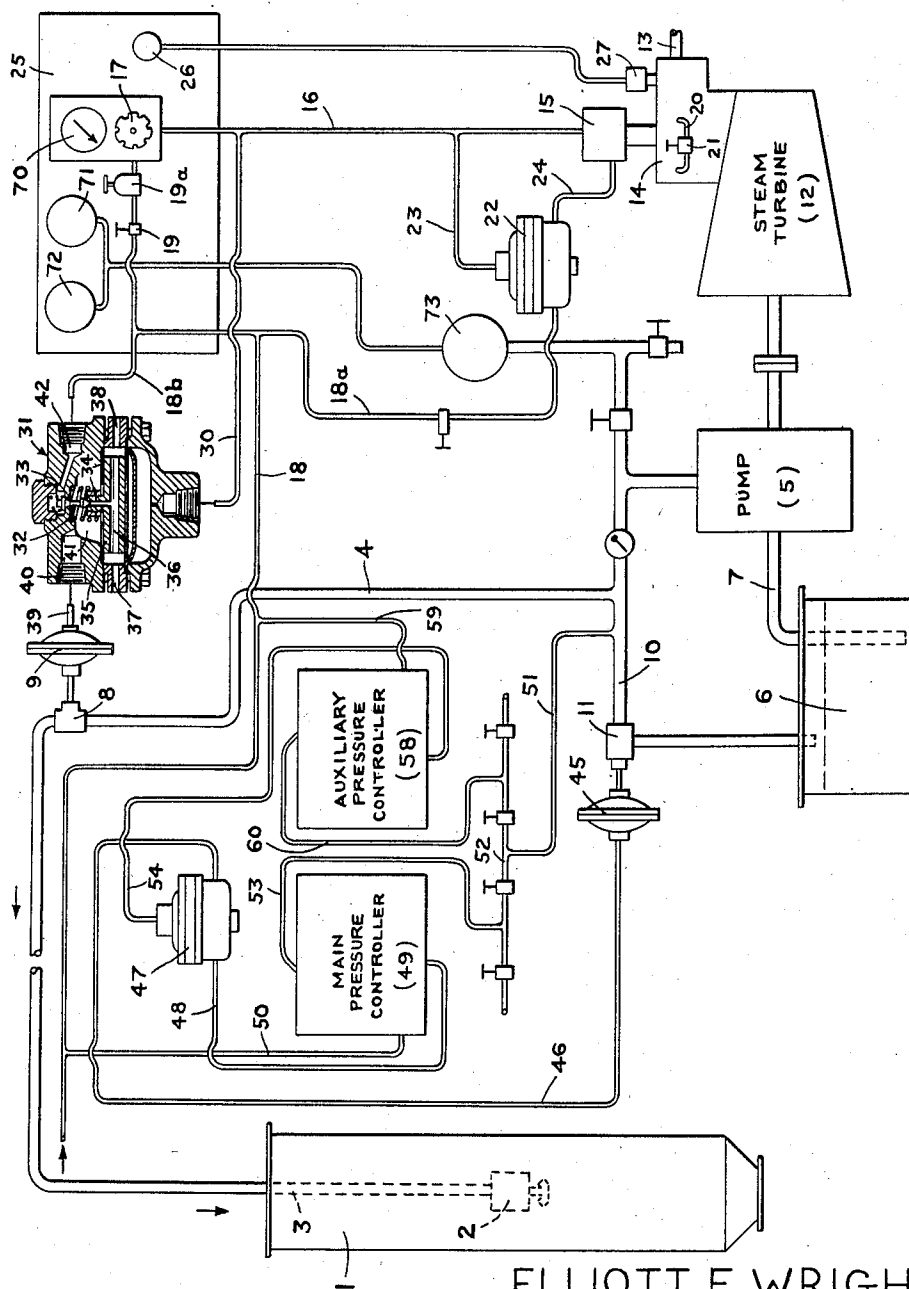


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CONTROL FOR HIGH VELOCITY HIGH PRESSURE
WATER DELIVERY SYSTEM
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ELLIOTT F. WRIGHT
AUGUST J. KEUFFEL
INVENTORS

BY *Daniel A. Bobis*
Atty

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CONTROL FOR HIGH VELOCITY HIGH PRESSURE WATER DELIVERY SYSTEM

Elliott F. Wright, Plainfield, and August J. Keuffel, Summit, N. J., assignors to Worthington Corporation, Harrison, N. J., a corporation of Delaware

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This invention relates generally to means for controlling the operation of a high pressure water delivery system adapted for use in various process industries where cutting of materials in drums or tanks is best performed through the application of high velocity, high impact water jets.

