipes 35 and 36 from a manually operated control valve 37. This valve 37 when open, and depending upon the degree of such opening, controls the pressure (within a low-pressure range having a ceiling, say, of 150#) of air fed from a pressure source of supply 29. This ceiling is low by comparison with the pressure potential of the fluid delivered from the pump 33. The valve 37 can be moved in either of two opposite directions from a centered neutral position. The direction in which it is moved from center determines which of the two pipes 35 and 36 receives air from said source. The degree of such movement determines the pressure, within said low-pressure range, of the air which is received. When valve 37 occupies said centered neutral position, both pipes 35 and 36 are brought into communication with an atmospheric exhaust 38. Pipes 41 and 42 lead from pipes 35 and 36 to opposite sides of a directional-control valve 39, and a pipe 44 connects valve 39 with the fitting 31. The characteristic of valve 39 is that two check valves 40 move in concert either to the right or left by a pressure condition in line 41 or in line 42, respectively, in the former instance bringing line 41 into communication with line 44 and in the latter instance bringing line 42 into communication with line 44. In either such case the lines 44–41 or 44–42, as the case may be, remain in communication until pressure air is delivered to the other of the two parent lines, thereby permitting air to be dumped from cylinder 28 back through the valve 39 and line 41 or 42, as the case may be, to valve 37 and through the latter to the atmospheric exhaust 38 as the control handle of such valve 37 is shifted either from a right-hand or a left-hand "on" position toward a centered "off" position. Valves 37 and 39 are both standard in the industry. Valve #521,774, produced by Westinghouse Air Brake Co., Wilmerding, Pa., and valve #332–A, produced by Williams Power Brake Co., Portland, Oregon, are suitable for my purpose.

The flow lines 45 and 46 which lead from two back-side ports of the control valve 34 to the two sides of the reversible hydraulic motor also connect by pipes 47 and 48 one with the fitting 10 and the other with the fitting 11. Flow lines 50 and 51 which connect with two front-side ports of said control valve extend one from the pump 33 and the other to a reservoir 53 from which said pump

draws its fluid. The spool of valve **34** provides direct connection at one end limit of its travel, and cross-over connection at the other end limit of its travel, between the front-side ports and the back-side ports of the valve. Upstream from the control valve **34**, and namely between said valve and the fixed-displacement pump **33**, a relief valve **54** dumping to the reservoir and set to a pressure of, say 1500# connects with the supply line **50** by a pipe **52**.

Let it be assumed that the operator desires to supply hydraulic fluid from the pump to the motor at a low pressure so as to cause the latter to turn slowly in a right-hand direction (clockwise in FIG. 2). For shifting the control spool so as to obtain this desired low-speed operation of the hydraulic motor, the air valve **37** is only "cracked," so to speak, toward the left. The maximum pressure of air which the present control system requires would be 150# where, as is here provided, the air piston has a differential superiority of 10 to 1. If the degree to which the air valve **37** is opened now supplies only a 10# pressure, this is the pressure which obtains upon the air piston and will consequently hold the relief valve **24** closed against no higher than a 100# pressure. As the spool of the valve **34** shifts to its right-hand position (considered from the vantage point of FIG. 2) in response to the 10# air pressure in the line **35**, hydraulic fluid from the pump **33** is delivered by the "direct" connection of such valve spool through connecting pipes **50** and **45** to the motor **32** and also through pipe **47** to the fitting **10** of the regulating valve. The shuttle spool **5** of such valve responsively moves to the right and brings the ports **15** into register with the center groove **18** and the ports **16** into register with the end groove **19**. Relief valve **24** is perforce subjected to the pressure which obtains in pipe **45**, wherefore the pressure in such pipe can rise no higher (in this instance 100#) than the pressure necessary to open the relief valve against the force imposed by the air against the air piston **27**. The operator, by modifying the air pressure through regulation of the control valve **37**, is enabled to raise or lower the pressure, and hence the resulting speed which the pumped hydraulic fluid imposes upon the fluid motor.

