

Jan. 25, 1966

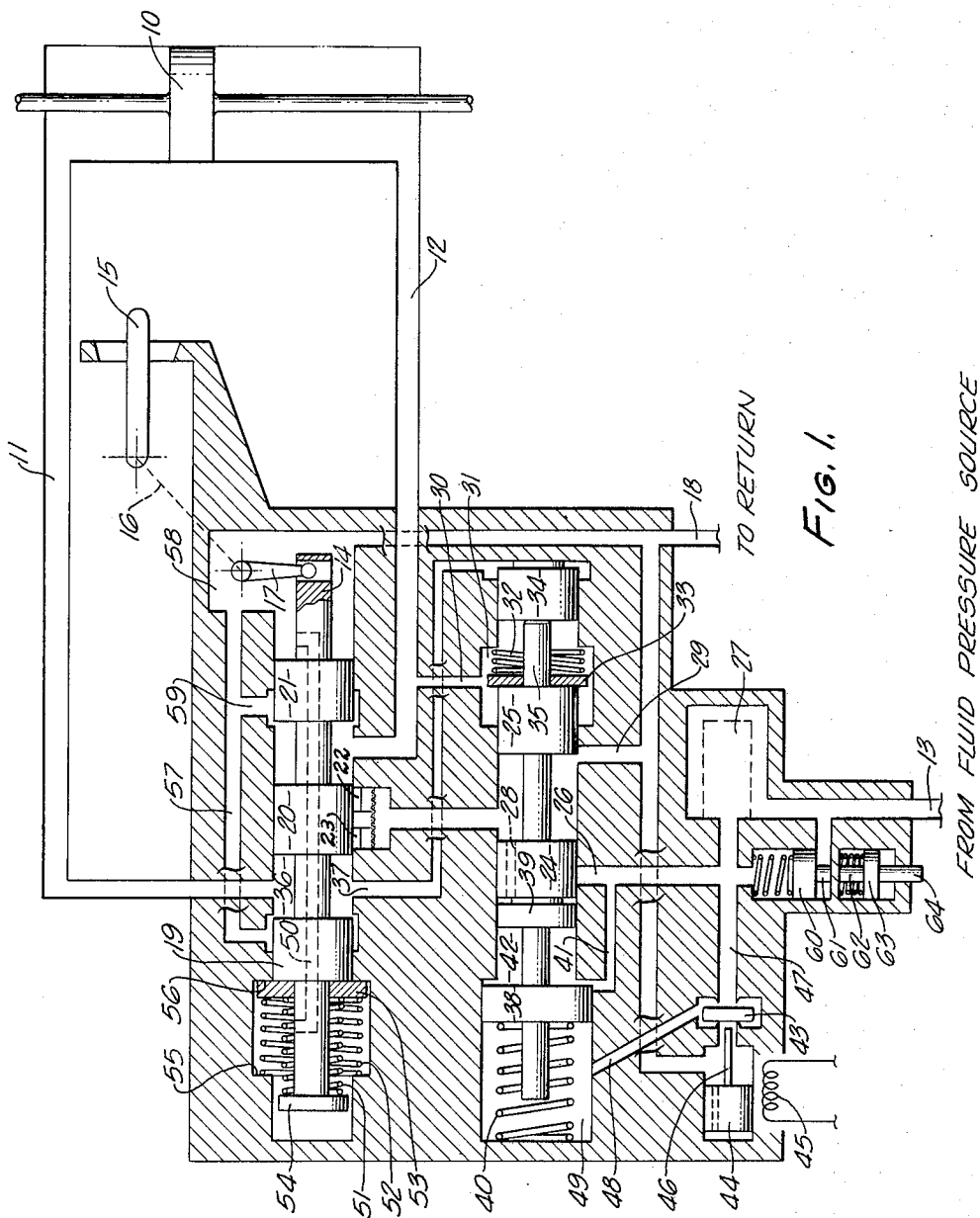
R. A. YORK

3,230,841

CONSTANT SPEED CONTROL FOR HYDRAULIC MOTORS

Filed Aug. 30, 1963

3 Sheets-Sheet 1



INVENTOR.
RAY A. YORK
