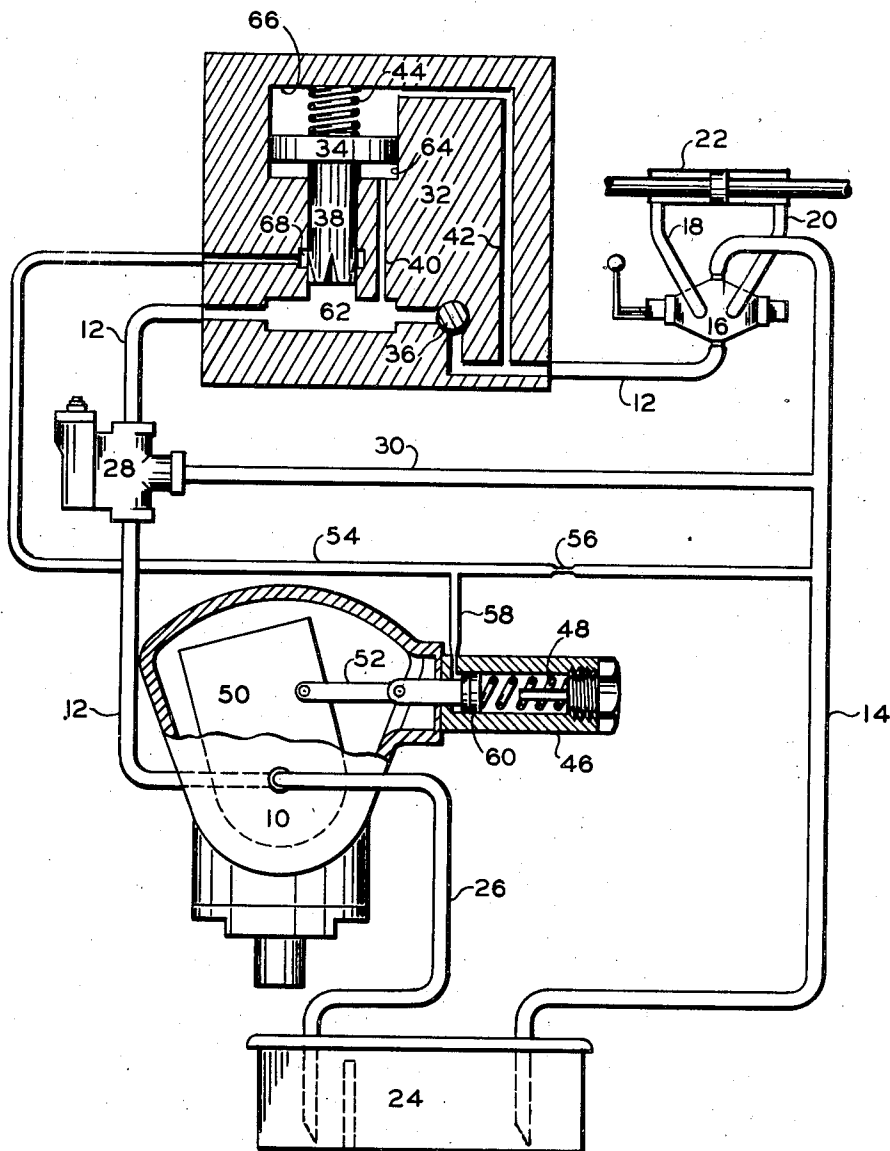


June 7, 1949.

F. T. HARRINGTON ET AL
VOLUME CONTROL SYSTEM FOR PUMPS

2,472,477

Filed Sept. 13, 1946



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2,472,477

VOLUME CONTROL SYSTEM FOR PUMPS

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Application September 13, 1946, Serial No. 696,864

13 Claims. (Cl. 60—52)

1

This invention relates to power transmissions, particularly to those of the type comprising two or more fluid pressure energy translating devices, one of which may function as a pump and another as a fluid motor.

This invention particularly relates to a hydraulic speed governor apparatus and a transmission of the type in which a constant speed is required at the output shaft.

