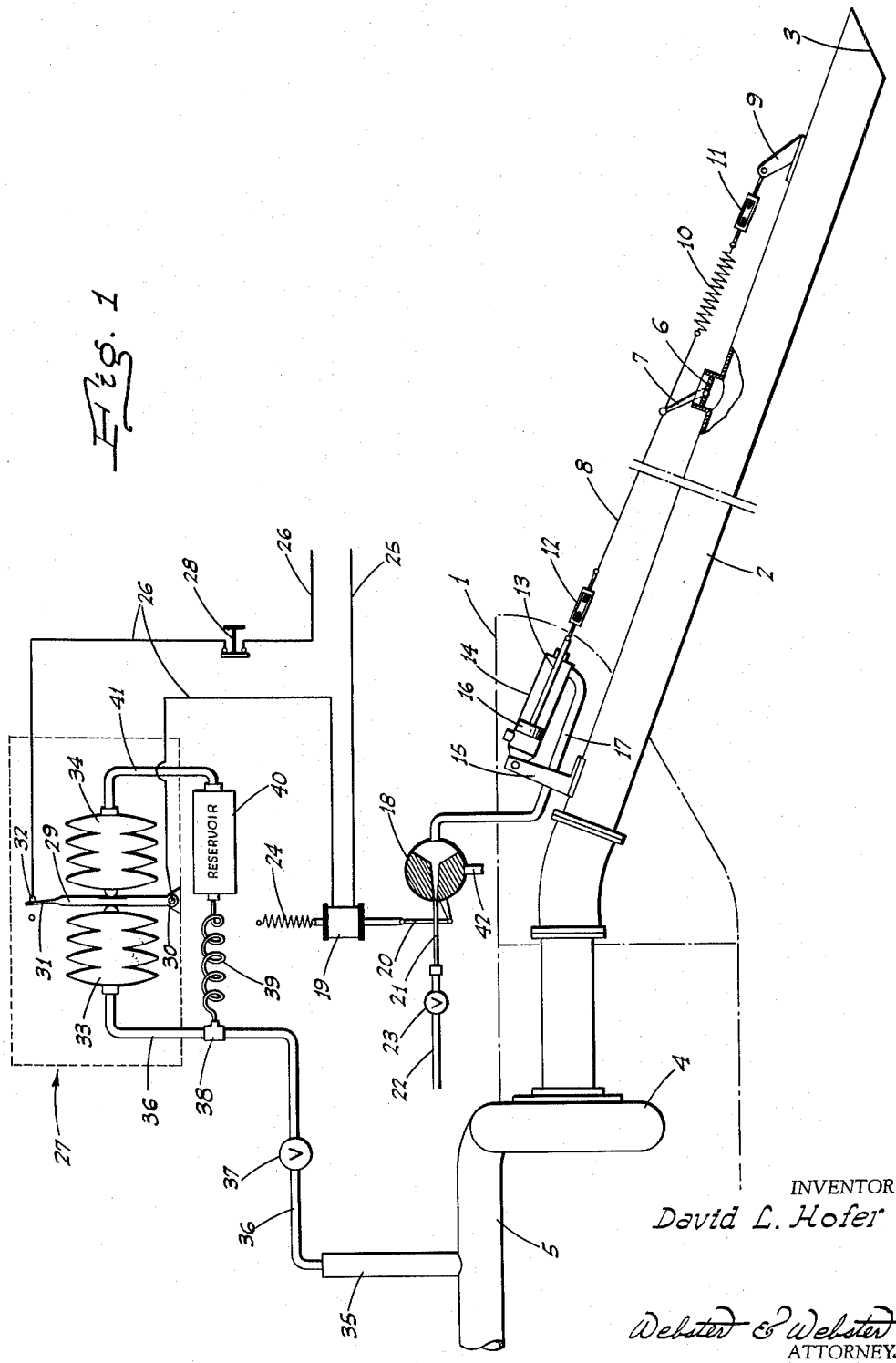
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RELIEF VALVE CONTROL SYSTEM FOR HYDRAULIC DREDGES