BY *Hazard & Miller*
ATTORNEYS

Jan. 25, 1966

R. A. YORK

3,230,841

CONSTANT SPEED CONTROL FOR HYDRAULIC MOTORS

Filed Aug. 30, 1963

3 Sheets-Sheet 2

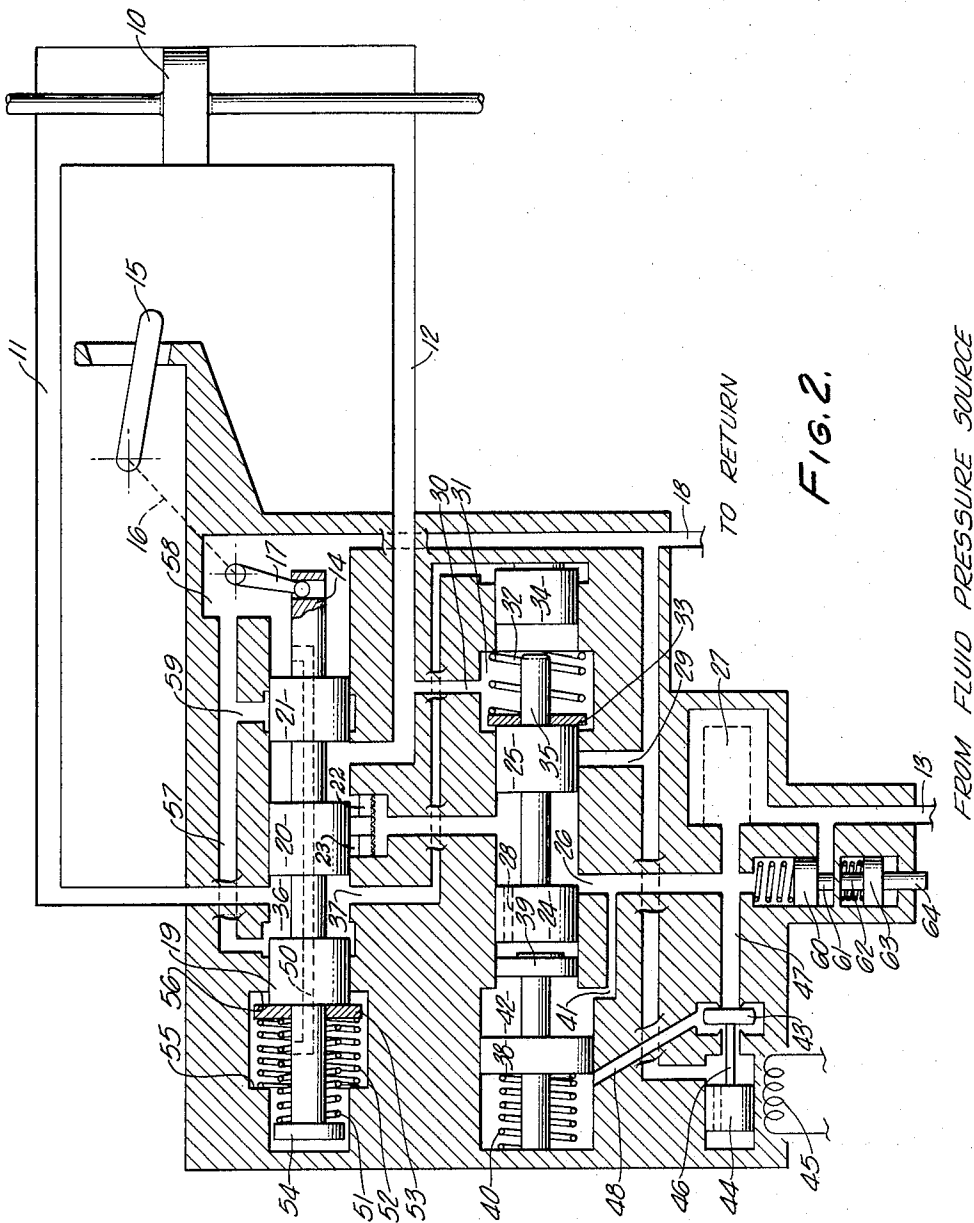


FIG. 2.

