

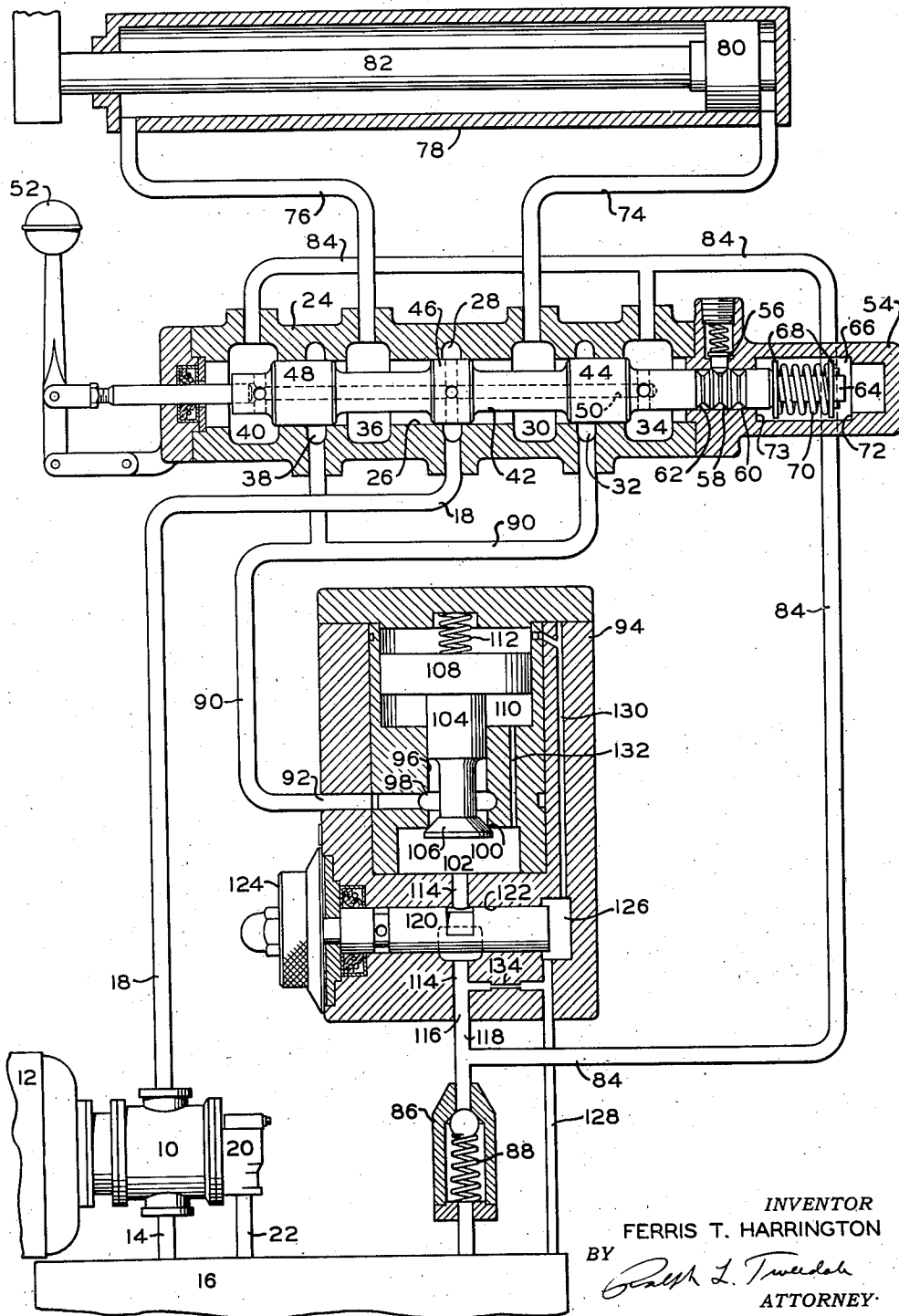
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POWER TRANSMISSION

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POWER TRANSMISSION

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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.

The invention is more particularly concerned with a power transmission system of the type incorporating what is termed a metering-out, flow rate control valve comprising an adjustable throttle together with a pressure responsive compensating valve for maintaining a constant pressure drop through the throttle. Valves of this character are customarily used in power transmission systems for producing a reduced feed rate of a machine tool slide or similar device which is hydraulically operated.