Should it be easier to drive the hydraulic motor at a greater speed it is necessary only that the control valve **37** be opened to a greater degree. Piston **27** thereupon becomes subject to a higher air pressure, exerting a greater closing force upon the relief valve **24**, and it follows that a proportionately greater hydraulic pressure must exist in the line **45** before the relief valve **24** will open and "dump" excess hydraulic fluid back to the reservoir. Otherwise stated, and still assuming that the air piston **27** has said given differential superiority of 10 to 1 over the relief valve **24**, an increase to, say, 55# in the force moment which the pressure air within the line **35** imposes upon the air piston would instantly subject the hydraulic motor **32** to a pressure of 550#. For reversing the hydraulic motor, the operator moves the handle of the control valve in the opposite direction from center. Air under pressure now enters line **36**, whereupon the spool of valve **34** shifts to the left extreme of its permitted travel. Hydraulic fluid responsively feeds by the "cross-over" connection of such valve spool from supply line **50** to the connecting lines **46** and **48** so that simultaneoulsy, (1) the shuttle spool **5** moves to the left extreme of its shuttle travel and (2) the hydraulic motor **32** is driven in a counter-clockwise direction, its speed being determined by the controlled pressure of the air which the operator's regulation of the variable-pressure valve **37** imposes on the relief valve **24**.

It is believed that the invention and the manner of its operation will have been clearly understood from the foregoing description of my now-preferred illustrated embodiment. Changes in the details of constuction may be resorted to without departing from the spirit of the invention and it is accordingly my intention that no limitations be implied and that the hereto annexed claims be given the broadest interpretation to which the employed language fairly admits.

What I claim is:

1. In combination: a source of constant-pressure high pressure fluid and a source of low pressure fluid, a variable-speed fluid motor, a supply line between said high pressure source and the motor, a normally closed valve at the ingress end of said supply line, a means which operates when subjected to pressure to open said valve so as to deliver fluid from the high-pressure source into said supply line, a line from the low pressure source for supplying said pressure to the valve-opening means, a manually operated control valve for said last-named supply line acting by the degree to which it is opened to variably govern the pressure, within a range the ceiling of which is prescribed by said low-pressure source, of the fluid fed to the supply line, and means governed automatically by said governed variable pressure which obtains in the low-pressure supply line for dumping fluid from the high-pressure supply line until the pressure in the latter is a predetermined multiple of the governed pressure obtaining in the low pressure supply line.

2. In combination: a source of hydraulic fluid under constant-pressure high pressure, a variable speed hydraulic motor, a supply line between said hydraulic source and the motor, a normally closed valve at the ingress end of said supply line, a means which operates when subjected to pressure to open said valve so as to deliver hydraulic fluid from the source thereof into said supply line, a low pressure source of air supply, a supply line from said source to the valve-opening means for supplying said valve-opening pressure to the valve-opening means, a manually operated variable-pressure control valve for said last-named supply line, and means governed automatically by the pressure of the air as determined by the setting manually given to said variable-pressure valve for dumping hydraulic fluid from the hydraulic supply line until the pressure in the latter becomes a predetermined multiple of said valve-determined air pressure.

3. In combination: a source of constant-pressure high pressure fluid and a source of low pressure fluid, a reversible variable-speed fluid motor, a selector valve movable from a normal closed position into either of two open positions and so operatively interconnected with the high pressure source and with the motor that fluid is fed from the high pressure source to one side and dumped from the other side of the motor, alternatively, according as the valve occupies one or the other of its two open positions, two separate connections from the low pressure source to the selector valve acting to move the valve to either of said open positions, selectively, according as fluid from the low pressure source is supplied to either of said connections, means subject to manual control for supplying fluid from the low pressure source to either of said connections, selectively, at selectively variable pressures, and means governed automatically by the pressure at which said low pressure fluid is being supplied for responsively dumping fluid from the connection through which high pressure fluid is being fed until the pressure in the latter is a predetermined multiple of the pressure obtaining in the low pressure supply line.

