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POWER TRANSMISSION

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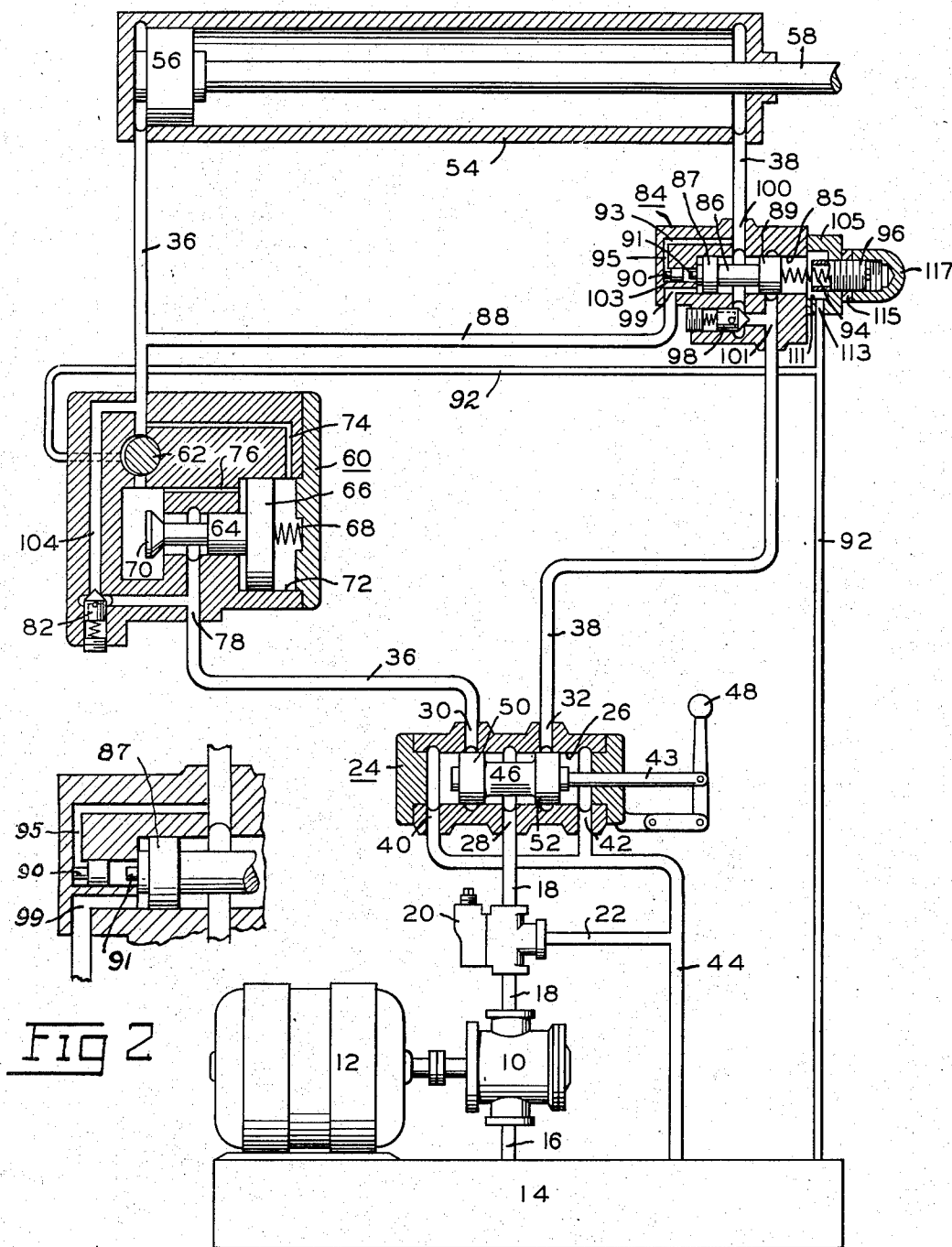


Fig 1

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POWER TRANSMISSION

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2 Claims. (Cl. 121—45)

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.

