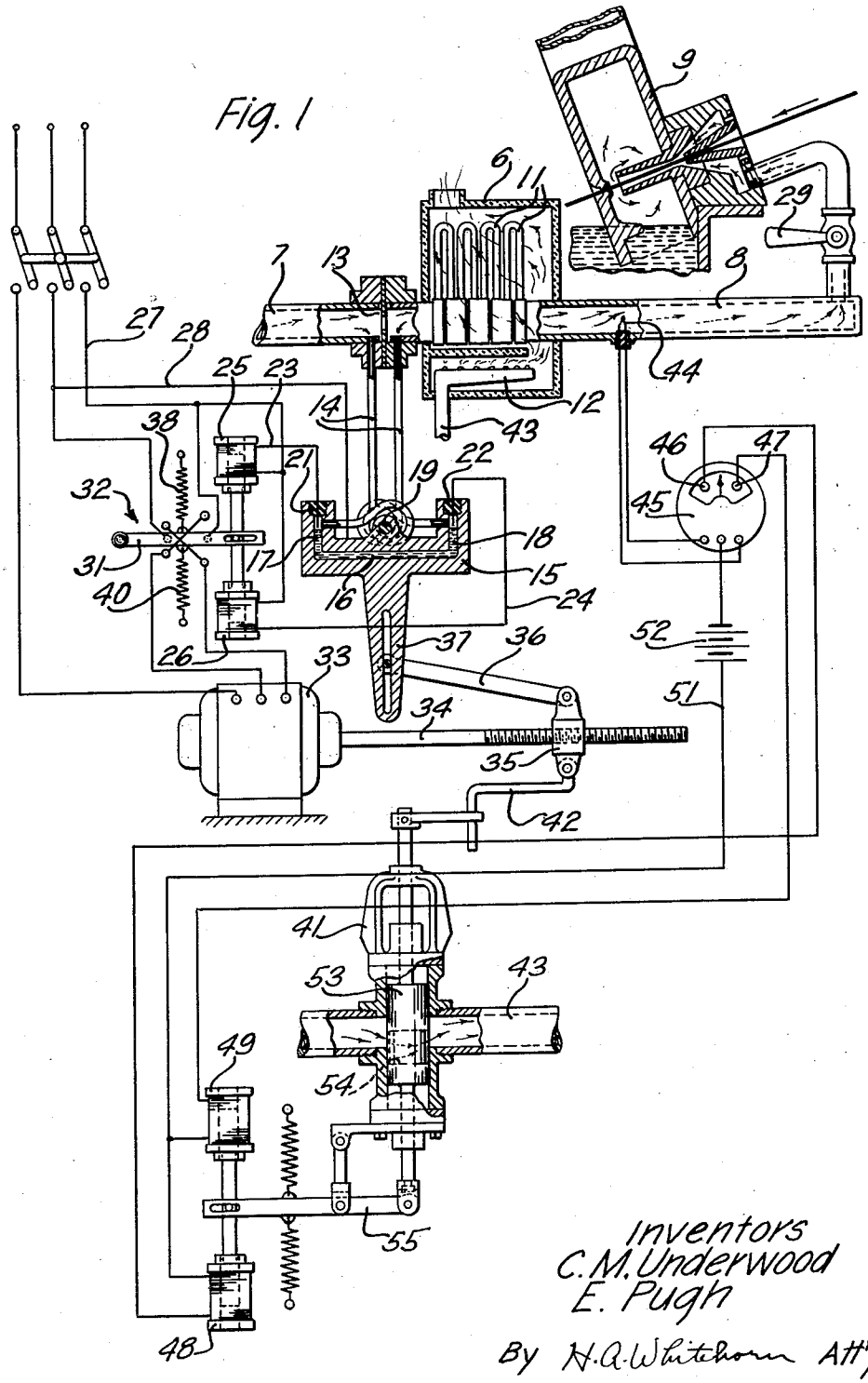
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APPARATUS FOR CONTROLLING THE TEMPERATURE OF A FLUID