It has been found that, where the flow regulating valve is placed on the outlet side of the circuit and is relied upon as the only obstacle to free flow from the exhaust side of the cylinder, some difficulty has been experienced at the time the slide is started into a feeding movement from rest. This difficulty lies in the inability of the compensating flow control valve to immediately assume its normal regulating position. During the time interval that this requires, fluid is directed to the motor at a greater than normal rate, causing the slide to jump ahead at the beginning of a feeding movement. This is particularly objectionable in machine tools where, for some reason, it may be necessary to stop the slide during the middle of a cut and then, if the feeding movement be resumed, the slide jumps ahead momentarily causing breakage of the cutting tool. This difficulty has been avoided in the past only by continued caution on the part of the operator to remember that, when stopping the slide in the middle of a cut, he must first back the tool away from the work slightly before resuming the feeding movement.

It is an object of the present invention to provide an improved circuit which overcomes this difficulty.

A further object is to provide in a power transmission system of this character a back-pressure valve beyond the flow regulating valve together with special internal connections in the flow regulating valve such that, when the slide is at rest, the compensating valve assumes a closed position.

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.

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 has a suction conduit 14, for withdrawing fluid from a tank 16, and a delivery conduit 18. A relief valve 20, on pump 10, is adapted to pass fluid to tank 16 through a conduit 22 whenever a predetermined maximum pressure is exceeded in the pump.

The delivery conduit 18 extends to a directional valve 24 where it opens into a valve bore 25 through an annular pressure port 28. Spaced along bore 25 to the right of port 28 are three annular ports 30, 32 and 34, while to the left of port 28 are corresponding ports 36, 38 and 40. A valve spool 42 mounted in bore 26, and slidable between five positions, has formed thereon three lands 44, 46 and 48 for controlling communication between the various ports. Spool 42 has drilled passageways 50 therein connecting the pressure port 28 to ports 34 and 40, which constitute tank ports, when it is in the position shown. A hand lever 52 is connected to the left end of spool 42 for shifting it between its five positions.

An end cap 54, on the right end of valve 24, has therein a spring-pressed detent 56 the purpose of which is to locate the three centermost positions of spool 42 by yieldably engaging in one of three annular grooves 58, 60 or 62 formed on the valve spool to the right of land 44.

The right end of valve spool 42 has a reduced diameter portion 64 which projects into a chamber 66 in end cap 54. The portion 64 carries thereon two spring abutment washers 68 between which is placed a spring 70. Washers 68 are movable toward but not away from one another. The chamber 66 has formed therein a shoulder 72 against which the righthand washer 68 abuts when spool 42 is moved beyond its "feed right" position, and a shoulder 73 against which the lefthand washer abuts when the spool is moved beyond its "feed left" position.

The two ports 30 and 36 constitute cylinder ports and are connected by conduits 74 and 76 to the head and rod ends, respectively, of a cylinder 78. A piston 80 reciprocally mounted in cylinder 78 has a rod 82 which may be operatively connected to the tool or work slide of a machine tool.

A conduit 84 connects the two tank ports 34 and 40 of valve 24 to tank 16 through a back-pressure valve 86, the spring 88 of which is heavy

enough to maintain a low pressure in conduit 84 for a purpose later to be described.

The two ports 32 and 38 of valve 24 are connected together by a conduit 90 which extends to an inlet connection 92 of a hydrostatic flow control valve 94. The connection 92 opens into a valve bore 96 through an annular port 98. A valve seat 100 is formed at the lower end of bore 96 where it opens into a chamber 102. A hydrostatic valve 104, slidable in bore 96, has an enlarged bevel portion 106 on the lower end thereof for controlling communication between port 98 and chamber 102. When valve 104 is in its uppermost position, as shown, portion 106 seats at 100 to close port 98 from chamber 102.

For the purpose of controlling valve 104, a piston 108 is formed on the upper end thereof and mounted in a control cylinder 110. A spring 112, lighter than spring 88 of valve 86, in the upper end of cylinder 110, abuts piston 108 and tends to move valve 104 downwardly to unseat portion 106.

The chamber 102 is connected by a passage 114 to an outlet port 116 of valve 94 where a conduit 118 extends therefrom and connects into conduit 84. A throttle valve 120, rotatably mounted in a bore 122, is interposed in passage 114 and serves as an adjustable restriction to flow through the latter. Throttle 120 is adjustable by rotation of a hand dial 124. Any fluid leakage along the space between throttle 120 and bore 122 passes to a drain chamber 126 which is connected directly to the tank 16 by a conduit 128.

