

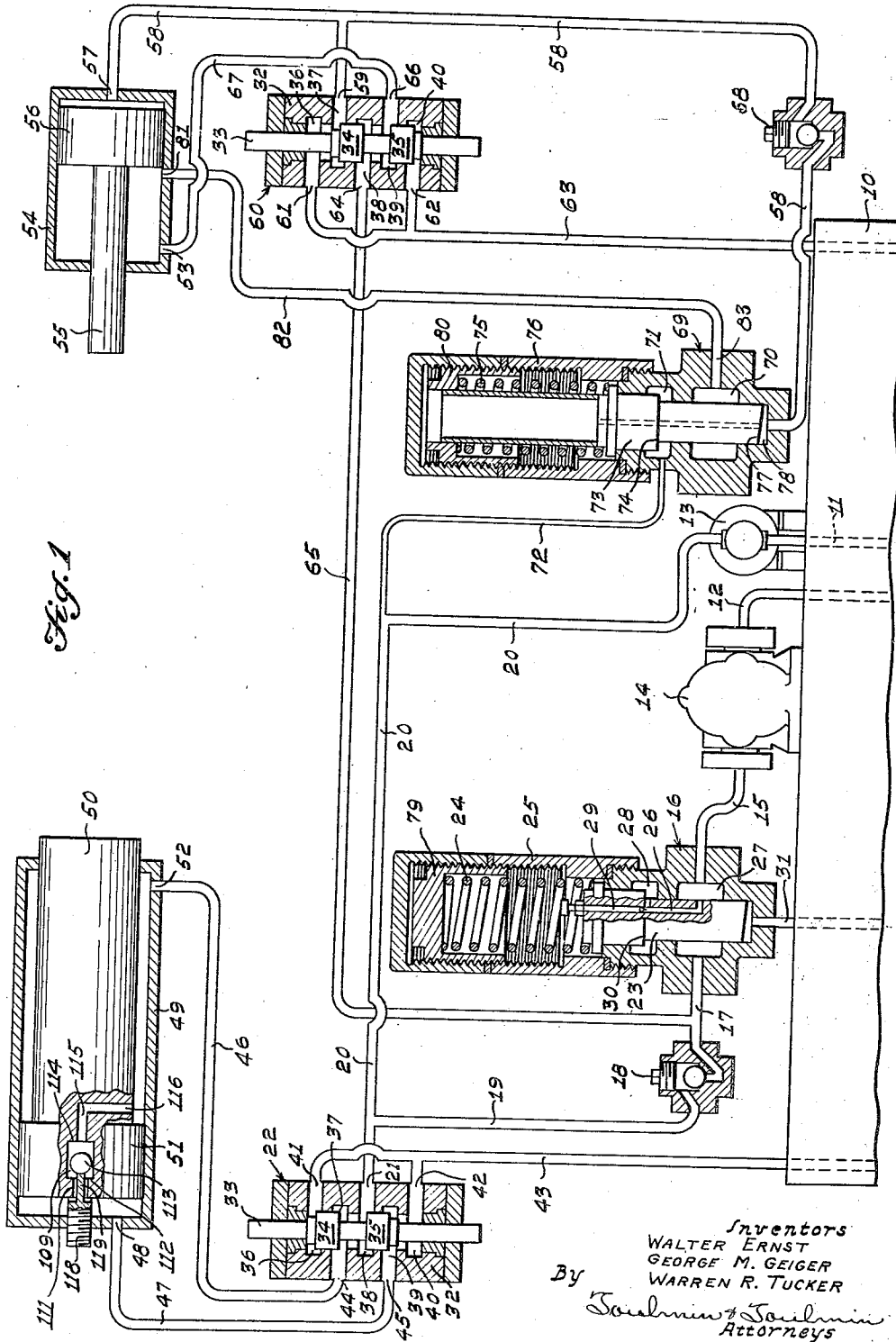
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HYDRAULIC CIRCUIT

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HYDRAULIC CIRCUIT

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This invention relates to hydraulic machine circuits, and in particular, to circuits for operating hydraulic machines having multiple hydraulic motors and pistons therein.

One object of this invention is to provide a hydraulic machine circuit for operating a hydraulic machine having a plurality of motors with a plurality of pumps for operating the motors, together with devices for unloading both of the pumps whenever they are not required to do useful work.