The object of the present invention is to provide a speed control apparatus for fluid motors which have variable speed adjustments, said control being adapted to accurately control the speed of the output shaft regardless of the load on the shaft.

In an ordinary transmission of the type, for example, wherein a variable displacement pump furnishes liquid to a fixed displacement motor, the speed of the motor will be reduced when a heavy load is applied because of the inherent leakage or slip of both the pump and the motor. Furthermore, in many of these drives, the speed of the pump input drive source is sometimes subject to variations and this influences the speed of the output motor.

The present invention contemplates an apparatus which provides automatic compensation for the speed changes in fluid motors and in the above example, the control compensates for both pump and motor slippage due to load changes and for variations in the speed of the pump input power source.

In earlier controls of this type, separate independent hydraulic control systems were employed for varying the pump or motor displacement and speeds. In the proposed device, the flow responsive control is in the main operating circuit and the compensating device for controlling the pump is actuated by pressure fluid from that pump in place of an auxiliary pump.

Therefore, another object of the invention is to provide a hydraulic speed governor actuated and controlled directly by the pressure fluid from the operating circuit.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred form of the present invention is clearly shown.

In the drawing:

The single figure is a diagrammatic view of a power transmission system incorporating a preferred form of the present invention.

Referring now to the drawing, a hydraulic transmission comprises the variable displacement

2

pump 10 connected by pressure and return conduits 12 and 14, respectively to the four-way valve 16 and by branch lines 18 and 20 to a fixed displacement motor 22. The circuit is supplied by hydraulic fluid from tank 24 through suction conduit 26. A relief valve 28 in the pressure conduit 12 is connected by relief conduit 30 to the return conduit 14.

A flow responsive valve 32 is connected in the pressure conduit 12 and includes a differential piston 34 and throttle 36. The piston valve 36 is pressure balanced through passage 40 connected to the pressure conduit 12 at a point ahead of the throttle 36 and through passage 42 to the conduit 12 beyond the throttle 36 and is normally closed by the spring 44.

The displacement of pump 10 is varied by the pressure controlled compensator 46. The spring 48 urges the yoke 50 by means of the linkage 52 to its left-hand position as shown in the drawing where the yoke is normally positioned for maximum displacement. A control conduit 54 connects the pressure conduit 12 through the flow responsive valve 32, to the return conduit 14 and is provided with a restriction 56. A branch conduit 58 of conduit 54 leads to the compensator 46 for communicating pressure fluid to the compensator piston 60.

In operation, the pump 10 is driven by the prime mover (not shown), and the compensator 46, by means of link 52, shifts the yoke 50 to its extreme left position for maximum displacement. As the pressure builds up in conduit 12 and flow valve chamber 62, operating fluid will pass through throttle 36 and four-way valve 16 to the motor 22.

So long as the load on motor 22 is normal, the pressure drop through the throttle 36 will remain constant. The piston valve 36 which operates as a variable orifice valve, will remain partially open. Therefore, under normal operation the pump delivery is divided between the motor circuit and the control circuit. The rate of flow through the conduit 54 and restriction 56 automatically adjusts the compensator 46 to vary the pump delivery until it equals the flow through the motor 22 and restriction 56. If, however, the load is released, the pressure in passage 42 of the flow responsive valve from a point beyond the throttle 36 will be less than the pressure in conduit 40 or chamber 62, a point ahead of the throttle 36. Under that momentary condition, the rate of flow through the throttle 36 and the speed of the motor 22 will increase. The piston valve 36 will then rise and open the port 66 since

3 the pressure on piston 38 from chamber 62 plus the pressure in lower cylinder chamber 64 will be greater than the pressure in upper cylinder chamber 66 plus the force of the spring 44.

Excess pressure in chamber 62 will be communicated through conduits 54 and 58 to the compensator piston 60 thereby shifting the yoke 50 to the right and reducing the pump displacement until a pressure-volume balance in relation to the flow through the throttle is obtained.