The upper end of cylinder 110 is connected by a passage 130 to the drain chamber 126 while the lower end is connected by a passage 132 to chamber 102. The passage 114 is in communication with drain chamber 126 and the tank conduit 128 through a restricted bleed-off passage 134, which is less restricted than passage 114 when throttle 124 is adjusted for maximum flow.

In operation, with the parts in the positions shown and the motor 12 driving pump 10, fluid is withdrawn from tank 16 through conduit 14 and delivered by conduit 18 to the pressure port 28 of valve 24. From there the fluid is passed to the tank 16 by passages 50 in spool 42, ports 34 and 40, conduit 84 and the back-pressure valve 86. The full pump volume is thus circulated to tank at a low pressure determined by the spring 88 of valve 86.

This pressure in conduit 84 is transmitted through conduit 118, port 116 of valve 94, passage 114 and throttle 120 to chamber 102 and by passage 132 to the lower end of cylinder 110. With the upper end of cylinder 110 open to tank, it will be seen that the pressure in chamber 102 and the lower end of cylinder 110 acts on the lower faces of valve 104 and piston 108, respectively, to hold bevel portion 106 seated at 100 against the resistance of spring 112. Flow through the bleed-off restriction 134 from passage 114 to tank is not sufficient to drop this pressure to the point where spring 112 could open valve 104.

To effect a feeding stroke of piston 80 and its rod 82, the lever 52 of valve 24 is moved, for example, to the left until detent 56 engages groove 60 of spool 42. The spring 70 is not compressed so the spool will remain in its "feed left" position.

The tank ports 34 and 40 are blocked from all of the other ports of valve 24. Ports 28 and 38 are now in communication with ports 30 and 36, respectively. This directs the pump delivery from port 28 to port 30 and through conduit 74

to the head end of cylinder 78. The rod end of cylinder 78 is placed in communication with the inlet port 98 of valve 94 through conduit 76, ports 36 and 38 of valve 24, conduit 90 and connection 92.

As conduit 84 is no longer receiving fluid from pump 10, pressure therein and in chamber 102 and the lower end of cylinder 110 will be relieved through restriction 134 and conduit 128 to tank 16, thereby permitting spring 112 to lower valve 104 and open port 98 to chamber 102.

Accordingly, with the pump delivery being directed to the head end of cylinder 78, the piston 80 will move to the left with exhaust fluid from the rod end following the path previously described to port 98 of valve 94 from where it will flow through chamber 102, passage 114, throttle 120, restriction 134 and conduit 128 to tank. Since this volume is small, the restriction 134 imposes negligible resistance.

Valve 104 will move downwardly until the rate of flow from port 98 into chamber 102 equals the rate of fluid flowing from chamber 102 through throttle 120 to tank.

The hydrostatic valve 104 maintains a constant pressure drop across throttle 120, in the well-known manner, which results in a constant feed rate of piston 80 regardless of variations in resistance thereto. The excess pump volume not accepted by the motor is bypassed to tank through relief valve 20, or the pump 10 may be of the type which automatically reduces its output in response to pressure built up during the feeding stroke.

If at any time during a feeding stroke the need arises to stop piston 80, valve spool 42 is returned to the position shown. The pump delivery will again be directed to tank through conduit 84 and valve 86. Pressure created in chamber 102, by back-pressure valve 86, will cause hydrostatic valve 104 to rise until bevel portion 106 seats. When valve 24 is again shifted to the left, to continue the leftward feed stroke of piston 80, the restriction 134 will relieve pressure in chamber 102 as previously described. Thus, it will be seen that, upon restarting of piston 80, the flow of exhaust fluid from cylinder 78 is gradually increased from zero to the maximum, as determined by the setting of throttle 120, as hydrostatic valve 104 is opened by spring 112. Thus it will be seen that the piston 80 is started without racing or jumping. This permits the piston 80 to be restarted, even though its operated tool or slide is engaging the work, without first having to back it up, as heretofore has been necessary to prevent tool breakage by the sudden jump or racing of the operating piston.

If it is desired to have piston 80 move to the right on a feed stroke, the operation is similar to that just described except that valve 24 is reversed. Valve spool 42 is shifted to the right until detent 56 drops into the right end of groove 62. The righthand spring abutment washer 68 moves up against shoulder 72 of chamber 66 but does not compress spring 70. The spool 42 is thus held in its "feed right" position. Ports 28 and 32 are placed in communication with ports 36 and 30, respectively. Pressure fluid is directed to the rod end of cylinder 78 through conduit 76, and exhaust fluid from the head end passes through conduit 74 and valve 24 to conduit 90. Valve 94 functions the same as when piston 80 was moving to the left.