Another object is to provide a hydraulic machine circuit, wherein two hydraulic motors are operated from cooperating constant delivery and variable delivery pumps in such a manner that one of the pumps is caused to idle at substantially zero pressure when it is not required to supply pressure fluid.

Another object is to provide a hydraulic machine circuit, wherein two hydraulic motors are operated from two hydraulic pumps, one of the motors having a check valve device in the piston thereof, arranged to unload both pumps when the piston is in its retracted position, as when the machine is at rest.

Another object is to provide a hydraulic machine circuit, wherein two hydraulic motors are operated by two hydraulic pumps in such a manner that one of the pumps is fully unloaded when the machine is at rest, with its pistons in a retracted position, and wherein the two pistons may be operated simultaneously or independently to a limited extent on both their retraction and advancement strokes.

Another object is to provide a hydraulic machine circuit, wherein two pumps are caused to supply pressure fluid to two hydraulic motors in such a manner that both of the pumps are fully unloaded when the machine is at rest, with its pistons in a retracted position, and wherein the two pistons may be operated simultaneously or independently to a limited extent both on their retraction and advancement strokes.

In the drawing:

Figure 1 is a diagrammatic view of a hydraulic machine circuit according to one form of the invention, wherein two hydraulic motors are operated from two different pumps, the pistons of the motors being operable independently of one another, both pumps being unloaded whenever they are not required to do useful work.

In general, the hydraulic machine circuit shown in Figure 1 has the purpose of enabling the operation of two independent hydraulic mo-

tors from a pair of pumps. One of the pumps is a low pressure constant delivery type, whereas the other is a high pressure variable delivery type. The circuit is arranged with devices for causing the high pressure pump to unload the low pressure pump when the latter has performed its work, the high pressure pump being employed to maintain pressure upon one of the motors while the other motor is being operated. When the pistons of both motors reach their retracted positions, devices are provided for unloading the discharges of both pumps at substantially zero pressure.

Hydraulic circuit for operating motors

Referring to the drawing in detail, Figure 1 shows the hydraulic machine circuit of this invention as consisting of a tank 10 from which lines 11 and 12 lead to the variable delivery high pressure and constant delivery low pressure pumps 13 and 14, respectively. From the low pressure constant delivery pump 14 the line 15 leads to the pressure relief valve, generally designated 16, from which the line 17 leads to the ball check valve 18, continuing in the line 19 joining the line 20, which terminates at one end in the port 21 of the first operating valve, generally designated 22. The variable delivery pump 13 discharges directly into the line 20, and hence, both pumps 14 and 13 cooperate to supply pressure fluid to the port 21 of the first operating valve 22. This is a conventional four-way piston valve.

The high pressure variable delivery pump 13 is of a conventional type, such as a radial piston type, wherein the eccentricity of the piston actuating ring may be varied relatively to the cylinder barrel, and thereby vary the strokes of the pistons to increase or reduce the output of the pump. This variable delivery pump 13 is provided with a control mechanism, of a type known to those skilled in the art, and forming no part of the present invention. This control permits the pump to be shifted to a neutral or zero stroke position, and to maintain pressure in the circuit when this pressure is built up to a predetermined value. A pump control of this type is disclosed in the Ernst Patent No. 2,039,893, issued May 5, 1936. The low pressure constant delivery pump 14 may likewise be of any suitable conventional type, such as the gear or vane type, and its details form no part of the present invention.

The pressure relief valve 16 is of a conventional type, and a complete disclosure thereof will be

found in Ernst application, Ser. No. 669,493, filed May 5, 1933, and which matured into Patent No. 2,086,295 of July 6, 1937. The relief valve 16 is provided with a plunger 23, urged in a downward direction by the spring 24 within the screw cap 25. The plunger 23 contains a drilled passageway 26 interconnecting the main valve chamber 27 and the plunger-lifting chamber 28, the flow being adjustable by means of a needle valve 29.

10 The plunger 23 within the plunger-lifting chamber 28 is provided with an annular shoulder 30, which serves as a piston area to lift the plunger 23 when the pressure exceeds a predetermined amount, as determined by the force of the spring 24. When this amount is exceeded and the pressure lifts the plunger 23, the fluid from the constant delivery pump 14 passes from the plunger-lifting chamber 27 downwardly, through the pipe 31, into the tank 10.

