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CONTROL SYSTEM FOR HYDRAULIC APPARATUS

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Fig. 1.

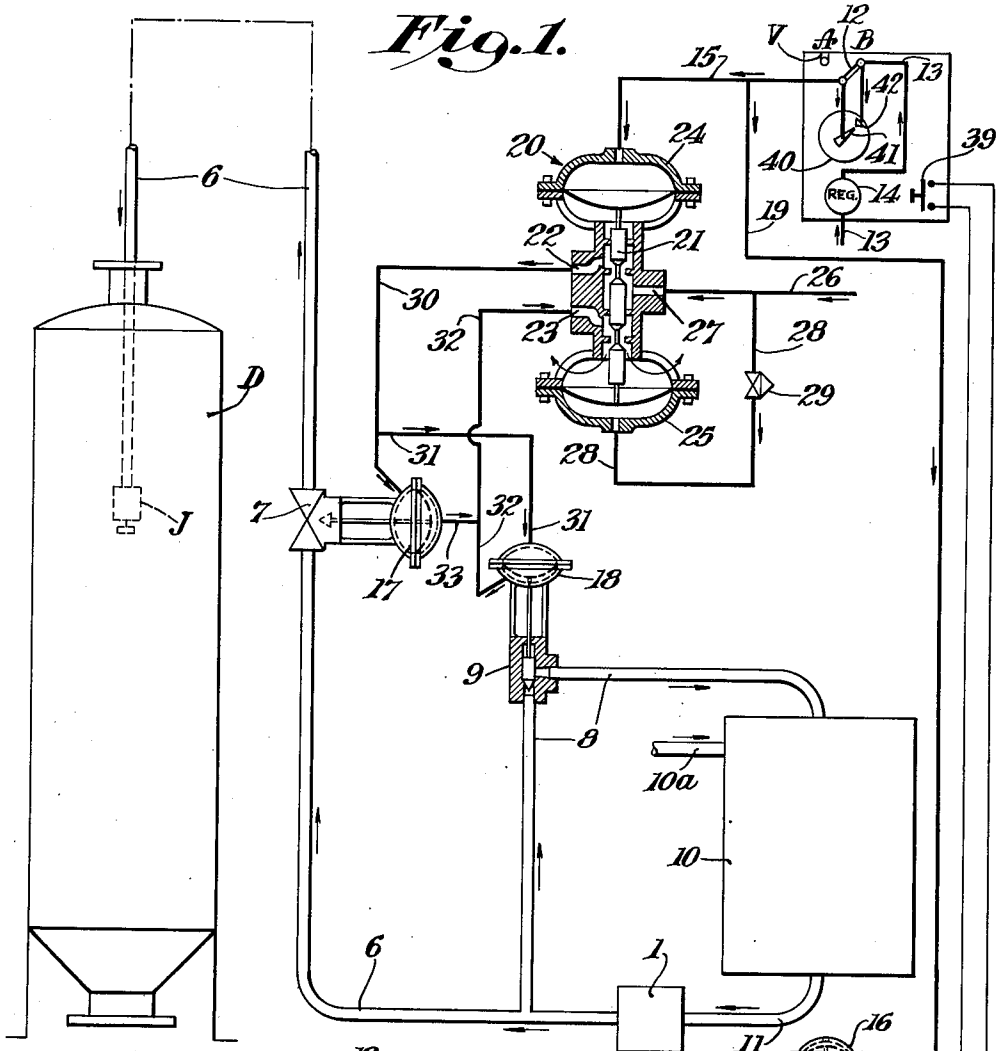
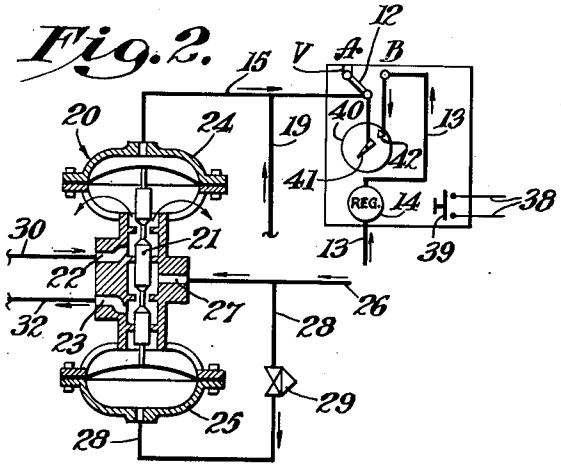

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Fig. 2.