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Fig. 1



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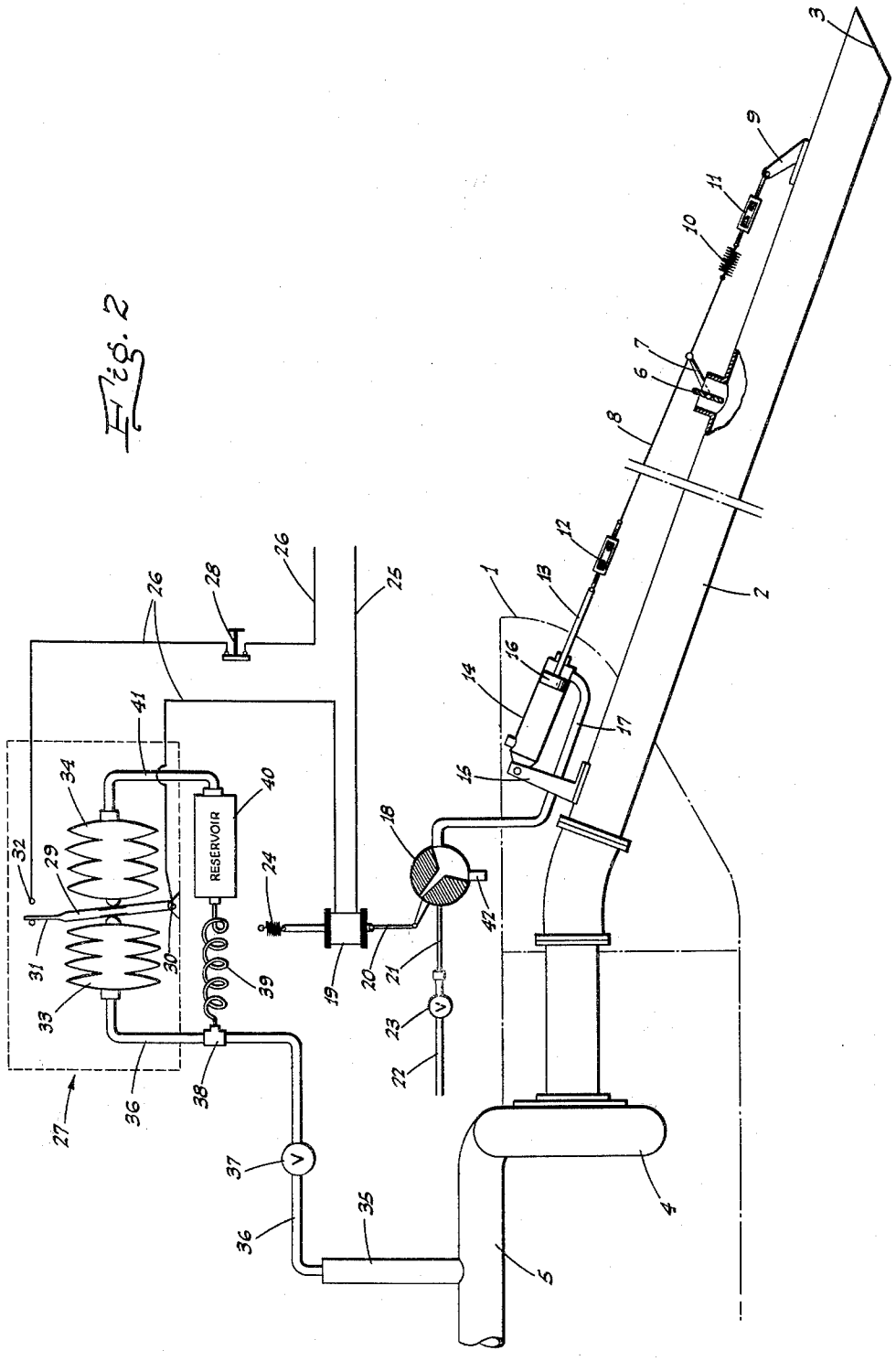
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RELIEF VALVE CONTROL SYSTEM FOR HYDRAULIC DREDGES

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Fig. 2



United States Patent Office 3,109,377 Patented Nov. 5, 1963

3,109,377
RELIEF VALVE CONTROL SYSTEM FOR HYDRAULIC DREDGES

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Filed Sept. 11, 1961, Ser. No. 137,152
5 Claims. (Cl. 103—11)

This invention relates to an automtaic system for the control of an under-water relief valve on the suction pipe of a hydraulic dredge.