20 The first operating valve 22 consists of a longitudinally bored casing 32 having a valve rod 33 with twin spaced heads 34 and 35 thereon. These heads open into spaced chambers 36, 37, 38 and 39 and 40. The chambers 36 and 40 open into the ports 41 and 42, connected by the line 43 to the tank 10. The chamber 38 opens into the port 21 and line 20, previously described. The chambers 37 and 39 open into the ports 44 and 45, to which are attached the lines 46 and 47, respectively. The line 47 leads to the port 48 in the main hydraulic cylinder 49. The latter has a piston 50 with a head 51 reciprocating therein. The line 46 is connected to the port 52 at the right-hand end of the cylinder 49. A port 53 is provided at the left-hand end of the auxiliary cylinder 54. The latter is provided with a piston 55 having a head 56.

35 The opposite end of the cylinder 54 is provided with a port 57 connected by the line 58 to the port 59 of the second operating valve, generally designated 60. The latter is of a similar construction to the first operating valve 22, and its corresponding parts bear similar numerals. The outlet ports, however, are differently designated for purposes of clarity. From the end ports 61 and 62 the line 63 runs downwardly to the tank 10. From the middle port 64 the line 65 runs to a junction with the line 17, between the check valve 18 and the pressure relief valve 16. From the remaining port 66 the line 67 runs to the port 53 of the cylinder 54. The line 58 also runs through the check valve 68 to the pilot-operated unloading valve, generally designated 69. The latter is provided with a valve chamber 70 and a plunger-lifting chamber 71, having pressure fluid supplied thereto by the pilot line 72 leading from the pressure line 20 of the high pressure variable delivery pump 13.

60 The unloading valve 69 contains a plunger 73 having an annular shoulder 74 forming a piston area within the plunger-lifting chamber 71, and urged downwardly by the coil spring 75 within the casing 76. The pressures at which the pressure relief valve 16 and unloading valve 69 open may be adjusted by turning the screw caps 79 and 80, with which these valves are equipped. The unloading valve 69 is also provided with a reduced diameter portion below the valve chamber 70, and forming an additional chamber 78 into which the lower end 77 of the valve plunger 73 operates. This chamber is connected by the line 58, containing the check valve 68, to the port 57 of the hydraulic cylinder 54. The latter also is provided with an additional port 81, located at approximately the point where it will be un-

covered when the piston head 56 reaches its retracted position. From the port 81 the line 82 runs to the port 83 opening into the valve chamber 70.

The piston head 51 and piston 50 of the main hydraulic cylinder 49 are provided with a special check valve device, which is forcibly opened when the piston reaches its retracted position. For this purpose the piston 50 is provided with a port 116 opening into a right-angled passageway 115, terminating in an enlarged chamber 109 containing a ball 113, and having a passageway 111 opening from the opposite end of the chamber 109 into the space at the left-hand side of the piston head 51. The end of the main cylinder 49 is provided with a threaded bore 117 carrying a threaded valve-operating member 118 having a valve-operating tip 119. The latter is adapted to extend through the passageway 111 and unseat the ball 113 when the piston head 51 reaches its retracted position at the extreme left-hand end of the main cylinder 49.

In practice, the passageway 111 of this check valve mechanism is provided with a valve seat 112. Similarly, the end of the passageway 115 is provided with a valve seat 114. By reason of the foregoing construction the piston halts instantly when the ball 113 is unseated by the action of the projecting member 119, after which pressure is released and fluid passes freely through the piston head 51. The plunger 50 containing the check valve 113 is described and claimed in itself in the copending application of Ernst and Geiger, Ser. No. 148,339, filed June 15, 1937.