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Fig. 1



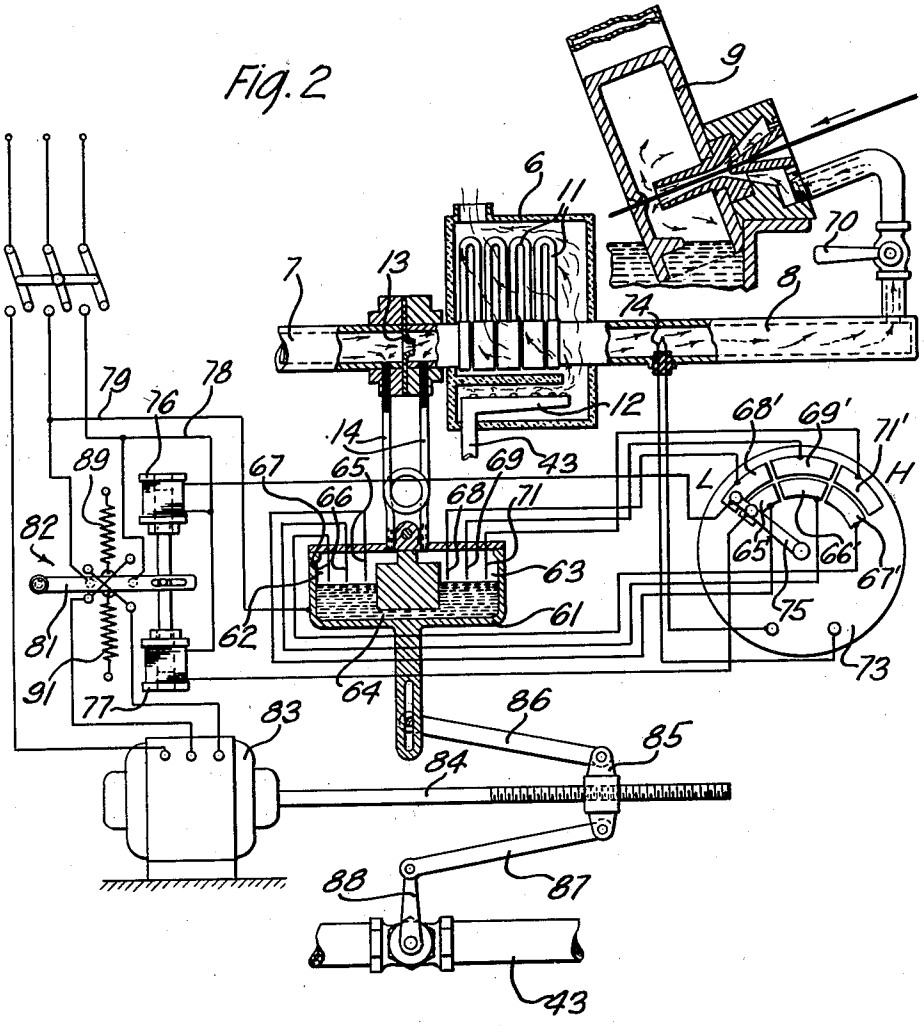
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Fig. 2



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2,023,627

APPARATUS FOR CONTROLLING THE TEMPERATURE OF A FLUID

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Application December 10, 1931, Serial No. 580,112

10 Claims. (Cl. 236—1)

This invention relates to an apparatus for controlling the temperature of a fluid and more particularly to an apparatus for controlling the amount of heat supplied to a steam superheater.

An object of the invention is to provide an effective and efficient apparatus for controlling the temperature of a fluid.

In the process of tinning wire strands using a steam wiper for removing excess tin from the strands, superheated steam is frequently supplied to a large number of wipers and the amount of steam required varies with the number of wipers in operation at any particular time. Thus for instance the amount of steam required may vary quite abruptly when one of the tinning machines is stopped due to a broken strand or the like, or when the number of machines in operation is increased or decreased.

As long as the amount of steam flowing through a superheater is constant, the amount of heat supplied to the heating coils may be substantially constant, but when the rate of flow of the steam increases, the amount of heat supplied must be increased to maintain the required temperature of the superheated steam and when rate of flow of the steam decreases the amount of heat supplied must be decreased to prevent burning out the coils of the superheater.