INVENTOR.
RAY A. YORK
BY *Hayard & Miller*
ATTORNEYS

Jan. 25, 1966

R. A. YORK

3,230,841

CONSTANT SPEED CONTROL FOR HYDRAULIC MOTORS

Filed Aug. 30, 1963

3 Sheets-Sheet 3

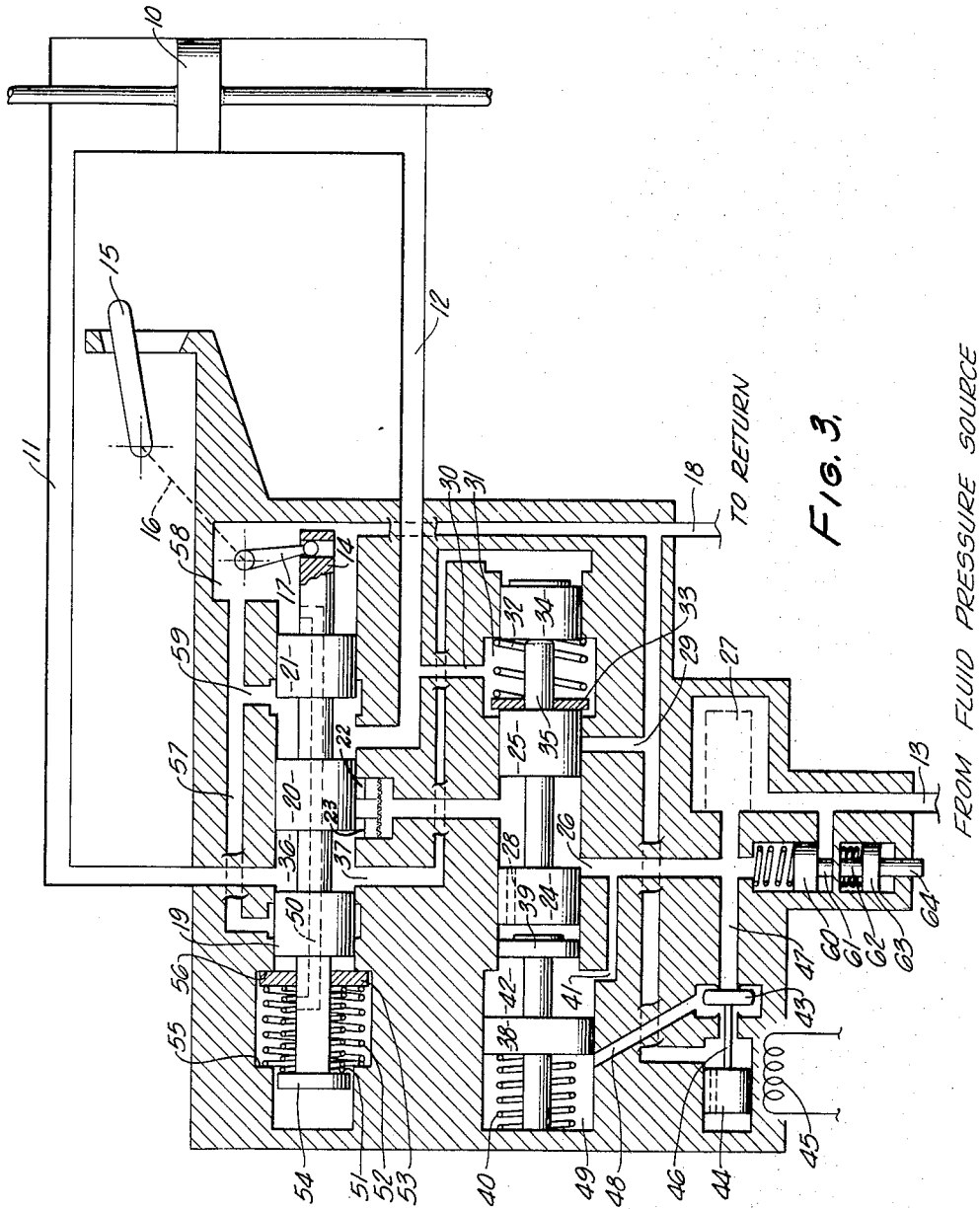


FIG. 3.

FROM FLUID PRESSURE SOURCE

INVENTOR
RAY A. YORK

BY

Lagard & Miller

ATTORNEYS

1

3,230,841 CONSTANT SPEED CONTROL FOR HYDRAULIC MOTORS

Ray A. York, 613 Alameda St., Altadena, Calif.
Filed Aug. 30, 1963, Ser. No. 305,443
7 Claims. (Cl. 91-446)

This invention relates to a hydraulic transmission system and is particularly suitable for use in controlling the flight control surfaces of aircraft although it may be employed for other purposes.