Operation

To perform a working stroke, the operator starts the pumps 13 and 14 and shifts the first operating valve 22 into the opposite position from that shown in Figure 1 so that the circuit is opened between the lines 20 and 47. When this is done the circuit will also be opened between the pull-back line 46 and the discharge line 43 running back to the tank 10. Under these conditions the pressure fluid in the line 20 coming from the pumps 13 and 14 will pass through the line 47 into the left-hand end of the cylinder 49. This fluid forces the ball 113 to the right against the seat 114, closing the passageway 115 through the piston head 51. The latter then moves forward to the right, and does its work, such as clamping a pair of dies. The fluid displaced from the forward end of the cylinder 49 passes through the line 46, the first operating valve 22 and the line 43, back to the tank 10. As the resistance to the motion of the plunger 50 increases, the rise of pressure in the line 20 backs up in the line 72 and the plunger-lifting chamber 71, moving the valve plunger 73 upward and opening the unloading valve 69. The discharge of the low pressure pump 14 is then bypassed through the conduit 15, the valve chamber 27 of the unloading valve 16, the conduits 17 and 65, the four-way valve 60, the conduit 67, the port 53, the cylinder 54, the port 81, the conduit 82, the unloading valve chamber 70, past the now lifted plunger 73, the conduit 58, through the check valve 68, the four-way valve 60 and the conduit 63 to the tank 10. Meanwhile, the check valve 18 has been closed by the backing up of pressure in the conduit 19. The pressure continues to build up in the left-hand end of the cylinder 49 and causes a consequent building up of pressure in the lines 47 and 20. When this

pressure reaches a predetermined value, according to the setting of the pump control of the variable delivery pump 13, the control mechanism moves the flow-control member of the pump to its "no delivery" or neutral position.

The operator next shifts the second operating valve 60 to the opposite position from that shown in Figure 1, so that the circuit is opened between the lines 65 and 58. The check valve 18 in the line 19 prevents the pressure in the cylinder 49 from backing up and dropping. This shifting of valve 60 shuts off the above-described by-pass of the low pressure pump 14 therethrough by way of the unloading valve 69. The pressure admitted to the cylinder 54 through the line 58 and port 57 moves the piston head 56 forward. The fluid displaced from the forward end thereof passes through the port 53, the line 67, the valve 60 and the line 63, into the tank 10. Since the variable delivery pump 13 at this time is developing the maximum pressure for which its control is set, the unloading valve 69 is held open by pressure from the line 72 acting against the piston area 74 within the plunger-raising chamber 71. Fluid cannot back up through the line 58 to the unloading valve 69, however, because such pressure instantly closes the check valve 68 so that no fluid escapes by this route. Urged by the fluid in the right-hand end of the cylinder 54, the piston head 56 moves forward to the end of its stroke. The consequent rise in pressure in the discharge circuit of the low pressure pump 14 then backs up in the chamber 27 of the pressure relief valve 16 and passes through the plunger passageway 26, into the plunger-lifting chamber 28. There it acts against the annular piston area 30 and raises the valve plunger 23 sufficiently to release the excess discharge of the low pressure pump 14 through the conduit 31 to the tank 10. In this way the work can be held with the plunger 50 while other work is being done with the plunger 55.

To retract the piston head 56 the operator shifts the second operating valve 60 to the position shown in Figure 1, whereupon the circuit is opened between the lines 58 and 63, permitting fluid to escape from the right-hand end of the cylinder, back to the tank 10. The same shifting of the second operating valve 60 opens the circuit between the pressure fluid line 65 and the line 67 leading to the port 53 at the forward end of the cylinder 54. The pressure fluid thus admitted moves the piston head 56 to the right until it uncovers the port 81. As the unloading valve 69 is still kept open by the pressure from the variable delivery pump 13 in the line 72, the fluid subsequently delivered to the cylinder 54 from the lines 65 and 67 now escapes through the port 81, line 82, chamber 70 of the unloading valve 69, line 58, check valve 68, ports 59 and 61 of the second operating valve 60, and line 63, back to the tank 10. In this manner the fluid flowing to the forward end of the cylinder 54 is by-passed back to the tank 10.

To reverse the motion and retract the piston head 51, the operator now shifts the first operating valve 22 to the position shown in Figure 1, thereby opening the circuit between the lines 20 and 46, and also between the lines 47 and 43. Pressure fluid now flows from the lines 10 and 20 through the first operating valve 22 and the line 46, into the forward end of the cylinder 49. This fluid passes through the passageway 115 and urges the ball 113 against the valve seat 112, closing the passageway 111. The

fluid then causes the piston head 51 to move to the left. Because a maximum pressure is not required to retract the pistonhead 51, a pressure drop occurs in the line 72, relieving the pressure in the chamber 71 of the unloading valve 69, causing the latter to close. This cuts off the by-pass of pressure fluid from the cylinder 54, through the port 81, and line 82, thereby causing both of the pumps 13 and 14 to subsequently discharge their fluid into the cylinder 49.