In accordance with one embodiment of the invention, the amount of heat supplied to heat the steam is varied both in accordance with the rate of flow of the steam and in accordance with the temperature of the steam.

A complete understanding of the invention may be had by reference to the following description taken in conjunction with the accompanying drawings, in which

Fig. 1 is a schematic view of an apparatus embodying the invention, and

Fig. 2 is a schematic view of a modified form of the invention.

Referring now particularly to Fig. 1 a steam superheater 6 is shown having an inlet conduit 7 which delivers steam to the superheater from a conventional boiler (not shown). An outlet conduit 8 from the heater leads to a steam wiping device 9 of a tinning machine, such as is more fully disclosed in the copending application of C. M. Underwood, Serial No. 331,362, filed January 9, 1929.

Within the superheater the steam is passed through a large number of U-shaped pipes 11 which are shown in the illustrations as heated by a gas burner 12, although it is evident that these pipes may be heated by any suitable means commonly used in steam superheaters. In the inlet conduit of the superheater an apertured diaphragm 13 is located and on each side of the diaphragm is a tube 14. These tubes lead to a mercury contact device 15 having a longitudinal passage 16 therein at the ends of which are upwardly extending arms 17 and 18. The passage 16 is filled with a conducting liquid, such as mercury, which extends upwardly into arms 17 and 18 a short distance. The device 15 is pivoted at 19 and the lower ends of tubes 14 are provided with a turn encircling the pivot 19 and then extend into the upper ends of arms 17 and 18. The purpose of the turns in the tubes is to increase the flexibility of the tubes. It will be seen that when no steam is flowing in the conduit 7, the static pressure of the steam will be equal on both sides of diaphragm 13 and, therefore, the level of the mercury in arms 17 and 18 will be equal. However, when there is a flow of steam through conduit 7, the pressure on the right-hand tube 14 will decrease, causing the mercury in arm 18 to rise and the mercury in arm 17 to fall.

The ends of arms 17 and 18 are closed by taps 21 and 22 of insulating material through which electrical contacts are sealed into the arms from conductors 23 and 24. These conductors are connected to electromagnets 25 and 26, respectively; and a common conductor 27 leads from the electromagnets to one line of a source of three phase alternating current. The body of the device 15 is made of conducting material and is connected to another line of the three phase source of alternating current through a conductor 28.

Assuming that no steam is flowing in conduit 7, the apparatus will be substantially in the position shown in Fig. 1. If steam is now caused to flow in conduit 7 by opening a valve 29 leading to the steam wiper of the tinning machine, the mercury will rise in arm 18 and engage the contact in the upper end of this arm, closing the circuit through magnet 26, thereby actuating an arm 31 of a reversing switch 32 to energize a three phase motor 33. This motor has an elongated threaded shaft 34 which carries an internally threaded member 35. The member 35 has a link 36 pivotally connected thereto which is in turn pivotally connected to a downwardly extending arm 37 of contact device 15. The direction of rotation of motor 33 when electromagnet 26 is energized is such as to move the member 35 to the right and this causes the contact device to tilt about its pivot point 19 and disengage the mercury in arm 18 from the

contact, thereby causing the electromagnet 26 to be de-energized, whereupon the arm 31 of reversing switch 32 will be returned to neutral position by means of a spring 38. This de-energizes the motor and causes it to stop. While the motor was rotating and moving the member 35 to the right, it also actuated a valve 41 through a link 42 for controlling the amount of fuel supplied to the superheater through a pipe 43. The distance which member 35 is moved to the right, and, therefore, the amount that valve 41 is opened, depends upon the height to which the mercury level is raised in arm 18 as a result of the flow of steam in conduit 7.

If now the rate of flow of steam in conduit 7 decreases, as, for instance, when the valve 29 is partially closed, the mercury will fall in arm 18 and rise in arm 17, causing the mercury to engage the contact in the upper end of arm 17 to energize electromagnet 25. The energization of electromagnet 25 moves the arm 31 of reversing switch 32 to its upper position, thereby energizing motor 33 in such a direction as to cause it to rotate in the opposite direction from that previously described, moving the member 35 to the left. This movement continues until the mercury in arm 17 disengages the contact in that arm to de-energize electromagnet 25 allowing a spring 40 to move arm 31 of the reversing switch to neutral position to de-energize the motor, at which time the valve 41 will have been closed to such a position as to supply the proper amount of fuel to the superheater for the rate of steam flowing therethrough. The amount of movement of valve 41 relative to the amount of tilting of the contact device may be varied by adjusting the link 36 vertically in the slot in arm 37.