Heretofore hydraulic transmission systems of this general character have been designed wherein fluid under pressure from a fluid-pressure source is conducted to a control valve. From the control valve two conduits lead to the opposite sides of a reversible motor. By manipulating the control valve the fluid-pressure source may be optionally connected through either of the conduits to operate the motor in one direction or the other in which case the other conduit serves as a return for returning fluid from the motor. By reversing the position of the control valve the motor may be operated in a reverse direction.

It is highly desirable in a transmission of this character to have the speed of the motor directly proportional or commensurate with the amount of opening of the control valve so that regardless of whether the motor is being driven forwardly or reversely a ten percent opening of the control valve will produce a ten percent speed of operation of the motor, and a twenty percent opening of the control valve will produce a twenty percent speed of the motor. The various factors that may affect such operation include (1) variations in the load imposed upon the motor, (2) variations in the pressure supplied from the fluid-pressure source, (3) variations in the pressure in the return passages returning fluid from the motor. All of these factors, operating either individually or collectively, tend to affect the speed of the motor at any selected position of the control valve.

A primary object of the present invention is to provide a hydraulic transmission system of this character with a regulating means or compensating means which will tend to maintain the speed of the motor more directly proportional to the opening of the control valve so that when the control valve is opened to a selected extent the speed of the motor will be more directly proportional thereto regardless of the effects of load, supplied pressure, or return pressure.

In addition to the foregoing object, objects of the invention include the equipment of the control valve with a centralizing means which will center the control valve when it is released to close the supplied source of fluid pressure from either conduit leading therefrom to the motor and to provide means for closing the regulating or compensating valve when this action is desired.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

FIGURE 1 is a diagrammatic view of a hydraulic power transmission system embodying a preferred form of the present invention the parts being shown in that position wherein the control valve is in neutral position and the regulating or compensating valve is in closed position;

FIG. 2 is a view similar to FIG. 1 but illustrating the control valve as having been shifted into a position wherein the motor is being driven forwardly by the fluid from the fluid-pressure source and the regulating or compensating valve is in its normal or operating condition; and

2

FIG. 3 is a view similar to FIG. 2 but illustrating the control valve as having been shifted from its neutral position into a position which will require reverse operation of the motor.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, 10 indicates a reversible fluid motor. As illustrated, this motor is shown in a simplified form consisting merely of a piston that is reciprocable in a cylinder. It will be understood, however, that in lieu of a simple hydraulic ram a more complex reversible motor may be employed such as, for example, a rotary motor. The motor 10 has connected to its opposite sides two conduits 11 and 12 which are supplied with hydraulic fluid under pressure from a fluid-pressure source, not shown, which enters the system at the inlet 13. A control valve, generally indicated at 14, is between the fluid-pressure source and the conduits 11 and 12. This control valve is axially shifted by means of a control shown as a simple crank or lever 15 mechanically connected as indicated by the dotted line 16 to a valve shifter 17. From the neutral position shown in FIG. 1 the control lever or crank 15 can be shifted to a forward position as illustrated in FIG. 2 wherein the control valve 14 is shifted axially in one direction to cause the conduit 12 to conduct fluid from the source 13 to the motor 10. In this position the conduit 11 becomes a return conduit and returns fluid from the motor to the fluid return indicated at 18. If the control lever or crank 15 is shifted from the neutral position shown in FIG. 1 to the reverse position shown in FIG. 3, the control valve 14 is axially shifted in the opposite direction which causes the fluid from the source 13 to be conducted to the motor 10 through conduit 11. In this position conduit 12 constitutes a return conduit returning fluid from the motor to the fluid return 18. It is thus apparent that shifting the control crank or lever 15 in either direction from the neutral position shown in FIG. 1 controls the direction of movement of the reversible hydraulic motor 10.

The control valve 14 not only controls the direction of drive of the motor 10 but also functions to some extent as a throttling valve. As illustrated the control valve is a spool having three lands 19, 20 and 21 rigidly connected. The central land 20 when displaced from the neutral position to a forward position, as shown in FIG. 2, partially opens the port 22 that receives fluid pressure from the fluid-pressure source 13. In the reverse position shown in FIG. 3, the land 20 partially opens the port 23 that also receives fluid from the fluid-pressure source 13. The degree of opening of the port 22 by the land 20 controls the speed of the motor 10 in a forward direction, that is, if the port 22 is opened wider more fluid under pressure will be conducted from the source 13 through conduit 12 to the motor 10. Conversely, if the land 20 is caused to open port 23 wider, more fluid will be conducted to the motor through conduit 11 to cause the motor 10 to be driven reversely at a higher speed.