The present invention will be described with reference to hydraulic decoking which is a method of disrupting and removing petroleum coke from the coking chambers by means of high pressure water.

In general, in order to facilitate the removal of the coke from a coking chamber, hydraulic apparatus is utilized which delivers high pressure water to drilling and cutting heads which first drill a center hole downwardly through the coke in the coke chamber and then by means of lateral jets, cut the coke in layers to facilitate the removal of the coke into a suitable conveying means for removing it from the area where the coke chamber is located.

In the drilling and cutting operation, the pump is run at full speed to get maximum rated pressure at the tools. However, there are at least two important factors in operating these systems which must be taken into account. First, whenever the drill stem and the cutting and boring tools are being filled preparatory to starting the working flow, the drill stem and tools should be cleared of air by operating the pump at an easily controlled moderate pressure before it is brought up to operating speed, thus minimizing hydraulic shock. Second, it is highly desirable to so operate the system that the plant steam will be utilized to the greatest advantage with the least power loss.

The present invention accomplishes these desirable results by providing a control system to cause the turbine and pump:

(a) to idle at a speed such that the tools can be changed and the drum inspected;

(b) to operate at a pre-fill speed with both the by-pass valve and main delivery line valves open to allow for fully expelling the air from the drill stem and cutting tools, filling the drill stem and cutting tool, and establishing flow through the cutting tool with a minimum of hydraulic shock;

(c) to allow the turbine to be brought up to working speed and pressure at a desired rate of change, and

(d) to provide safety mechanisms which allow the turbine and pump to be shut down quickly and to prevent the delivery pressure exceeding a predetermined maximum value.

The present invention thus embodies a means for controlling the operation of a delivery system wherein pressure air is utilized to directly control the speed of operation of the turbine driving the jet pump or pumps in the system and the valve controlling the delivery of pressure fluid to the drill stem and the hydraulic tools to provide the desired conditions of operation; and to indirectly coact with the pressure of the fluid delivered by the pump to actuate the by-pass valve when the conditions of operation require.

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Further objects and advantages of the invention will become evident from the following description with reference to the accompanying drawing in which the single figure shows a diagrammatic sketch of a control system for a high pressure, high velocity fluid delivery system.

Referring to the drawing in which the control system is shown operatively connected to the high pressure fluid delivery system being utilized for removing coke from a coking chamber shown at 1, the coke will be drilled and cut by hydraulic tools 2 mounted on the end of a hollow drill stem element 3 to be moved upwardly and downwardly in the coke bed in the coking chamber 1 by any suitable means (not shown).

High pressure water is fed to the drill stem element 3 from the main delivery line 4 to which it is connected.

The main delivery line 4 is in communication with the discharge of a pump or pumps 5 in turn having its suction communicating with the water reservoir 6 through the suction pipe 7. The main delivery line 4 is provided with a normally closed main delivery line control valve 8 operated through a diaphragm type motor 9 in turn actuated by pneumatic pressure, as hereinafter described. A by-pass pipe 10 connected between the main delivery line 4 and the reservoir 6 and provided with a normally open by-pass control valve 11 will by-pass water from the discharge side of the pump 5 to the reservoir at all times unless the valve 11 is actuated to a closed position as is hereafter described in the operation of the present control system.

The pump 5 may be any suitable type of high pressure fluid delivery pump of which there are many now available on the open market. It is driven by any suitable type of prime mover such as a steam turbine diagrammatically illustrated at 12. The steam turbine receives its steam through the steam inlet pipe 13 and the flow of steam to the turbine rotor (also not shown) is controlled from the steam inlet to a rotor by suitable valves in a chest generally designated 14 in a manner which is well known in the steam turbine art.

Turbine control

The governor valve in chest 14 is controlled by a pneumatic-hydraulic turbine governor 15 which receives its loading air through an air delivery line 16 connected through a manually operated regulator 17 to the main air supply line 18 which receives air under pressure from any suitable source (not shown). The main air supply line 18 has a needle valve as at 19 to control the flow of air to the manual air regulator 17 and a reducing valve 19a which regulates the pressure air. In the present system shown it will be delivered to the regulator 17 at about 30 p. s. i. g.

By manually adjusting the regulator 17, the delivery of air through air delivery line 16 acts to control governor 15 and thus the turbine speed. This in turn varies the speed of the pump driven thereby between the predetermined minimum and predetermined maximum conditions of pressure at which the water is to be delivered through the main delivery line 4 to the drill stem 3 and boring head 2, as is hereinafter described.