It is important in a steam wiper of a thinning machine that the heater steam be held at a rather uniform temperature in order to insure a uniform coating on the tinned strand. Another reason for regulating the amount of heat supplied to the pipes of the superheater is that unless the heat is taken away from the pipes at the same rate at which it is supplied, the pipes will very rapidly become overheated and burn out. It is important, therefore, that the fuel supplied to the super-heater be reduced immediately as soon as the rate of flow of steam through the superheater decreases.

It has been found that the temperature of the steam at the output end of the superheater should also be taken into consideration in determining the amount of heat supplied to the superheater. For this purpose a thermocouple 44 is placed in the outlet conduit 8 and is connected to a galvanometer 45. This galvanometer is provided with two contacts 46 and 47, one of which is connected to an electromagnet 48, while the other is connected to an electromagnet 49. A common conductor 51 of the electromagnets is connected through a source of electrical energy 52 to the pointer of the galvanometer. When the temperature of the steam in conduit 8 is low, the pointer will engage contact 46 and energize electromagnet 48. The valve 41, previously referred to, is a double acting valve and has a piston 53 which is reciprocable as well as rotatable. This piston has a rectangular aperture 54 therethrough and thus it will be seen that the opening through the valve may be regulated either by rotating the piston or by reciprocating the piston, or by both. When the electromagnet 48 is energized, a lever 55 causes the piston 53 to move upwardly and increase the opening through the valve to increase the flow of fuel to the superheater. When the pointer of the galvanometer is in a neutral position, piston 53 will be in its neutral reciprocable position; and when the pointer moves into engagement with contact 47, electromagnet 49 will be energized to further close the opening through valve 41. Thus it will be seen that the action of the valve, due to the flow of steam through the superheater, is modified to a certain extent by the temperature of the steam.

In the embodiment of the invention shown in Fig. 2, a superheater 6 is provided with an inlet conduit 7, and an outlet conduit 8 leads to a steam wiping device 9 of a tinning machine. The conduit 7 is provided with a diaphragm 13 on each side of which is a flexible tube 14 leading to a contact device 61. This contact device has two arms 62 and 63 which are connected by a passage 64. The top of the contact device is preferably made of insulating material and each arm has three contacts therein. The arm 62 has contacts 65, 66, 67 and the arm 63 has contacts 68, 69 and 71 sealed through the insulating top of the device. The contacts in each arm are successively spaced farther from the pivot point of the device.

Cooperating with the contact device is a galvanometer 73 which is controlled by a thermocouple 74 in the outlet conduit 8 of the superheater. The galvanometer has a pointer 75 having two radially spaced contacts, the upper one of which is connected to an electromagnet 76 and the lower one is connected to an electromagnet 77. The galvanometer also has two sets of plates spaced at different radial distances from the pivot point of the pointer, one set comprising plates 65^1, 66^1, and 67^1, which are electrically connected to contacts 65, 66 and 67, respectively; and the other set of plates comprising plates 68^1, 69^1, and 71^1, which are electrically connected to contacts 68, 69 and 71 of contact device 61. The electromagnets 76 and 77 are connected to one line of a three phase source of alternating current by a conductor 78 and the body of the contact device 61, which is made of conducting material, is connected by a conductor 79 to another terminal of the three phase source of alternating current.

It will be seen that only two of the six contacts of the contact device will be effective at one time. If the pointer 75 of the galvanometer is in its left-hand position, as a result of a low temperature of the steam in conduit 8, contacts 65 and 68 will be connected to the electromagnets. When the pointer 75 is vertical, indicating a medium temperature of the steam in conduit 8, the contacts 66 and 69 will be connected to the electromagnets; and when the pointer of the galvanometer is in the right-hand position engaging plate 67^1 and 71^1, indicating high temperature of the steam in conduit 8, the contacts 67 and 71 will be connected to the electromagnets.