An analysis of the flow responsive valve 32 of the present invention in comparison with the flow control and relief valve shown in the patent to Vickers 2,102,865 will disclose their approximate similarity in operation but different purposes. In the present invention, in place of merely doubling the excess relieved fluid directly to tank, the relief process has been restricted and its pressure made available for the operation of a device adapted to lower the pump displacement and increase the efficiency of the transmission.

The overall result is that the pump displacement is automatically regulated to maintain a delivery rate, (independently of variations in pump slip and pump speed) which will exactly equal the constant flow through orifice 36 plus a small amount represented by the substantially constant amount flowing through orifice 56. This is true because valve 38 must be open in order for compensator 46 to be in any position except full stroke position. In addition with valve 38 open compensator 46 then acts to reduce the pump stroke until the pressure in conduit 58 balances the force of spring 48. Thus a constant pressure is maintained in conduits 54 and 58 and therefore the flow through orifice 56 is maintained constant. While this discussion has neglected the effect of progressive compression of springs 44 and 48 that effect may be very small by proper proportioning of the springs so as to be insignificant for most purposes.

It will thus be seen that the present invention has provided a speed governor responsive to the rate of flow for controlling a variable displacement pump and hydraulic transmission required to drive a fixed displacement motor at a constant speed. This is accomplished by a flow controlled valve in the transmission circuit adapted to bypass a portion of the delivery fluid to a control circuit wherein a pressure actuated compensator adjusts the pump displacement to balance the load demand on the transmission.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a hydraulic power transmission, a variable displacement pump hydraulically connected to a fixed displacement motor to be driven at constant speed, a throttle in the hydraulic circuit for controlling the rate of flow, a pressure controlled compensator for controlling the pump delivery, a passage connecting the circuit to tank at a point ahead of the throttle, a restriction in the passage, and a conduit connecting the compensator to the passage at a point between the throttle and the restriction, and means responsive to the pressure differential across the throttle for controlling the communication of pressure fluid to the compensator.

2. In a hydraulic power transmission, a variable displacement pump hydraulically connected

to a fixed displacement motor to be driven at constant speed, a throttle in the hydraulic circuit for controlling the rate of flow, a pressure controlled compensator for controlling the pump delivery, a passage connecting the circuit to tank at a point ahead of the throttle, a restriction in the passage, and a conduit connecting the compensator to the passage at a point between the throttle and the restriction, and a pressure balanced piston valve actuated by the difference in pressures ahead of and beyond the throttle for controlling the communication of fluid to the compensator.

3. A pressure-volume control for a variable displacement pump hydraulically connected to a fixed displacement constant speed motor comprising a motor circuit, a metering circuit, a pressure actuated valve in the metering circuit responsive to excessive flow rate through the motor circuit for diverting a portion of the excess flow into the metering circuit, and a compensator actuated by pressure in the metering circuit and responsive to the flow rate through the metering circuit for varying the pump displacement and reducing the volumetric delivery in proportion to the flow rate through the metering circuit.

4. A pressure-volume control for a variable displacement pump hydraulically connected to a fixed displacement constant speed motor comprising a motor circuit, a metering circuit, a throttle in the motor circuit, a pressure balanced piston valve in the metering circuit and actuated by the pressure differential in the motor circuit across the throttle in response to excessive flow rate through the motor circuit for diverting a portion of the excess flow into the metering circuit, and a compensator actuated by pressure in the metering circuit and responsive to the flow rate through the metering circuit for varying the pump displacement and reducing the volumetric delivery in proportion to the flow rate through the metering circuit.

5. A pressure-volume control for a variable displacement pump hydraulically connected to a fixed displacement constant speed motor comprising a motor circuit, a metering circuit, a pressure actuated valve in the metering circuit responsive to excessive flow rate through the motor circuit for diverting a portion of the excess flow into the metering circuit, a restriction in the metering circuit, and a pressure actuated compensator connected to the metering circuit at a point ahead of the restriction for varying the pump displacement and reducing the volumetric delivery in proportion to the flow rate through the metering circuit.