Transmissions of this character are widely used on machine tools for actuating reciprocating slides, rotary spindles, etc. It is frequently necessary in applications of this character to make provision for sudden and wide fluctuations in motor load, as, for example, when a cutting tool breaks through a work piece, and to so arrange the circuit that the motor is positively prevented from ever jumping ahead under a sudden relief in load.

There are in use several methods which accomplish this result, one method comprising the use of a back-pressure valve in the motor outlet line which acts to maintain a predetermined back pressure therein. Systems of this character present one drawback particularly troublesome in large size machines, namely, that the back-pressure valve is an energy dissipator, and, if the back pressure which must be maintained is very high and the volume of fluid passed therethrough is also high, a considerable heating of the oil occurs which adversely affects the system as a whole. In addition, the waste of power at the back-pressure valve requires a larger power input to the machine and thus gives the circuit as a whole a low efficiency.

It is an object of the present invention to provide an improved power transmission system wherein the above difficulties are avoided, at least to a substantial extent, and at the same time to positively prevent any jumping ahead of the fluid motor under a sudden relief in load.

A further object is to provide a system of this character wherein a relatively low value of back pressure is normally maintained in the motor outlet when the motor load is sufficiently high to, of itself, prevent jumping ahead. At the same time, additional means are provided for increasing the back pressure to a higher value whenever the motor load falls below a certain value. In this way it is assured that the high back pressure necessary to prevent jumping ahead is applied only during intervals when jumping ahead is otherwise likely to occur.

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:

Figure 1 is a diagrammatic view of a power transmission system embodying a preferred form of the present invention.

Figure 2 is an enlarged view of a portion of a valve shown in Figure 1.

There is indicated at 10 a pump adapted to be driven by a suitable prime mover, such as an electric motor 12. The pump 10 withdraws fluid from a tank 14 through a suction conduit 16 and delivers the same to a delivery conduit 18. The latter has a relief valve 20 of conventional construction for bypassing oil to the tank 14 through a conduit 22 whenever a predetermined pressure is exceeded in the delivery conduit 18.

The conduit 18 extends to a directional four-way valve 24 which directs the flow of liquid from the pump 10 to and from either end of the cylinder 54. The directional valve 24 comprises a main body member having a longitudinal bore 26 within which is mounted a slidable spool 46. The bore 26 is provided with a plurality of annular ports arranged along its length, of which 28 is the pressure port, 30 and 32 the cylinder ports, and 40 and 42 the tank ports. The pressure port communicates with the delivery conduit 18, while the tank ports 40 and 42 communicate with the tank 14 through a conduit 44. The cylinder ports 30 and 32 communicate with motor connections 36 and 38, respectively, which lead to the opposite ends of a fluid motor 54. The latter comprises a cylinder within which is mounted a reciprocable piston 56 to move a rod 58 and cause it to do work.

The spool 46 of valve 24 is provided with solid lands 50 and 52 which close the cylinder ports 30 and 32 when the spool is in central position, illustrated. The righthand end of the spool 46 has secured thereto an operating stem 43 which is attached to a manually operated lever 48.

Conduit 36 extends from port 30 of valve 24 to the head end of cylinder 54 through a hydrostatic flow control valve 60 which controls the rate of liquid flow thereto. Valve 60 includes an adjustable throttle valve 62 which limits the rate of fluid flow and a pressure compensator 64 which maintains the rate of controlled flow independent of the variations in the operating pressure or fluctuations in cutting tool resistance. The pressure compensator 64 consists of a piston 66, a piston spring 68 and a valve 70. Piston 66 is mounted in a cylinder 72 from which two passages 74 and 76 extend, one from each side of piston 66 to the opposite sides of the throttle 62. A light spring 68 tends to keep open valve 64 by

urging it to the left. The hydrostatic pressure compensator 64 regulates the fluid flow to the throttle 62 in accordance with the pressure drop across the throttle 62, that is, as pressure in port 78 rises slightly, the piston 66 will move to the right, pressure on its left side being greater than that on its right, and continue to close valve 70 until the rate of liquid flowing into port 78 is the same as that of the liquid being discharged through the throttle 62. Since the rate of discharge through the throttle 62 will remain constant, the rate of movement of the working tool will also be relatively constant. The flow control valve 60 contains an integral check valve 82 to allow free flow in the opposite direction. A drain conduit 92 connects to the throttle valve 62 at a point below the plane of the drawing for the purpose of collecting seepage lengthwise of the throttle valve stem.

