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[54] **MECHANICAL DISPLACEMENT TYPE FLOW SWITCH WITH FLUID STATE MAINTENANCE HEATING MEANS**
 7 Claims, 9 Drawing Figs.

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 137/341; 219/309
 [51] Int. Cl. H01h 35/40
 [50] Field of Search. 200/81.9;
 219/309, 10.49, 10.51, 116, 201, 209; 137/341,
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ABSTRACT: In a mechanical displacement type flow switch employing a mass adapted to be displaced by a flowing medium, the improvement comprising heating means for maintaining the medium in a fluid state in a region adjacent the mass, thereby affording the mass freedom of operative movement in the medium.

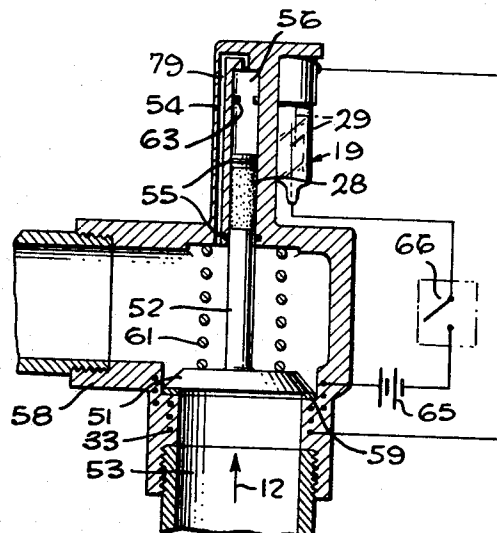


Fig. 1

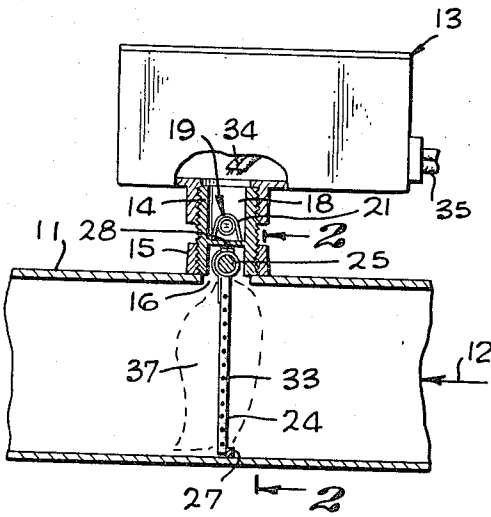