The turbine governor 15 is so adjusted that the regulator enters into the operation for controlling the turbine only from its prefill speed condition to full speed condition. Accordingly an idling by-pass line 20 having a manually operated by-pass valve 21 is provided across the valves in the steam chest 14. The by-pass valve 21 is set to deliver sufficient steam to run the turbine at idling speed. The regulator 17 then adjustably controls, by suitable air signals to the governor 15 and the relay 22 as hereinafter described, the turbine speed from idling through prefill and on up through an infinite number of

working speeds to full speed conditions whereby the desired conditions of pump discharge can be secured.

At any time that the pressure of the air signals delivered through line 16 drops below that required for prefill speed, a controller mechanism 22 of the positive relay type more fully described hereinafter which receives these air signals through line 23 will open to allow air at source pressure to pass from line 18a through to controller 22 to a connecting line 24 connected between the controller and the governor 15 to deactuate the governor whereby the steam valves in the steam chest 14 are closed and the turbine will drop to the idling speed conditions set by the by-pass valve 21.

The panel or control board 25 on which the regulator 17 is mounted will be at a point remote from the turbine and pump in that it will be located at the point where the operator can manipulate the regulator to accomplish the desired conditions of operation. In the event of an emergency, however, in order to shut down the system an emergency switch 26 of the push button or the like type is also provided on the panel board 25 which is connected to a solenoid trip valve 27 in the inlet to the steam chest 14. The tripping of the valve 27 will act to cut off the flow of steam to the steam chest 14 thereby shutting down the system.

Main delivery line valve control

Associated with the operation of the turbine 12 and controlled through connecting line 30 which receives pressure air from air delivery line 16 is a positive acting relay 31. Relay 31 and controller mechanism 22 are illustrated as identical in the present preferred form of the invention. It will be understood, however, that any suitable controller mechanism which will perform the desired operation may be utilized for this purpose.

Accordingly, only relay 31 is fully shown in the drawing, as including a valve 32 adapted to engage and maintain port 33 normally closed and port 34 in the diaphragm head 35 normally open. The port 34 communicates with atmosphere through passage 36 and outlets 37 and 38 and will act in this open position to vent the diaphragm motor 9 to atmosphere through line 39 communicating with port 40 and valve chamber 41 in the relay 31.

When the regulator is adjusted to bring the air signaling pressure in lines 16 and 30 up to prefill signaling pressure, the diaphragm head 35 will be actuated to close port 34 and move valve 32 to open port 33 thereby allowing air at source pressure to expand from line 18b through port 42, and valve chamber 41 and port 40 of the relay 31 and line 39 to the diaphragm motor 9 thereby actuating the delivery line valve 8 to an open position.

By-pass valve control

It is believed clear that the pressure of the fluid delivered by the pump 5 will vary proportionately with the speed of the turbine.

This variation in discharge head of pump 5 provides a simple means to control the operation of the by-pass valve 11, to correlate the opening and closing of the by-pass valve 11 with the speed of the turbine 12 and the opening of the main delivery line valve 8 above described.

Thus, the figure shows valve 11 operated by a diaphragm motor 45 connected through line 46 to a relay 47 through which pressure air is delivered from line 48 through a main pressure controller generally designated 49 communicating through line 50 to the main pressure line 18.

The relay 47 is the positive acting type substantially identical to relay 31 above described.

Accordingly, in one position of the relay 47 the valve (not shown) will vent the diaphragm motor 45 so that the by-pass valve 11 will be in its normally open position. In the other position of the relay, actuating air will be

passed to the diaphragm motor 45 to change the by-pass valve 11 to a closed position.

The pressure delivered by pump 5 at all times acts in pressure conduit 51, and common conduit 52. This pressure is transmitted through line 53 to the main pressure controller 49. When the pressure due to an increase in turbine speed exceeds a predetermined minimum the main pressure controller will open to pass the pressure air from line 50 to line 48 which in turn delivers the air to the relay 47.

The relay 47 is normally maintained so that this air can pass through to line 46 by action of pressure air delivered from line 54 to act against the diaphragm head (also not shown) of the relay 47.

The pressure air delivered from line 54 is controlled by the auxiliary pressure controller 58 which receives air at source pressure through connecting line 59 and fluid at pump pressure through connecting line 60.

As long as the pressure delivered by the pump through lines 51, 52, and 60 does not reach a predetermined maximum pressure air will pass through the controller 58 to line 54 and thence to the relay to act therein as above stated. When the fluid delivered by the pump exceeds the predetermined maximum pressure the air is prevented from activating the diaphragm head and the relay will vent the diaphragm motor 45 to atmosphere, thereby opening the by-pass valve 11.