6. A pressure-volume control for a variable displacement pump hydraulically connected to a fixed displacement constant speed motor comprising a motor circuit, a metering circuit, a throttle in the motor circuit, a pressure balanced piston valve in the metering circuit and actuated by the pressure differential in the motor circuit across the throttle in response to excessive flow rate through the motor circuit for diverting a portion of the excess flow into the metering circuit, a restriction in the metering circuit, and a pressure actuated compensator connected to the metering circuit at a point ahead of the restriction for varying the pump displacement and reducing the volumetric delivery in proportion to the flow rate through the metering circuit.

7. A speed control for a hydraulic transmission

5

of the type employing a variable displacement pump hydraulically connected by pressure and return conduits to a fixed displacement motor required to be driven at constant speed, comprising a control circuit connecting the pressure conduit to the return conduit in parallel with the motor, a restriction in the control circuit, a pressure controlled compensator for varying the pump displacement and connected to the control circuit at a point ahead of the restriction, a valve, normally closed in the control circuit, and pressure actuated means for automatically opening the valve when the flow rate through the pressure conduit is excessive.

8. A speed control for a hydraulic transmission of the type employing a variable displacement pump hydraulically connected by pressure and return conduits to a fixed displacement motor required to be driven at constant speed, comprising a control circuit connecting the pressure conduit to the return conduit in parallel with the motor, a restriction in the control circuit, a pressure controlled compensator for varying the pump displacement and connected to the control circuit at a point ahead of the restriction, a throttle in the pressure conduit in combination with a valve in the control circuit, and pressure actuated means for opening the valve when the pressure drop across the throttle is above a predetermined figure.

9. In a hydraulic power transmission employing a variable displacement pump hydraulically connected by pressure and return conduits to a fixed displacement motor, said pressure conduit having a throttle therein, a control circuit connected to the pressure conduit through a pressure actuated, flow controlled valve, a restriction in the control circuit, and a pressure actuated compensator, mechanically coupled to the pump and hydraulically connected to the control circuit at a point ahead of the restriction for varying the pump displacement inversely in proportion to the flow across the throttle.

10. In a hydraulic power transmission employing a variable displacement pump hydraulically connected by pressure and return conduits to a fixed displacement motor, a control circuit connected to the pressure conduit through a variable orifice, flow responsive valve comprising a throttle in the pressure conduit, a differential piston valve pressure balanced by operating pressures ahead of and beyond the throttle, a restriction in the control circuit, and a pressure actuated compensator, mechanically coupled to the pump and hydraulically connected to the control circuit at a point ahead of the restriction for varying the pump displacement inversely in proportion to the flow across the throttle.

11. In a hydraulic power transmission employ-

6

ing a variable displacement pump hydraulically connected by pressure and return conduits to a fixed displacement motor, a control circuit connected to the pressure conduit through a pressure actuated variable orifice valve adapted to be opened and the orifice increased in proportion to the increase in flow rate above normal through the throttle whereby the flow rate through the control circuit is varied in proportion to the excessive pressure drop across the throttle, a restriction in the control circuit, and a pressure actuated compensator, mechanically coupled to the pump and hydraulically connected to the control circuit at a point ahead of the restriction for varying the pump displacement inversely in proportion to the flow through the control circuit.

12. A speed governor for a hydraulic transmission employing a variable displacement pump hydraulically connected to a fixed displacement constant speed motor, comprising a motor circuit, a flow control and relief valve in the motor circuit, a control conduit connected to the relief valve for receiving excess pressure fluid, a restriction in the control conduit, and a pressure actuated pump compensator connected to the control conduit at a point ahead of the restriction for varying the pump displacement.

13. A speed governor for a hydraulic transmission employing a variable displacement pump hydraulically connected to a fixed displacement constant speed motor, comprising a motor circuit, a flow control and relief valve in the motor circuit comprising a throttle in the motor circuit in combination with a pressure balanced differential piston valve controlled by pressures ahead of and beyond the throttle, the piston valve being adapted to open a relief port when the pressure drop across the throttle is above a predetermined amount, a control conduit connected to the relief port for receiving excess pressure fluid, a restriction in the control conduit, and a pressure actuated pump compensator connected to the control conduit at a point ahead of the restriction for varying the pump displacement.

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