In the operation of such a dredge an abrupt drop in the pumping pressure occurs under certain abnormal pumping conditions, as—for example—when the lower end of the suction pipe becomes plugged by excess mud, debris, etc. To prevent possible damage to the equipment, especially the pump, being caused by such an abnormal pumping condition, a normally closed, under-water relief valve mounted on the suction pipe above its lower end is opened, whereupon water surges into such suction pipe, relieving the abnormal pumping condition. Also, after opening of the under-water relief valve, as above, it is desirable that the subsequent closing of the valve be quite slow in order to avoid any hammering effect—again to prevent equipment damage.

It is therefore the major object of the present invention to provide a novel control system for automatically and rapidly opening the under-water relief valve in response to an abrupt drop in the pumping pressure, but which system is non-responsive to normal and relatively slow variations in such pumping pressure.

An additional object of the invention is to provide a relief valve control system, as above, which is operative—without manual adjustment—regardless of the value of the normal pumping pressure immediately preceding any abrupt drop in such pressure. In other words, the system automatically "follows" normal pumping pressure, but stands ready to automatically function at any time.

Another important object of the invention is to provide a relief valve control system which, together with the above features, is also operative to time-delay initiation of the valve closing action, and to thereafter accomplish the latter relatively slowly; all to the end that sufficient time elapses for the pumping conditions to return to normal, and without equipment damage that might ensue from rapid closing of said valve.

A further object of the invention is to provide a practical, reliable, and durable relief valve control system for hydraulic dredges, and one which will be exceedingly effective for the purpose for which it is designed.

These objects are accomplished by means of such structure and relative arrangement of parts as will fully appear by a perusal of the following specification and claims.

In the drawings:

FIG. 1 is a diagrammatic elevation of the system, with the parts illustrated in the positions occupied thereby under normal pumping conditions, and with the relief valve closed.

FIG. 2 is a like view, but with the parts illustrated in the positions occupied thereby under abnormal pumping conditions, and with the relief valve open.

Referring now more particularly to the drawings, and to the characters of reference marked thereon, the relief valve control system is employed on a suction dredge, indicated generally at 1, which includes a suction pipe 2 whose intake end is indicated at 3.

At its upper and opposite end the suction pipe 2 delivers to a heavy-duty motor driven pump 4 connected, in turn, to a discharge pipe 5.

Adjacent but short of the intake end 3 thereof the

suction pipe 2 is provided with a normally closed butterfly valve 6 which includes a radial operating lever or arm 7 disposed in an upstanding position.

A control cable 8 is attached intermediate its ends to the radial arm 7, and such cable 8 extends longitudinally above the suction pipe 2 and in opposite directions from said radial arm 7.

At its forward end the cable 8 is connected to an upstanding bracket 9 by an assembly which includes—in end to end connection—a heavy-duty tension spring 10 and a turnbuckle 11.

At its upper or opposite end the cable 8 is connected by means including a turnbuckle 12 to the outer end of the piston rod 13 of a longitudinally disposed air pressure actuated power cylinder 14 which is attached, at the end opposite the piston rod 13, to an upstanding bracket 15.

When the power cylinder 14 is deenergized its piston 16 is advanced toward the intake end of pipe 2, as is the piston rod 13, as shown in FIG. 2.

A conduit 17 of substantial inside diameter or capacity is connected to the forward end of the power cylinder 14, and thence leads to a three-way rotary valve 18 suitably mounted on the dredge and adapted to be actuated by a solenoid 19 connected to said rotary valve by suitable linkage 20.

In one position of said valve 18, as in FIG. 1, such valve establishes communication between the conduit 17 and a restricted air pressure feed pipe 21 which leads to said valve; such feed pipe 21 being connected to an air pressure supply pipe 22 having a normally open hand valve 23 interposed therein.

With the valve 18 in the position of FIG. 1, air pressure is delivered from supply pipe 22 through restricted air pressure feed pipe 21, said valve 18, and conduit 17, causing energization of the power cylinder 14.

When the power cylinder 14 is energized, the piston 16 travels rearwardly therein, retracting the piston rod 13 and pulling the cable 8, against the tension of spring 10, to close the butterfly valve 6. This is the normal working position of such valve, and at which time the solenoid 19 is energized and works against the tension of a pull-back spring 24. The solenoid 19 is energized by a circuit which comprises leads 25 and 26 which extend from an electric current source (not shown).