Now when there is no steam flowing through conduit 7, the static pressure of the steam on each side of diaphragm 13 will be equal and the device will be substantially in the position shown in Fig. 2. If now the valve 70 is opened, causing a flow of steam through conduit 7, the pressure on the right-hand pipe 14 will be reduced, causing the mercury to rise in arm 63 and fall in arm 62. As soon as the mercury in arm 63 makes engagement with contact 68, magnet 76 will be energized to move an arm 81 of a reversing switch 82 upwardly and cause the energization of a three phase alternating current motor 83. The motor

83 is provided with a threaded shaft 84 carrying an internally threaded member 85. At the upper end of this member a link 86 is pivotally connected to contact device 61 and a second link 87 is connected to the lower side of member 85 for operating a valve 88. The direction of rotation of motor 83, when electromagnet 76 is energized, is such as to move the member 85 to the right, as viewed in Fig. 2, tilting the device 61 so as to break the connection between the mercury and contact 66, while at the same time the valve 88 is opened to supply more fuel to the superheater.

If the rate of flow of steam in conduit 7 decreases, the mercury in arm 63 will drop and the mercury in arm 62 will rise, engaging contact 65 which causes the electromagnet 77 to be energized to reverse the direction of rotation of the motor until the connection between the mercury and contact 65 is broken, while at the same time partially closing valve 88. If the temperature of the steam in conduit 8 increases, the pointer 75 will move into such a position as to contact with plates 66^1 and 69^1. At this time contacts 65 and 68 will become inoperative and contacts 66 and 69 will become operative. With these connections when the mercury in arm 63 rises, it will be seen that a connection between mercury and contact 69 will be broken sooner by the tilting of contact 61 than the connection between the mercury and contact 68. As a consequence thereof, valve 88 will not be opened as far when the pointer of the galvanometer is in engagement with plates 66^1 and 69^1 as it would be if the pointer were in engagement with plates 65^1 and 68^1. When the pointer is in engagement with plates 67^1 and 71^1, the connection between the mercury and contact 71 will be broken upon a still smaller movement of member 85. The amount of movement of the valve 88 relative to the tilting of the contact device may be varied by adjusting the link 86 vertically in the slot in the downwardly extending arm of the contact device.

In order to move the valve toward its closed position, the procedure takes place in just a reverse order. If the pointer 75 is in engagement with plates 67^1 and 71^1, the valve 88 will be closed farther to break the contact between the mercury in arm 62 and contact 65, than it would be if the arm were in engagement with contacts 65^1 and 68^1, because in that case the valve would have to be closed only far enough to break the connection between the mercury in arm 62 and contact 67. When the mercury is not engaged with any of the contacts, the arm 81 of reversing switch 82 is held in neutral position by springs 89 and 91.

The apparatus described controls the temperature of the superheated steam, both in accordance with the temperature of the steam and the rate of flow thereof. It has been found that the temperature of the superheated steam cannot be controlled by a temperature responsive control alone. For instance, the thermo-couple temperature control described in connection with the apparatus is capable of controlling the temperature only of the steam in the output conduit 8. However, since the heat is being supplied to the coils in the superheater, the temperature of the steam in the superheater when the steam in the superheater is not moving at all or moving slowly may be much higher than at the point where the thermocouple is located, so that it would be possible to completely burn out the coils in the superheater without shutting off the fuel supply by means of the temperature control. While the control of the temperature of the superheated steam is best controlled by the rate of flow of the steam through the superheater, this in itself is not completely satisfactory because the moisture of the steam fed to the superheater through the conduit 7 may vary, and also the richness or mixture of the fuel may vary, making it necessary to supply different amounts of fuel with a constant rate of flow of steam through the superheater.

The apparatus described above combines both of these control features, which are correlated in such a manner that the action of one modifies the action of another.