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CONTROL SYSTEM FOR HYDRAULIC APPARATUS

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5 Claims. (Cl. 103—12)

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This invention relates to control of the operation of hydraulic apparatus capable of use in a variety of services. An example is the removal of a hard deposit of coke from a coking drum. In such service it is common practice to use downwardly directed hydraulic jets to first drill a central passage through the coke deposit and then use jets directed laterally outward from said passage to cut the coke into layers to facilitate its dislodgement and removal through the lower end of the drum. For effective operation of the jets, hydraulic apparatus capable of delivering water at a pressure of approximately 1500 lbs. per sq. in. is required. In the operation of the apparatus, variations in pressure and changes in direction thereof such as occur in the starting and stopping of the delivery to the jets cause severe shock and strain upon the pump and the piping of the apparatus. The present invention is concerned particularly with control of the operation of the apparatus in a manner to eliminate such shock.

Important objects of the invention are, to provide an improved control system for hydraulic apparatus devised to eliminate injurious shock in the operation thereof; to provide such a system capable of accomplishing its purpose with minimum attention from the operator; to provide a system responsive to one setting of a single switch device to cause starting and build-up of the hydraulic delivery by the apparatus without shock and responsive to another setting of the switch device to cause the apparatus to stop delivery without shock; and to provide such a system with efficient pneumatically operable mechanism responsive to the settings of the switch device to effect said control of the apparatus.

Further objects and advantages of the invention will appear from the following description taken in connection with the accompanying drawing.

In the drawing:

Fig. 1 is view, partly diagrammatic, showing the improved control system operatively connected to hydraulic apparatus employed for a decoking operation.

Fig. 2 is a view, partly diagrammatic, of a portion of the control system with the switch adjusted to stop hydraulic delivery by the apparatus.

According to the invention, the normal operation of the hydraulic apparatus is under the control of a single air switch which is settable to either of two positions for starting or stopping delivery of hydraulic pressure by the apparatus. For starting delivery by the apparatus the switch

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is set in one of said positions and, in response to said setting, pneumatically operable mechanism is actuated to do three things namely, open a valve in the delivery line of the pump, close a valve in a by-pass line through which the delivery line is connected to the suction line of the pump, and also cause increase of the rate of operation of the pump. In response to the other setting of the switch the pneumatic mechanism is actuated to cause opening of said by-pass valve, reduction of the speed of the pump and closing of the valve in the delivery line. Through such control injurious shock is avoided in both the starting and stopping of the delivery.

In Fig. 1 the improved control system is shown as operatively connected to hydraulic apparatus for delivery of water under high pressure to a jet device employed in a decoking operation. The apparatus includes a pump 1 driven by a steam turbine 2 having a hydraulic governor, indicated at 3. A hydraulic pipe 4 leads to the governor and has a valve 5. A delivery pipe 6 leads from the pump and has a valve 7. Beyond said valve the pipe 6 is in delivery connection with a jet device J through the usual rigging which enables lowering and raising of the device through a coke drum D. The rigging is omitted from the drawing, to simplify the illustration. A by-pass conduit formed of pipe sections 8 connected by an angle valve 9, leads from the delivery pipe, at a point between the pump and the valve 7, to a tank 10. The suction or charge line 11 of the pump leads from the bottom of said tank to the pump inlet. A water make-up conduit line 10a leads to the tank.

The control system includes a manually operable air switch 12 mounted for shifting of one end thereof between positions A and B. The switch may be mounted in a position adjacent the top of the coking drum for convenient operation. It is shown, however, displaced from said position for convenient illustration. An air supply line 13 leads to the switch position B and has a manually settable pressure-regulating valve 14. An air line 15 leads from the switch to pneumatic mechanism for causing operation of the hydraulic valves 5, 7 and 9. Diaphragm motors 16, 17 and 18 are operatively connected to the valves 5, 7 and 9 respectively, and are operable in response to the switch settings. Motor 16 is connected by an air line 19 to the line 15 which leads from the switch. Said line 15 also leads to a four-way valve device 20. This device includes a plunger type valve 21 reciprocable to control air flow through two spaced ports 22 and 23 in the valve casing, and diaphragm motors

24 and 25 are operatively connected to the opposite ends of the valve. An air supply line 26 leads to a port 27 of the valve casing, and a branch line 28 leads from the line 26 to the diaphragm chamber of the motor 25 and has a pressure-reducing valve 29. Line 15 from the switch leads to the diaphragm chamber of the motor 24.

Each of the motors 17 and 18 which operate the valves 7 and 9 respectively, has chambers at opposite sides of its diaphragm. An air line 30 leads from the port 22 of the four-way valve device 20 to the inner diaphragm chamber of motor 17. A branch line 31 leads from line 30 to the outer diaphragm chamber of motor 18. Another air line 32 leads from port 23 of the four-way valve device to the inner diaphragm chamber of the motor 18, and a branch 33 of line 32 leads to the outer diaphragm chamber of motor 17.