The above arrangement is disclosed in my United States Patent No. 2,889,779, and the present system comprises therewith, in combination and cooperative relation, the following:

A differential pressure responsive switch unit of opposed bellows type, and indicated generally at 27, is suitably mounted on the dredge; such switch unit being interposed in the lead 26, as is a separate and manual switch 28. The switch unit 27 and manual switch 28 are normally closed.

The switch unit 27 includes a pivotally mounted switch arm 29 pivoted at one end, as at 30, and provided at the opposite end with a switch blade 31 normally in engagement with a live contact 32. The lead 26 has one portion connected to the switch arm 29 and another portion to the contact 32.

The switch arm 29 is interposed between, and positionally controlled by, the opposed bellows 33 and 34 of the differential pressure responsive switch unit 27. When the air pressure within the bellows 33 and 34 is equal, the switch unit 27 is closed, i.e. the switch blade 31 rests in engagement with the contact 32; the direction of engagement being away from the bellows 33.

An air column standpipe 35 is mounted on, and upstands from, the discharge pipe 5, and a conduit 36 leads from the upper end of the standpipe 35 to the outer end of the bellows 33 of switch unit 27; there being a

normally open manual valve 37 included in the conduit 36.

Between the bellows 33 and the valve 37 the conduit 36 has a T-fitting 38 interposed therein, which T-fitting, on the lateral side, is connected to a restricted-diameter, helically coiled tube 39. At the end opposite the T-fitting 38 the helically coiled tube 39 is connected to one end of an air pressure reservoir 40. A conduit 41 connects between the opposite end of said reservoir and the outer end of the bellows 34.

Under normal pumping conditions—i.e. normal pumping pressure in the discharge pipe 5—the air pressure in the bellows 33 and 34, and as received from the air column standpipe 35, is equal, with the result that the switch unit 27 is closed; the solenoid 19 is energized; the valve 18 is in the position of FIG. 1; and the butterfly valve 6 is held closed by the power cylinder 14.

The switch unit 27, and consequently the valve 6, will remain closed even though there be normal, relatively slow variations in the pumping pressure in the discharge pipe 5. This is for the reason that the pressure in the bellows 33 and 34 correspondingly varies while remaining equal, and which pressure balance is not affected by the restriction of tube 39; the latter—together with the reservoir 40—serving a purpose hereinafter described.

When the pumping pressure in discharge pipe 5 abruptly drops due to an abnormal pumping condition, as when a plug occurs at the intake end 3 of suction pipe 2, the control system immediately acts to cause quick-opening of the valve 6; this being accomplished as follows:

An abrupt drop in the pumping pressure in discharge pipe 5 produces a corresponding and immediate pressure drop in the air column standpipe 35, conduit 36, and bellows 33. Such pressure drop in the bellows 34 is however time-delayed by reason of the restricted helically coiled tube 39 and the reservoir 40; the pressure drop thus occurring relatively slowly in said bellows 34. As a consequence the bellows 33 collapses to a certain extent and the bellows 34 expands to a certain extent, i.e. follows the bellows 33. When this occurs the switch arm 29 is swung in a direction to disengage the switch blade 31 from the contact 32, opening the switch unit 27.

When switch unit 27 is thus opened the circuit to the solenoid 19 is broken, whereupon the pull-back spring 24 functions to actuate the valve 18 from its position as in FIG. 1 to its position as in FIG. 2. In such latter position of the valve 18 it establishes full open communication between the conduit 17 and an unrestricted vent 42, whereupon the air pressure is instantaneously released from the power cylinder 14, through conduit 17, valve 18, and vent 42.

When this occurs the piston 16, piston rod 13, and cable 8 snap forward under the influence of the loaded tension spring 10, and which results in quick-opening of the butterfly valve 6. With such quick-opening of the butterfly valve 6 a large quantity of water rushes into the suction pipe 2 for the purpose of relieving the abnormal pumping condition; i.e., the low pressure in the discharge pipe 5, and which was caused—for example—by a plug at the intake end 3 of suction pipe 2.

Then, after a lag dependent on the extent of time-delay cause by the restricted tube 39 and reservoir 40, the pressure in the bellows 33 and 34 again comes into balance, so that such bellows return the switch arm 29 to a position with the switch blade 31 in engagement with contact 32, causing closing of the switch unit 27 and reestablishment of the energizing circuit to the solenoid 19. Upon reenergization of the solenoid 19 the latter then returns the valve 18 to its initial position, as in FIG. 1.