It will be understood that the nature and embodiments of the invention herein described and illustrated are merely convenient and useful forms of the invention and that many changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In an apparatus for controlling the temperature of a fluid, a tiltable liquid contact device, means for rendering said device responsive to fluid pressure due to the flow of the fluid, an electrical circuit associated with said contact device, a source of motive power, means for controlling said motive power in accordance with the combined effect of the tilted position of and fluid pressure in said device, and means actuated by said source of motive power for controlling the heat supplied to the fluid.

2. In an apparatus for controlling the temperature of a fluid, a tiltable liquid contact device, means for rendering said device responsive to fluid pressure due to the flow of the fluid, an electrical circuit associated with said contact device, a source of motive power, means for controlling said motive power in accordance with the combined effect of the tilted position of and fluid pressure in said device, means actuated by said source of motive power for controlling the heat supplied to the fluid, and means responsive to the temperature of the fluid for modifying the effect of the tiltable liquid contact device.

3. In an apparatus for controlling the temperature of a fluid, means for heating the fluid, a mercury contact device having two upwardly extending arms, means actuated in accordance with the differential pressure of the fluid for controlling the level of mercury in said arms, an electrical circuit having contacts extending into said arms, said circuit being associated with a source of power, means for closing the circuit through said source of power when the mercury in one arm rises to a predetermined level, means for opening said circuit when the source of power has moved a predetermined distance, and means actuated by said source of power for controlling the amount of heat supplied to the fluid.

4. In an apparatus for controlling the temperature of a fluid, means for heating the fluid, a mercury contact device having two upwardly extending arms, means actuated in accordance with the differential pressure of the fluid for controlling the level of mercury in said arms, an electrical circuit having contacts extending into said arms, said circuit being associated with a source of power, means for closing the circuit through said source of power when the mercury in one arm rises to a predetermined level, means for opening said circuit when the source of power has moved a predetermined distance, means actuated by said source of power for controlling the amount of heat supplied to the fluid, and means responsive to the

temperature of the fluid for effecting the control of the heat supplied to the fluid.

5. In an apparatus for controlling the temperature of a fluid, means for supplying heat to the fluid, a tiltable mercury contact device having two upwardly extending arms, a plurality of contacts extending into each of said arms and spaced different distances from the pivot point, means responsive to the rate of flow of the fluid for varying the level of mercury in said arms, an electric motor, means for energizing the motor when the mercury in one of said arms reaches a predetermined level, means for causing the motor to tilt said device to de-energize the motor, means controlled by the temperature of the fluid for rendering various of said contacts effective, and means actuated by the motor for controlling the amount of heat supplied to the fluid.

6. In an apparatus for controlling a fluid, a movable contact device, means for applying a differential fluid pressure thereto in response to the rate of flow of said fluid and rendering said device responsive to said differential fluid pressure, an electrical circuit associated with said contact device, a source of motive power for positioning said device, means for controlling said motive power in accordance with the combined effect of the said differential fluid pressure in the contact device and position of said device, and means actuated by said source of power for controlling a condition of the fluid.

7. In an apparatus for controlling a fluid, a contact device operable directly in response to the flow of the fluid, a second contact device operable in response to the temperature of the fluid, and an electrical circuit including means operable to combine the effects of said contact devices to control the fluid.

8. In an apparatus for controlling a condition of a fluid, a tiltable liquid contact device, means for rendering said device responsive to fluid pressure due to the flow of the fluid, an electrical circuit associated with said contact device, a source of motive power, means for controlling said source in accordance with the combined effect of the tilted position of and fluid pressure in said device, and means actuated by said source of motive power for controlling said condition.

9. In an apparatus for controlling a fluid, a movable contact device, means for rendering said device responsive to a differential fluid pressure in response to the rate of flow of said fluid, a source of motive power for positioning said movable contact device, and means for controlling said motive power in accordance with the combined effect of the differential fluid pressure in response to the rate of flow of said fluid in and position of said contact device to control a condition of said fluid.

10. In an apparatus for controlling a fluid, a movable contact device, means for rendering said device responsive to a differential fluid pressure in response to the rate of flow of said fluid, a source of motive power for positioning said movable contact device, means for controlling said motive power in accordance with the combined effect of the differential fluid pressure in and position of said contact device, means actuated by said source of power for controlling a condition of the fluid, and means responsive to the temperature of the fluid for modifying said control.

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