Provision is made for stopping the turbine 2 in an emergency. For that purpose, a solenoid device 34 is operatively connected to a valve device 35 for controlling admission of steam from the steam line 36 to the turbine. The line 36 also has a manually operable valve 37. The circuit 38 of the solenoid has a push-button switch 39 located adjacent the air switch 12 for convenient operation.

An air gauge device 40 is associated with the air switch 12. This device has a dial and two pointers 41 and 42. The pointer 41 is movable in response to pressure variations in the line 15 and the pointer 42 is movable in response to pressure variations in the line 13.

Preparatory to operating the apparatus, the air line 13 is supplied with air at a pressure of, say 20 lbs. p. s. i. g., and the reducing valve 14 is adjusted to reduce said pressure to a desired loading of say 15 lbs. p. s. i. g. Air pressure at, say 35 lbs. p. s. i. g., is supplied to the line 26 leading to the four-way valve device 20, and the reducing valve 29 reduces the pressure going to the diaphragm motor 25, to, say 5 lbs. p. s. i. g. Then, with the valve 37 of the steam supply line 36 to the turbine closed, the air switch 12 is set in the position indicated at A which may be identified as the "Minimum" position. Fig. 2 shows the switch in this position. In this position the switch registers with a vent V to atmosphere and the air escapes from above the diaphragm of motor 24 through the line 15, the switch and said vent. The air pressure beneath the diaphragm of motor 25 then forces the diaphragm and the valve 21 upward with reference to the drawing. In its elevated position the valve admits pressure from the line 26, through the port 23 and the lines 32 and 33 to the inner chamber of the motor 18 and the outer chamber of motor 17. Simultaneously, the valve 21 vents to atmosphere the outer chamber of motor 18 and the inner chamber of motor 17 through the lines 31, 30, the valve port 22 and past the upper portion of valve 21 to atmosphere. Thereby, the hydraulic by-pass valve 9 is opened and the delivery valve 7 is closed. When the air switch is in the position shown in Fig. 2, air pressure beneath the diaphragm of the motor 16 escapes through the line 19, the line 15, the air switch 12 and the vent V. The valve 5 is then operated toward closed position by spring loading upon the diaphragm or the valve. The valve 37 in the steam supply line 36 is next opened to bring the turbine up to minimum speed, as determined by a setting of the governor 3.

When ready to start decoking operations the air switch 12 is set in the B position, as shown in Fig. 1. This position may be designated the "Maximum" position. Air from the line 13 is then admitted through the switch 12, and the line 15 to the upper side of the diaphragm of the motor 24. Thereby, the diaphragm and the valve 21 are forced downward against the resistance of the inferior pressure beneath the diaphragm of the motor 25. In its depressed position, the valve 21 exhausts to atmosphere the pressure within the outer diaphragm chamber of the motor 17, through the lines 33 and 32, the port 23 and the lower portion of the valve casing. The inner diaphragm chamber of motor 18 is also vented to atmosphere through the line 32. At the same time, pressure from the air supply line 26 is admitted through the port 22 and the lines 30 and 31 to the inner diaphragm chamber of motor 17 and the outer diaphragm chamber of motor 18, to cause opening of the hydraulic delivery valve 7 and closing of the by-pass valve 9. In its said "Maximum" position the air switch also admits pressure from the line 13 through the switch, the line 15 and the line 19 to the under side of the diaphragm of the governor valve motor 5. Thereby, the valve 5 is opened to increase the speed of the turbine and obtain the required working delivery by the pump through the line 6 to the jet device J.

In order to stop delivery by the hydraulic apparatus it is merely required that the air switch 12 be shifted back to the "Minimum" position. The pneumatic control system then responds to cause opening of the by-pass valve 9, closing of the delivery valve 7 and operation of the governor valve 5 to reduce the speed of the turbine and the rate of operation of the pump 1. In the intervals between decoking operations the valve 5 may reduce the pump delivery to one-third of the working delivery and the reduced delivery is by-passed to the pump inlet. Thereby, the load upon the pump during said intervals is reduced, with a reduction in discharge pressure from say 1500 lbs. to 175 lbs. per sq. in.

Should the operator deem it advisable, the turbine speed may be reduced slowly by operation of the reducing valve 14.

In an emergency, the pump can be stopped quickly by pressing the push-button switch 39 to close the circuit of the solenoid 34 and cause operation of the device 35 to stop delivery of steam to the turbine 2.