The degree of opening of either of the ports 22 or 23 by the land 20 will not cause the motor to be driven in direct proportion to the displacement of the control crank or lever 15 from its neutral position. Thus for any given setting of opening of port 22 the load on the motor may increase tending to retard the speed of the motor. The same is true for any given setting of the control valve opening the port 23 which causes the motor to be reversely driven. Another influential factor may be variation in the pressure of the fluid supplied from the fluid-pressure source at 13. If this pressure decreases, the rate at which fluid is supplied to the motor 10 through conduit 12 will decrease, thus reducing the speed at which the motor 10 operates. Also, if the pressure of fluid returning at 18 should decrease, this would tend to speed up the move-

3

ment of the motor for any given setting and, conversely, if the pressure in the return line should increase this would have a retarding effect on motor 10. Any one of these factors or a combination of them tends to make the speed of operation of the motor non-commensurate with the degree of displacement of the control crank or lever 15 from its neutral position. In accordance with the present invention a regulating or compensating valve is interposed between the fluid-pressure source at 13 and the control valve 14 and its ports 22 and 23. This control valve consists of a spool having spaced lands 24 and 25 rigidly connected together. The land 24 opens and closes a port or passage 26 that receives fluid from the fluid-pressure source 13 after the fluid has passed through a filter 27. The land 24 has a passage 28 there-through which equalizes the pressure on opposite ends of this land. The land 25 serves to close the port 29 when port 26 is open. One end of this land is subject to the pressure that is supplied through port 26 to the chamber between the land 24 and 25. The other side of land 25 is subject to the pressure that exists in conduit 12 by virtue of passage 30 which connects conduit 12 with the chamber 31. It is also subject to the force of a compression spring 32 that surrounds the stem of the regulating or compensating valve and presses against a washer 33 that is loose on the stem. In the right hand end of the chamber 31 there is disposed a loose piston 34 which is engageable with the end of the stem 35 of the compensating valve and which is exposed on one end to the pressure existing in chamber 31 and on the other end to the pressure existing in the chamber 36 between the lands 19 and 20 of the control valve. This pressure is conducted to the outer side of piston 34 through passage 37 and is equal to the pressure conducted to the chamber 36 by conduit 11. On the opposite end of the regulating or compensating valve there is a cylinder containing differential pistons 38 and 39 which are rigidly connected together by a stem. A coil compression spring 40 bears against the piston 38 urging this piston from left to right as viewed in the figures and into a position wherein it engages the regulating or compensating valve and shifts the compensating valve into a closed position wherein land 24 closes the port 26. However, inlet pressure that is supplied to the port 26 is conducted through passage 41 to the chamber 42 between the differential pistons and the effect of this pressure on piston 38 is to move both differential pistons from right to left against the compression of the spring 40 when valve 43 is closed as illustrated in FIGS. 2 and 3. When the differential pistons 38 and 39 are moved from right to left, as viewed in FIG. 2 for example, the regulating or compensating valve is free to open the port 26 and allow inlet pressure to be conducted from 13 to ports 22 and 23. Valve 43 is adapted to be closed by the armature 44 of a solenoid valve, the solenoid of which is indicated at 45. When this solenoid is energized it tends to centralize the armature 44 causing its stem 46 to engage and hold valve 43 against its seat, as illustrated in FIGS. 2 and 3. Opening of the circuit through the solenoid 45 allows the inlet pressure from 13 through passage 47 to open the valve and to be conducted through passage 48 to the chamber 49 that contains the differential piston 38. It will thus be appreciated that, when solenoid 45 is de-energized allowing valve 43 to open, pressures in chambers 42 and 49 equalize on opposite sides of piston 38 and compression spring 40 becomes effective to move the differential pistons from left to right causing the regulating or compensating valve to assume its closing position, as illustrated in FIG. 1.