If it is desired to return piston 80 to the left or right at a rapid rate, the valve spool 42 is

shifted to its extreme position, for example, to the right until detent 56 is past groove 62. Spring 70 will be compressed making it necessary that lever 52 be held in "rapid traverse right" position as long as a rapid movement of piston 80 is desired. If the lever is released, it will return to "feed right" position.

In the "rapid traverse right" position of spool 42, port 38 is opened to the tank port 40 while all other connections remain the same as when piston 80 was moving to the right at a feed rate.

The pump 10 delivers fluid to the rod end of cylinder 78 through conduit 76 while exhaust fluid from the head end passes through conduit 74, ports 30 and 32, conduit 90, ports 38 and 40, conduit 84 and valve 86 to tank 16.

The valve 94 is bypassed and piston 80 moves to the right at a rapid rate. Valve 86 maintains the low back pressure in conduit 84 to hold hydrostatic valve 104 closed. Similarly, in "rapid traverse left" position, port 32 is opened to tank port 34, leaving the other connections the same as for "feed left."

Whenever piston 80 is stopped, or operating in rapid traverse, hydrostatic valve 104 will close port 98 from chamber 102. Thus it will be seen that piston 80 may be started from any stopping point at a feed rate, regardless of its previous action, without racing or jumping.

It will be noted that, while the piston is stopped, any leakage inherent in valve 24 will not drop the pressure in either end of cylinder 78 as is the case with prior circuits. Thus, any leakage across the lands 46 and 48 at either side of port 36, for example, will take place from 90 and 18, respectively, toward conduit 76 since the former conduits carry the light pressure which is maintained by back-pressure valve 86. In this way it is assured that the oil on the advancing side of the piston 80 is always under a slight pressure at the very last instant before a feeding motion is resumed.

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 the combination of a pressure fluid source, a fluid motor, a directional control valve for selectively directing fluid to and from the motor for either direction of operation thereof and having a neutral position in which flow from the source is bypassed around the motor, fluid supply and return conduits connecting the source to the motor with the directional control valve therebetween, a back-pressure valve interposed in the return conduit between the directional control valve and the source, a flow rate control valve interposed in the return conduit ahead of the back-pressure

valve and having a compensating valve therein of the type which opens fully whenever flow through the valve is interrupted, and means for directing fluid bypassed around the motor while the latter is stopped to a point between the back-pressure valve and the outlet of the flow regulating valve whereby the compensating valve is maintained closed during periods when the motor is stopped.

2. In a hydraulic power transmission the combination of a pressure fluid source, a fluid motor, a directional control valve for selectively directing fluid to and from the motor for either direction of operation thereof at either of two different speeds and having a neutral position in which flow from the source is bypassed around the motor, fluid supply and return conduits connecting the source to the motor with the directional control valve therebetween, a back-pressure valve interposed in the return conduit between the directional control valve and the source, a flow rate control valve interposed in the return conduit ahead of the back-pressure valve to obtain one of said speeds and having a compensating valve therein of the type which opens fully whenever flow through the valve is interrupted, means forming a bypass around said control valve to obtain the other said speed and means for directing fluid bypassed around the motor while the latter is stopped to a point between the back-pressure valve and the outlet of the flow regulating valve whereby the compensating valve is maintained closed during periods when the motor is stopped.

3. In a hydraulic power transmission the combination of a pressure fluid source, a fluid motor, a directional control valve for selectively directing fluid to and from the motor for either direction of operation thereof and having a neutral position in which flow from the source is bypassed around the motor, fluid supply and return conduits connecting the source to the motor with the directional control valve therebetween, a back-pressure valve interposed in the return conduit between the directional control valve and the source, a flow rate control valve interposed in the return conduit ahead of the back-pressure valve and having a spring-loaded compensating valve therein of the type which opens fully whenever flow through the valve is interrupted, and means for directing fluid bypassed around the motor while the latter is stopped to a point between the back-pressure valve and the outlet of the flow regulating valve, said back-pressure valve having a higher pressure setting than the pressure required to overcome the spring load on the compensating valve, whereby the compensating valve is maintained closed during periods when the motor is stopped.

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