Attached to the exhaust end of the cylinder 54 by a conduit 38 is a valve 84 for providing back pressure therein to firmly hold the piston 56 as it moves through its work stroke. Valve 84 comprises a main body having a central longitudinal bore 85 which is provided with ports 100 and 101, communication between which is controlled by a movable spool 86. The latter has two lands 87 and 89 which are freely slidable with a close fit in bore 85 and also a projection 91 on its left end.

The body 84 includes two means for actuating the valve spool 86, one of which consists of an auxiliary passage 93 extending from port 100 to orifice 95 which connects with chamber 103 in which a slidable plunger 90 is mounted for moving the valve spool 86 by a fluid pressure exerted on the left end of the plunger 90 in opposition to the force of the spring 94. The other said means consists of an orifice 99 which extends from the left end of the bore 85 to the side of the main body where it connects with a conduit 88 which is in communication with the inlet conduit 36. The main body contains also a check valve 98 to provide for the reverse flow.

On the righthand end of the main body is secured an end cap 105 through which is threaded an adjusting screw 96. A spring 94 extends from within the screw 96 to the valve spool 86 holding it in a closed position to the left, disconnecting the ports 100 and 101. The spring 94 is adjusted by the screw 96 to whatever back pressure in cylinder 54 is desired. A chamber 111 in the end cap 105 is in communication with the end of the bore 85 for exhausting oil from the bore 85 through passage 113 which is externally connected to a conduit 92 permitting free flow to the tank 14. The end cap 105 also carries a lock nut 115 and a closure cap 117, both secured on the screw 96.

In operation, while pump 10 is being driven by the electric motor 12, oil is withdrawn from the tank 14 through a suction conduit 16 and delivered through conduit 18 to the directional valve 24. With the spool 46 in neutral position, illustrated, the full pump delivery is bypassed to the tank 14 through a relief valve 20 via conduits 22 and 44.

To advance the piston 56, lever 48 of valve 24 is pushed inward. This allows the pump delivery to be directed from the pressure port 28 to motor port 30 where it is delivered by conduit 36 to the flow control valve 60. The fluid flow enters valve 60 at port 78, flows by valve 70 of pressure compensator 64 to the throttle 62 where it is metered into the inlet line 36 of cylinder 54, and forces

back piston 56 at a certain rate of speed as determined by adjustment of the throttle valve 62. The metered liquid also enters conduit 88 leading to valve 84, exerting equal pressure in either conduit.

The discharging liquid from the back of piston 56 enters the foot valve 84 through conduit 38 and encounters a resistance at port 100 before flowing through it to port 101. The resistance to discharge of back pressure on the discharge end of the cylinder helps prevent surging of the piston 56 after the work is completed and also maintains back pressure proportional to the load fluctuations, thus preventing jerky action on the feed stroke.

This resistance may be overcome either by a direct action, that is, whenever pressure in port 100 rises above the value for which the spring 94 is set, valve spool 86 will move to the right permitting oil to be bypassed from port 100 to port 101 until the pressure in port 100 drops below the setting of spring 94, or by a remote action, that is, by pressure supplied by conduit 88 acting over the left end of spool 86. By this arrangement it will be seen that pressure in either port 99 or 100 will at times aid the other in the shifting of the spool 86.

Although a predetermined pressure for which the valve spring 94 has been adjusted must be reached to cause the spool 86 to open and allow liquid to flow through port 100 to port 101 to tank, pressure required to shift spool 86 will be less in port 99 than in port 100. This is caused by the difference in areas over which the pressure acts. Pressure from conduit 88 acts over the entire left end of spool 86 which is greater in area than is the left end of plunger 90. Thus, it will be seen that valve 84 may be made to operate either at low pressure, remotely, or at high pressure, directly.