The ends of the control valve are subject to equalizing pressures, an equalizing passage being illustrated in dotted lines at 50. Centralizing springs are illustrated at 51 and 52 which surround the stem of the control valve and which both bear on a washer 53 that is loose on the stem. Spring 51 is compressed between the washer and

4

a shoulder 54 on the stem while spring 52 is compressed between the washer and a shoulder 55. The washer is engageable with a shoulder 56. Whenever the control crank or lever 15 is released these centralizing springs are free to return the control valve to its neutral position regardless of whether the control valve has been displaced in one direction, as shown in FIG. 2, or whether it has been displaced in the other direction as shown in FIG. 3. The conduit 11 leads to the chamber 36 and from this chamber fluid may pass through passage 57 and chamber 58 to the return 18. The passage 57 has a branch 59 leading to the chamber between lands 20 and 21 to which chamber the conduit 12 is connected.

In the drawing I have illustrated an indicator to indicate the condition of filter 27 consisting of merely a spring-actuated piston 60 that is subject on opposite sides to inlet pressure from inlet source 13. This piston has a permanent magnet 61 that attracts a similar permanent magnet 62 on a spring-actuated piston 63 having a button 64. If the filter 27 becomes dirty, inlet pressure supplied to the under side of piston 60 becomes greater than the pressure on the upper side thereof, lifting piston 60 and separating the permanent magnets 61 and 62. The spring on piston 63 then is effective to force piston 63 downwardly projecting the button 64 which indicates that the filter 27 needs servicing.

The operation of the improved transmission system is substantially as follows. Assuming the system to be in the neutral position shown in FIG. 1, the solenoid 45 may be energized causing the armature 44 to shift valve 43 into closing position. The control crank 15 may then be shifted into the position shown in FIG. 2 or a forward position displacing the control valve into the position shown in FIG. 2. Under these circumstances land 20 of the control valve partially opens port 22 allowing fluid to flow from the pressure fluid source 13 through conduit 12 to motor 10. Returning fluid returns through conduit 11 to chamber 36 and as land 19 has opened the entrance to passage 57 returning fluid can flow through passage 57 to the return 18. If the crank 15 is depressed farther land 20 opens port 22 to a greater extent and more fluid is supplied to motor 10 at a greater rate through conduit 12, so that under ideal conditions the extent to which the crank 15 is depressed governs the speed of movement of motor 10. However, assume that a load is imposed on the motor 10 tending to retard its movement. This load causes back pressure to build up in conduit 12 which is conducted through passage 30 to chamber 31 and is effective on the right hand side of land 25. This back pressure build-up causes land 25 to move land 24 a little farther toward the left thus opening port 26 to a slightly greater extent and thus supplying fluid at a greater rate from the source 13 to the port 22. The opening of the port 26 to a greater extent as a result of the increase in pressure in conduit 12 compensates largely for the load so that for a given setting of the control 15 the motor will continue to operate at commensurate speed.

In another situation, assume that the control 15 has been given a selected setting supplying incoming pressure to conduit 12. If the load remains the same but the supplied pressure at 13 increases, this supplied pressure is effective on the left hand side of land 25 tending to move the regulating or compensating valve from left to right and closing port 26 to a greater extent. This throttling of the supplied pressure by the regulating or compensating valve before it reaches port 22 has a compensating effect on the rate at which fluid is conducted to motor 10 through conduit 12 so that the speed of operation remains the same or substantially so.

In a third situation, assume that the pressure in the return line 18 increases. This would be equivalent to increasing the load on the motor 10 and a compensation is automatically effected in the same manner as if there were an increased load on the motor.

If the control 15 is lifted into the position shown in FIG. 3, conduit 11 becomes the supply line to motor 10 and conduit 12 becomes the return line, its returning fluid being conducted from conduit 12 through branch 59 and chamber 58 to the return 18. Under these circumstances if the load is increased on the motor 10, pressure builds up in conduit 11 and this back pressure is conducted through passage 37 to the right hand side of piston 34. The left hand side of this piston is merely subjected under these conditions to the return pressure in return conduit 12 and the piston 34 is consequently moved into engagement with stem 35 moving the regulating or compensating valve to cause land 24 to open port 26 to a wider extent thus compensating for the increase in load and maintaining the speed of motor 10 commensurate with the setting of control 15. Likewise, under these circumstances, if the pressure at 13 increases tending to drive the motor 10 in the reverse direction at greater speed, the increase in pressure is effective on the left hand side of land 25 to cause port 26 to be closed a commensurate amount, it being understood that the right hand side of land 25 is, under these conditions, only subject to the return pressure in conduit 12 and the spring 32. Spring 32 is, of course, constantly urging the regulating or control valve into open position when the pressure effective on its lands enables it to do so.