Upon such return of the valve 18 to its initial position air pressure is fed, but relatively slowly, to the conduit 17 from the restricted air pressure feed pipe 21; the latter being of quite small internal diameter. With such slow feed of air pressure through the conduit 17 to the power

cylinder 14 the piston 16 slowly retracts, and which results in a corresponding slow closing of the butterfly valve 6.

The time-delay in reclosing of the switch unit 27, together with the subsequent slow closing of the butterfly valve 6, normally provides a total time lapse sufficient for the abnormal pumping condition to be relieved before said valve 6 completely recloses; the entire system then being reestablished in its normal position of the parts, as in FIG. 1.

However, if the abnormal pumping condition is not relieved within the period of such total time lapse then the operator can accomplish a reopening of the butterfly valve 6 by merely manually opening the switch 28, which switch can be held open until such abnormal condition is fully relieved. Then, the manual switch 28 is closed, which results—just as when the system is automatically operating—in slow closing of said valve 6 and return of the system to normal.

The above described relief valve control system for hydraulic dredges is highly effective and most practical for the purpose of automatically responding to and relieving abnormal pumping conditions that result in an abrupt drop in the pumping pressure in discharge pipe 5; the features of time-delay in reclosing the switch unit 27, in combination with the slow closing of the valve 6, being of substantial importance in the attainment of the desired result.

From the foregoing description it will be readily seen that there has been produced such a system as will substantially fulfill the objects of the invention, as set forth herein.

While this specification sets forth in detail the present and preferred steps of the system, still in practice such deviations therefrom may be resorted to as do not form a departure from the spirit of the invention, as defined by the appended claims.

Having thus described the invention the following is claimed as new and useful, and upon which Letters Patent are desired:

1. A pressure-drop responsive device to control the opening and subsequent reclosing of an under-water relief valve on the suction pipe of a dredge, the dredge having a discharge pipe and said device comprising an electric member adapted to cause the valve to close and remain closed when the member is energized, means applied to the member to cause the valve to open when said member is deenergized, an energizing circuit in which the member is interposed, a differential-pressure responsive switch unit interposed in the circuit and including opposed pressure chambers having movable elements whose movement, under pressure, actuates the switch in an opening or closing direction, a first pressure conduit connected at one end to one chamber and the pressure in which is the same as that in the discharge pipe, a second conduit connected to the other chamber, and means including a tube of restricted diameter connecting the second conduit with the first conduit intermediate the ends of the latter.

2. A device as in claim 1, with a reservoir connected in series with and between said tube and the second conduit.

3. A device as in claim 1, with a manually operable switch in the circuit ahead of the switch unit.

4. A pressure-drop responsive device to control the opening and subsequent reclosing of an under-water relief valve on the suction pipe of a dredge, the dredge having a discharge pipe and said device comprising an electric member adapted to cause the valve to close and remain closed when the member is energized, means applied to the member to cause the valve to open when said member is deenergized, an energizing circuit in which the member is interposed, a differential-pressure responsive switch unit interposed in the circuit and including a movable switch arm, a pressure chamber hav-

ing a movable element engaging the switch arm and responsive to pressure changes in the discharge pipe, said element moving the switch arm to close and hold the switch unit closed when the pressure in the chamber is normal and moving in reverse when the pressure in the chamber is reduced to a predetermined extent, and pressure responsive means acting on the switch arm to open the switch unit when said element thus moves in reverse.

5. In the assembly of a normally closed relief valve on the suction pipe of a dredge, and means normally maintaining the relief valve closed but operative to quick-open and thereafter slow-close the same and including a normally energized solenoid and a circuit therefor, the valve being quick-opened upon deenergization of the solenoid and slow-closed upon reenergization of said solenoid; a device responsive to an abrupt drop in the pumping pressure of the dredge operative to deenergize the solenoid and after a time-delay to reenergize the same and including a normally closed switch interposed in the circuit, opposed bellows operative to maintain the switch closed or to open the same under conditions of equal or unequal pressure respectively in said bellows, and conduits subject to said pumping pressure and coupled to corresponding bellows; the conduit for one bellows having a restriction interposed therein whereby a drop in pumping pressure is reflected in the bellows with a time-delay in one relative to the other so that unequal pressure exists in said bellows, and the switch is open, during the period of said time-delay.

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