Operation

In operation, steam is introduced through steam inlet 13 of the turbine and pressure air through main pressure air line 18.

The steam is utilized to drive the turbine 12 and during starting up will be by-passed through the by-pass line 20 in an amount sufficient to idle the turbine to allow it to heat up.

The needle valve 19 is opened and the pressure reducer 19a adjusted manually to the desired pressure. Regulator 17 will now be used to vary the pressure delivered through line 16 to the governor 15 between 5 p. s. i. g. to 25 p. s. i. g. as indicated by gauge 70.

When the regulator 17 is now manually turned to raise the pressure from 5 p. s. i. g. to 8 p. s. i. g., this pressure will through lines 16 and 30 signal relay 31 to actuate valve 8 to an open position and through the action of relay 22 and turbine governor 15, all as above described, the turbine speed will increase to that required for the pump to fill gradually and without shock the drill stem 3 and hydraulic tool 2, connected to the main fluid delivery line 4, thus preparing the system for the fluid at working pressure.

The discharge head of the pump can now be increased to that required to close by-pass valve 11 thru action of the main pressure controller 49 and then brought up to full operating pressure by further manipulating the regulator 17. As long as the pressure of fluid delivered by the pump 5 remains within the predetermined minimum and maximum pressure conditions at which the main pressure controller 49 and the auxiliary pressure controller 58 will come into operation, the by-pass valve will remain closed and high pressure fluid will be delivered through the main delivery line 4 to the cutting and boring head 2.

The diaphragm motor operated valves 8 and 11; the relays 22, 31, and 47; the controllers 49 and 58 and solenoid valve 27 are elements which are well known and easily purchasable on the open market, hence they have not been more fully shown and described, as their specific structure does not form part of this invention.

A pressure gauge 71 and an alarm bell 72 are provided at the control panel 25 which connect through pressure transmitter 73 communicating with the delivery line 4 to convey pump discharge pressure signals to these instruments.

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It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. The combination with a high pressure fluid delivery system including a fluid reservoir, a pump having its suction connected to said reservoir and a discharge, a main delivery line connected to said discharge of the pump to receive fluid therefrom, a normally closed pneumatically operated valve in said main delivery line to control the flow of fluid therethrough, a by-pass line connecting the discharge of said pump to said reservoir, a normally open pneumatically operated valve in said by-pass line, a prime mover for driving said pump, a fuel inlet to deliver fuel to said prime mover, and a pneumatically operated valve for controlling the flow of fuel to said prime mover to regulate the speed thereof, of a pneumatic system comprising a source of compressed gas, means connected to said source for regulating delivery of compressed gas at reduced pressure to directly actuate said fuel control valve to regulate the prime mover operation from idle to full speed, means operated off of said regulating means to control delivery of pressure gas at a predetermined pressure to said main delivery line valve to actuate said valve to an open position, and means operatively connected to the discharge of said pump to control delivery of pressure gas to said by-pass valve to actuate said valve to a closed position between predetermined minimum and maximum pump discharge pressures.

2. In the combination as claimed in claim 1 wherein means are provided to regulate the idling speed of said prime mover when said fuel inlet valve is not in operation, and a control mechanism connected between said regulator and said fuel inlet valve to render said regulator inoperative at a predetermined minimum pressure.

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3. The combination with a high pressure fluid delivery system including a fluid reservoir, a pump having its suction connected to said reservoir and a discharge, a main delivery line connected to said discharge of the pump to receive fluid therefrom, a normally closed pneumatically operated valve in said main delivery line to control the flow of fluid therethrough, a by-pass line connecting the discharge of said pump to said reservoir, a normally open pneumatically operated valve in said by-pass line, a prime mover for driving said pump, a fuel inlet to deliver fuel to said prime mover, and a pneumatically operated valve for controlling the flow of fuel to said prime mover to regulate the speed thereof, of a pneumatic system comprising a source of compressed gas, a regulator connected to said source and to said fuel control valve to regulate delivery of operating air directly to said valve whereby the speed of said prime mover can be adjusted from idle to full speed conditions, a relay connected between said regulator and said fuel control valve to control delivery of pressure air from said source to said main delivery line valve to actuate said valve to an open position at a predetermined pressure intermediate the idle and full speed pressure position of the regulator, means for controlling delivery of pressure air to said by-pass valve to move said valve to a closed position, said means operatively connected to the discharge of said pump and to actuate delivery of pressure gas at a predetermined minimum pump delivery pressure and to stop delivery of pressure gas at a predetermined maximum pump delivery pressure.

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