After the motor 10 has been driven in either direction for the desired length of time a mere release of the control 15 enables the centralizing springs 51 and 52 to return the control valve to its neutral position as shown in FIG. 1 and if it is desired at any time to discontinue operation of the regulating or compensating valve and to close the control valve from the source 13, this may be accomplished by opening the circuit through the solenoid 45. This allows valve 43 to open and the differential pistons 38 and 39 to move from left to right, shifting the compensating valve to the position shown in FIG. 1 wherein land 24 closes port 26 entirely.

It will thus be appreciated that by interposing a regulating or compensating valve between the source 13 and the control valve 14 which compensating valve is influenced by pressures supplied thereto from the fluid pressure source and the pressures existing in the lines connecting the control valve with the motor, it is possible to maintain the speed of operation of the motor commensurate with the setting of the control 15. In effect, the regulating or compensating valve measures the pressure drop that exists through the port 22 or the port 23 depending upon which port is open and, as this pressure drops, changes as a result of change of load on the motor, change of supplied pressure, or change of return pressure, an automatic compensation is made. I do not represent that the above disclosed mechanism is so precise as to keep the speed of the motor 10 precisely commensurate with the setting of the control lever 15. Some slight departure will occur largely occasioned by the fact that the pressure exerted by the spring 32 is not uniform in all positions. Nevertheless the speed of operation of the motor is sufficiently close to the degree of displacement of the control 15 that it is highly desirable over hydraulic transmissions heretofore designed.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. In a fluid transmission system including a source of fluid pressure and a reversible fluid motor operable there-

by, conduits leading to and from the motor either of which may conduct fluid pressure to the motor or return fluid therefrom, control means between the fluid pressure source and the motor for selectively connecting either conduit to the fluid pressure source and rendering the other conduit a return to control the direction of operation of the motor, said control means serving at will to vary the rate of fluid flow from the fluid source to the motor, and regulating means between the fluid pressure source and said control means, said regulating means comprising a plurality of fluid chambers, one of said chambers being responsive to inlet pressure to said control means and another of said chambers having connection with a separate conduit leading to said motor.

2. In a fluid transmission system as in claim 1, wherein said first mentioned fluid chamber receives inlet pressure from a passage through said regulating means.

3. In a fluid transmission system as in claim 2, wherein a second one of said fluid chambers houses a regulating spring.

4. In a fluid transmission system as in claim 3, wherein a third one of said fluid chambers contains therein a slidable piston which actuates said regulating means.

5. In a fluid transmission system as in claim 1, including means for causing the regulating means to shut off the supply of fluid from the fluid pressure source to the control means.

6. In a fluid transmission system as in claim 1, including means for holding the control means in an adjusted position.

7. In a hydraulic transmission system including a source of fluid pressure and a reversible fluid motor operable thereby, conduits leading to and from the motor either of which may conduct fluid pressure to the motor or return fluid therefrom, control means between the fluid pressure source and the motor for selectively connecting either conduit to the fluid pressure source and rendering the other conduit a return to control the direction of operation of the motor, said control means serving at will to regulate and to vary the rate of fluid flow from the fluid source to the motor, regulating means between the fluid pressure source and said control means responsive to pressure in the conduit delivering fluid from the control means to the motor and also to pressure supplied by the fluid pressure source for regulating the rate at which fluid is supplied to the control means, and means for causing the regulating means to shut off the supply of fluid from the fluid pressure source to the control means including a solenoid valve whose solenoid on being de-energized will allow the regulating means to effect a shut off.

References Cited by the Examiner

UNITED STATES PATENTS

501,959	7/1893	Rawlings	91-446
1,067,233	7/1913	Adams	137-494
1,600,542	9/1926	Gaag	91-458 X
2,751,752	6/1956	Metcalf	91-216

FOREIGN PATENTS

1,127,225	4/1962	Germany.
-----------	--------	----------

SAMUEL LEVINE, *Primary Examiner.*

65 FRED E. ENGELTHALER, *Examiner.*

P. T. COBRIN, *Assistant Examiner.*