The piston head 51 moves rearwardly until the projection 119 upon the threaded member 118 strikes the ball 113 and pushes it from its seat 112. This opens the passageway 111 and permits the fluid to escape subsequently through the right-angled passageway 115, the chamber 109, the passageway 111, the port 48, the line 47, the first operating valve 22 and the line 43, back to the tank 10. The piston head 51 immediately halts because of this by-passing of the fluid, and the pumps 13 and 14 subsequently discharge at substantially zero pressure into the tank 10.

It will be understood that we desire to comprehend within our invention such modifications as come within the scope of the claims and the invention.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. In a hydraulic machine circuit, a pair of cylinders, pistons in said cylinders, a high pressure pump and a low pressure pump connected to one of said cylinders, one of said pumps being connected to the other cylinder, valve means in said circuit responsive to the development of a predetermined pressure in said circuit for by-passing the flow of pressure fluid from said low pressure pump, and means responsive to the arrival of one of said pistons at a predetermined position for by-passing the flow of pressure fluid from both of said pumps.

2. In a hydraulic machine circuit, a pair of cylinders, pistons in said cylinders, a high pressure pump and a low pressure pump connected to one of said cylinders, one of said pumps being connected to the other cylinder, valve means in said circuit responsive to the development of a predetermined pressure in said circuit for by-passing the flow of pressure fluid from said low pressure pump, and means responsive to the arrival of one of said pistons at a predetermined position on the retraction stroke thereof for by-passing the flow of pressure fluid from both of said pumps.

3. In a hydraulic machine circuit, a pair of cylinders, pistons in said cylinders, a high pressure pump and a low pressure pump connected to one of said cylinders, one of said pumps being connected to the other cylinder, a pair of pressure-responsive valves in said circuit adapted to cause by-passing of the low pressure pump, one of said valves being openable in response to the development of a predetermined pressure by said high pressure pump and the other openable in response to the development of a predetermined pressure by said low pressure pump only, and means responsive to the arrival of one of said pistons at a predetermined position for by-passing the flow of pressure fluid from both of said pumps.

4. In a hydraulic machine circuit, a pair of cylinders, pistons in said cylinders, a high pressure pump and a low pressure pump connected to one of said cylinders, one of said pumps being connected to the other cylinder, a pair of pres-

sure-responsive valves in said circuit adapted to cause by-passing of the low pressure pump, one of said valves being openable in response to the development of a predetermined pressure by said high pressure pump and the other openable in response to the development of a predetermined pressure by said low pressure pump only, and means responsive to the arrival of one of said pistons at a predetermined position on the retraction stroke thereof for by-passing the flow of pressure fluid from both of said pumps.

5. In a hydraulic machine circuit, a pair of cylinders, pistons in said cylinders, a high pressure pump and a low pressure pump connected to one of said cylinders, one of said pumps being connected to the other cylinder, a pair of pressure-responsive valves in said circuit adapted to cause by-passing of the low pressure pump, one of said valves being openable in response to the development of a predetermined pressure by said high pressure pump and the other openable in response to the development of a predetermined pressure by said low pressure pump only, and means associated with the head of one of said pistons and responsive to its arrival at a predetermined position for by-passing the flow of pressure fluid from both of said pumps.

6. In a hydraulic machine circuit, a pair of cylinders, pistons in said cylinders, a high pressure pump and a low pressure pump connected

to one of said cylinders, one of said pumps being connected to the other cylinder, a pair of pressure-responsive valves in said circuit adapted to cause by-passing of the low pressure pump, one of said valves being openable in response to the development of a predetermined pressure by said high pressure pump and the other openable in response to the development of a predetermined pressure by said low pressure pump only, and means responsive to the arrival of one of said pistons at a predetermined position for by-passing the flow of pressure fluid from both of said pumps, one of said pistons being connected in said circuit for advancement by pressure fluid from said low pressure pump only.

7. In a hydraulic machine circuit, a pair of cylinders, pistons in said cylinders, a high pressure pump and a low pressure pump, one of said pumps being adapted to be connected to one of said cylinders and the other pump being adapted to be connected to both of said cylinders, valve means in said circuit responsive to the development of a predetermined pressure at one of said pistons for by-passing the flow of pressure fluid from said low pressure pump when the other piston has reached a predetermined position.

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