Fig. 2

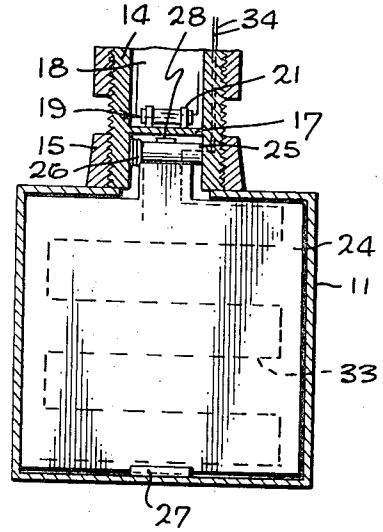


Fig. 3

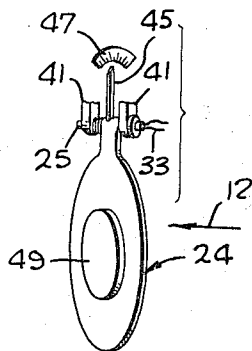


Fig. 4

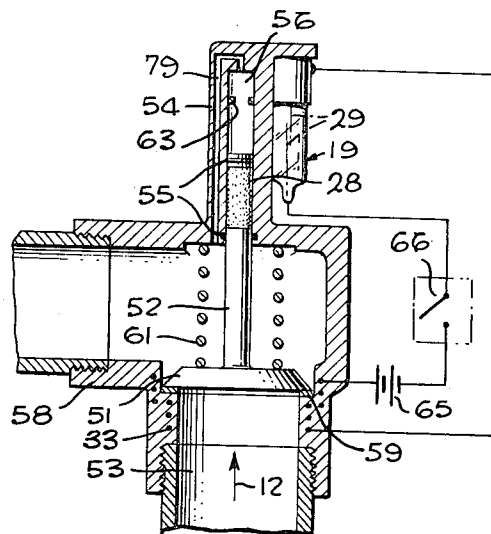
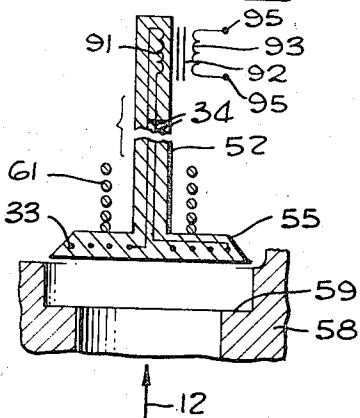


Fig. 5



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Fig. 6

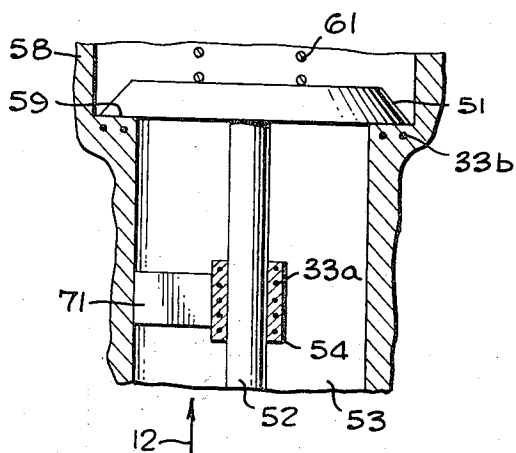


Fig. 7

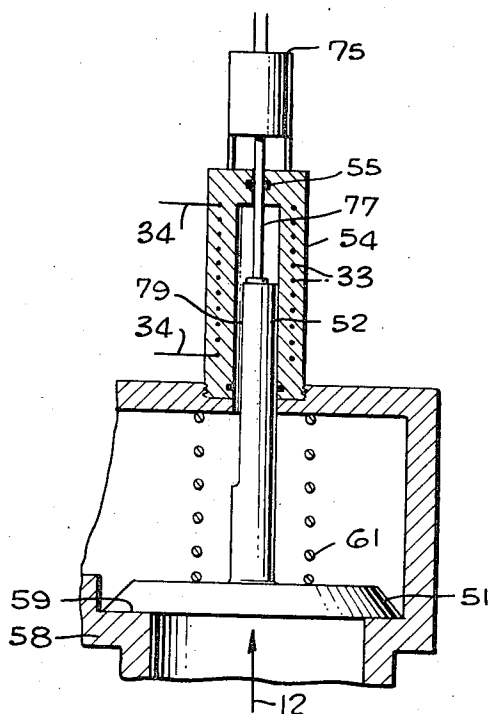


Fig. 8

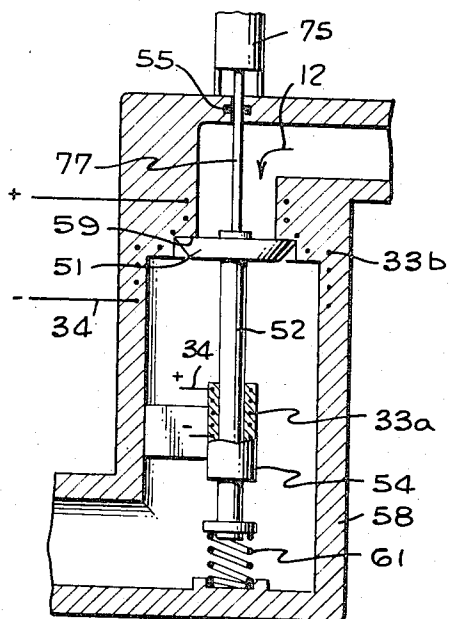
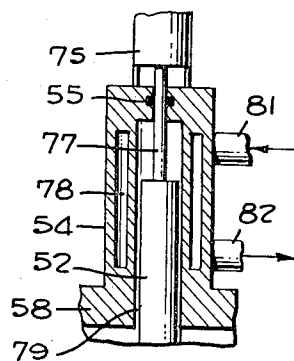


Fig. 9



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MECHANICAL DISPLACEMENT TYPE FLOW SWITCH WITH FLUID STATE MAINTENANCE HEATING MEANS

This invention relates to flow switches, and particularly to mechanical displacement type switches for detecting the existence, variation or cessation of flow in a fluid medium.