4. In combination: a source of constant-pressure high pressure hydraulic fluid, a source of low pressure air, a reversible variable-speed hydraulic motor, a pressure-operated selector valve movable from a normal closed position into either of two open positions and so operatively connected by a supply line with the source of hydraulic fluid and by feed lines with the two sides of the motor that hydraulic fluid is fed from the source to either one of the two sides, selectively, while being dumped from the other side, two separate connections from the air source to the selector valve acting to move the valve to either of said open positions, selectively, according as air from the air source is supplied to one or the other of

said separate connections, means including a valve subject to manual control for supplying air from the air source to either of said separate connections, selectively, at selectively variable pressures, and means governed automatically by the pressure at which said air is being supplied for responsively by-passing the hydraulic motor through a diversion of hydraulic fluid directly from the high pressure to the low pressure side thereof until the pressure in the line which feeds to the former is a predetermined multiple of the applied air pressure selected by the variable-pressure valve.

5. In combination: a reservoir of hydraulic fluid, a reversible variable-speed hydraulic motor, a selector valve chest presenting a separated pair of front-side ports and a separated pair of back-side ports, a connection between one of said front-side ports and the reservoir, a pump drawing hydraulic fluid from the reservoir and feeding the same at constant high pressure to the other of said front-side ports, separate feed connections one between one of the back-side ports and one side of the motor and the other between the other of the back-side ports and the other side of the motor, a selector valve for said chest movable by pressure from a normal closed position isolating the front-side from the back-side ports into either of two open positions one of which provides a direct and the other a cross-over connection between the two front-side ports and the two back-side ports, a source of air pressure, two air-flow lines connecting with the selector valve acting to supply the pressure responsible for moving the selector valve, a manually-controlled variable-pressure valve between the air source and said air-flow lines enabling air to be delivered at variable pressure to either of said air-flow lines, selectively, while dumping air from the other air-flow line, a valved by-pass connection between the two hydraulic feed connections, and means controlled by the applied air pressure as determined by the setting of said variable-pressure valve for automatically opening and closing the valve in said by-pass connection as required to maintain the pressure of the hydraulic fluid being supplied to the motor in a predetermined ratio relative to the pressure of the applied air.

6. Structure according to claim 5 characterized in that said predetermined ratio gives to the supplied hydraulic fluid a substantial superiority over the applied air.

7. Structure according to claim 5, said valve in the by-pass connection closing against the pressure of the supplied hydraulic fluid, the means last recited comprising a

piston working in a cylinder and attached to the by-pass valve so as to move in unison therewith, said piston having a surface subject to the applied air pressure which is differentially superior to the surface of the by-pass valve exposed to the hydraulic fluid.

8. Structure according to claim 7, said by-pass valve being complemented by a shiftable spool presenting two separated pockets one in constant communication with one and the other in constant communication with the other hydraulic feed connection, and a chest for said spool providing two connecting passageways which by movement of the spool in opposite directions from a normal neutral position are selectively brought into registration one with one and the other with the other pocket, alternatively, the connection between said passageways being closed by the by-pass valve.

9. Structure according to claim 7, the cylinder in which said piston works having separate connection with each of the two air-flow lines, each of said air connections being fitted with a check valve closing against the pressure in the related air-flow line, the two check valves being characterized in that the same are connected to move in concert with one opening and the other closing, alternatively, only by the presence of a pressure condition in a selected one of the two air-flow lines so as to permit a reverse flow of pressure air to return past a check valve and be dumped from the cylinder to atmosphere in the absence of a pressure condition in either said line.

10. Structure according to claim 5 in which the pump has a fixed displacement, the selector valve acting in its closed position to connect the two front-side ports so that the hydraulic fluid pumped by the pump returns directly to the reservoir.

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