During the feed-in operation with zero load to overcome, before the piston 56 can be forced back, because of the resistance encountered by the liquid at valve 84, a certain pressure must be built up in front of the piston 56. Because of the reduced area at the back of the piston 56, a greater pressure is transmitted to port 100 through conduit 38 than is transmitted to port 99 through conduit 88. Under such conditions, pressure in either port 100 or in port 99 will not be sufficient to open the spool 86, but the combined lifting force of both will produce the desired effect, allowing the discharged liquid to flow to the tank, with port 99 supplying the greater lifting force.

As the load on the rod 58 increases, pressure will increase in the inlet conduit 36 which will be transmitted to port 99 causing the spool 86 to be moved more to the right, allowing a greater volume of liquid to be discharged, thus lessening the back pressure. As the spool 86 is moved to the right, the aiding force of the plunger 90 is lessened proportionately, for the pressure in port 100 is being reduced.

As soon as a substantial load on rod 58 exists, the valve 84 will be held fully open by the pressure in the inlet conduit 36, thus interposing no back pressure whatever through valve 84. Upon the lessening of said load, pressure in the inlet line 36 will drop and accordingly in port 99. This pressure drop will tend to close the valve spool 86 causing the valve 84 to create back pressure in the motor outlet line 38 which replaces, so to speak, the load resistance which was lessened.

If, however, the load drops to zero, the valve begins to operate at high pressure directly, acting in the capacity of a relief valve, by-passing oil until sufficient pressure is again built up in port 99. It is at this phase that the plunger 90 is dominant in lifting the spool 86.

To reverse the operation, returning the piston 56 to its former position, lever 48 is pulled outward. This connects pressure port 28 with motor port 32 providing for rapid return. The full pump delivery is now directed to conduit 38, to port 101 of valve 84, unseating the check valve 98, flowing around valve spool 86, through port 100 to the rod end of the cylinder 54. Liquid discharging from the front of the piston 56 will be by-passed around flow control valve 60 through conduit 104, unseating the check valve 82, to port 78 where it is delivered to valve 24 by conduit 36. The valve spool 46, being in the extreme right position, will direct the liquid to tank conduit 44 leading to tank 14.

Thus it will be seen that the present invention maintains back pressure while "feeding-in" and at the same time keeps the oil in the circuit much cooler than heretofore because during normal load conditions the motor exhaust fluid flow passes to the tank freely through the back-pressure valve. At the same time, any jumping ahead of the slide as upon sudden falling off of load resistance is prevented.

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 system the combination with a source of pressure fluid, a fluid motor operable by fluid supplied from said source, supply and return conduits connecting

the source with the motor, a flow controller in the supply line for regulating the rate of flow to the motor, and a back pressure valve in the return conduit responsive both to motor outlet pressure to produce a variable but limited amount of back pressure in the return conduit and also to motor inlet pressure to maintain the sum of the pressures produced in the supply conduit by said back pressure and by motor load above a predetermined minimum, said valve having a small operating piston exposed to motor outlet pressure and a larger operating piston exposed to motor inlet pressure and resilient means opposing the pressures effective on said means.

2. In a hydraulic power transmission system the combination with a source of pressure fluid, a fluid motor operable by fluid supplied from said source, supply and return conduits connecting the source with the motor, a flow controller in the supply line for regulating the rate of flow to the motor, a back pressure valve in the return conduit responsive both to motor outlet pressure to produce a variable but limited amount of back pressure in the return conduit and also to motor inlet pressure to maintain the sum of the pressures produced in the supply conduit by said back pressure and by motor load above a predetermined minimum, said valve having a small operating piston exposed to motor outlet pressure and a larger operating piston exposed to motor inlet pressure and resilient means opposing the pressures effective on said means, and a single adjusting means for varying the force of said resilient means whereby both the predetermined low back pressure and the predetermined minimum inlet pressure may be simultaneously adjusted.

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