The delivery valve 7 is designed for closure mainly by hydraulic pressure within the delivery line 6 when the diaphragm motor 17 is conditioned by the setting of the air switch 12 for closure of the valve. Also, the angle valve 9 is designed and piped for closure against the stream through the by-pass 8. This is contrary to prior practice and produces good results. The arrangement of the valve according to prior practice has been found to cause cavitation, serious erosion and hammering. These faults are minimized by the reversed arrangement.

The invention eliminates injurious shock in the operation of the hydraulic apparatus and greatly facilitates control of the operation. By mere setting of a single air switch in its "Maximum" position for hydraulic delivery the delivery valve 7 is caused to open, the by-pass valve 8 is caused to close and the rate of delivery is caused to increase. Another setting of the air switch causes opening of the by-pass valve, reduction in the rate of operation of the pump and closing of the delivery valve 7. Thereby, comparatively

gentle operation of the hydraulic apparatus is obtained and injurious shock is eliminated.

While the invention is disclosed as employed in connection with decoking apparatus it may be employed advantageously in other services requiring high pressure hydraulic delivery. It will of course be understood that the present disclosure of the invention is merely illustrative and in nowise limiting and that the invention comprehends such modifications as will fall within the scope of the following claims.

We claim:

1. A pneumatic system for controlling the operation of hydraulic apparatus of a type including a pump, a motor for driving same, means operable to control the speed of said motor, a charge conduit leading to the pump inlet, a delivery conduit leading from the pump outlet and having a valve, and a by-pass conduit connection leading from said delivery conduit, at a point between said valve and the pump, to the pump inlet and having a valve, said pneumatic system comprising an air switch connected to a compressed air source and settable selectively at a low speed position or a high speed position, pneumatically operable devices operatively connected to said switch and operatively associated respectively, with said two valves and said motor speed control means, and responsive to the low speed setting of the switch to cause opening of the by-pass valve, closing of the delivery conduit valve and reduction of the motor speed, said devices being responsive to the high-speed setting of the switch to cause opening of the delivery conduit valve, closing of the by-pass valve and increase of the motor speed.

2. A fluid pressure operated system for controlling operation of hydraulic apparatus of a type including a pump, a motor for driving same, means operable to control the speed of said motor, a charge conduit leading to the pump inlet, a delivery conduit leading from the pump outlet and having a valve, and a by-pass conduit connection leading from said delivery conduit, at a point between said valve and the pump, to the pump inlet, and having a valve, said control system comprising a settable device, and mechanism operable by fluid pressure under control of said device and responsive to a setting thereof to cause opening of said by-pass valve, closing of said delivery conduit valve and operation of said motor speed control means to cause low speed operation of the motor.

3. A fluid pressure operated system for controlling operation of hydraulic apparatus of a type including a pump, a motor for driving same, means operable to control the speed of said motor, a charge conduit leading to the pump inlet and a delivery conduit leading from the pump outlet and having a valve, said control system comprising a fluid pressure switch settable selectively at a low-speed position or a high-speed position, and mechanism operable by fluid pressure under control of said switch and responsive to the low-speed setting of the switch to cause closing of said valve and operation of said motor speed control means to reduce the motor speed, and responsive to the high-speed setting of the switch to cause opening of said valve and operation of the motor speed control means to increase the motor speed.

4. A system for controlling the operation of hydraulic apparatus including a pump, a motor for driving same, means operable to control the speed of said motor, a charge conduit leading to the pump inlet, a delivery conduit leading from the pump outlet and a by-pass conduit connection leading from said delivery conduit, at a point between said valve and the pump, to the pump inlet and having a valve, said control system comprising a switch settable selectively at a low-speed position or a high-speed position, and mechanism responsive to the low speed setting of said switch to cause opening of said by-pass valve, closing of said delivery conduit valve and operation of said speed control means to reduce the motor speed, said mechanism being responsive also to the high speed setting of the switch to cause opening of the delivery conduit valve, closing of the by-pass valve and operation of the speed control means to increase the motor speed.

5. A system for controlling the operation of hydraulic apparatus including a pump, a motor for driving same, means operable to control the speed of said motor, a charge conduit leading to the pump inlet, a delivery conduit leading from the pump outlet and having a valve, and a by-pass conduit connection leading from said delivery conduit, at a point between said valve and the pump, to the pump inlet, and having a valve, said control system comprising a manually operable control device, and mechanism responsive to one operation of said device to cause opening of said by-pass valve, closing of said delivery conduit valve and operation of said speed control means to reduce the motor speed, said mechanism being responsive also to another operation of said device to cause opening of the delivery conduit valve, closing of the by-pass valve and operation of the speed control means to increase the motor speed.

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