Commonly mechanical displacement switches fall into two categories, the hinged type, and the reciprocating type. In the former a mass, often in the form of a paddle is pivotably supported in the flow path of the fluid medium so as to be deflected thereby. In the latter the mass takes the form of a poppet supported for reciprocating movement along the line of flow of the fluid medium. Generally, both classes of switches are designed so that the mass is returned to a rest position either under the influence of gravity, or through the action of resilient means such as a spring, when the flow ceases. The existence, and in some cases the rate or variation in rate of flow, is determined by a variety of means responsive to the displacement of the mass.

While such mechanical switches operate quite satisfactorily in media which remain in the fluid state at all times, they are subject to varying degrees of error, and even to complete failure, when used in very dense media such as heavy crude oil, which tend to thicken or congeal at low flow rates. In these situations the high density or viscosity of medium substantially inhibits the response of the mass to variations in the flow rate and, in extreme cases, actually prevents the mass from returning to its rest position even after all flow has ceased.

The principal object of the subject invention is the provision of means for maintaining such media in a fluid state in a region adjacent the mass in order to allow the mass to move freely through the medium in response to changes in its flow rate. This is accomplished by introducing sufficient heat into the medium in the operational path of the mass to maintain the medium along and adjacent to this path in the fluid state.

As will be observed, the means employed do not require that the entire body of the medium be heated to the fluid condition; and it is a second object of this invention to provide such means which will allow a mechanical flow switch to remain operative even after the body of the medium surrounding it has become hard.

The invention may take the form of a number of embodiments, but basically they employ means for heating the mass itself, the conduit through which the medium is flowing, the structure supporting the mass, or a combination of these. Accordingly, another object of the invention is the provision of such heating means.

Still another object is the provision of a heated mechanical displacement type flow switch of the class described which can be manufactured and installed inexpensively, which will offer a minimum of maintenance problems, and which will function effectively through the widest possible range of operating conditions.

Other characteristics and objects of the subject invention will be perceived from an examination of the following specification as illustrated in the accompanying drawings in which:

FIG. 1 is a partially sectional side elevational view of one embodiment of the invention as it is installed in a conduit of rectangular cross section;

FIG. 2 is an enlarged detailed view of the heated pivoted mass shown in FIG. 1, taken in the direction 2-2;

FIG. 3 illustrates another form the pivoted mass of a switch such as that illustrated in FIG. 1 may take;

FIG. 4 is a side sectional view taken through a poppet type switch embodying the subject invention and illustrating schematically an electrical circuit for use with the switch;

FIG. 5 is an enlarged detail of the poppet shown in FIG. 4 illustrating diagrammatically the transfer of heat from the poppet head to the fluid medium;

FIG. 6 is a fragmentary view illustrating another embodiment of the subject invention in a poppet type switch;

FIG. 7 is a side view of another form of poppet type switch embodying the subject invention;

FIG. 8 is a side view illustrating yet another form of poppet type switch embodying the subject invention; and

FIG. 9 is a fragmentary side sectional view of the poppet support in a poppet type switch illustrating the use of hot circulating fluid as the heat source in another embodiment of the subject invention.

Wherever practical to do so the same numeral is used in the several FIGS. to designate the same or like components.

FIGS. 1 and 2 illustrate one embodiment of the subject invention as it may be installed for use in a fluid conduit 11 having a square or rectangular cross section. The arrow designated by numeral 12 indicates the normal direction of flow of the fluid medium through the conduit 11. The switch comprises an external accessory housing 13 mounted on the top of conduit 11 by means of a nipple 14 threaded into an internally threaded boss 15 formed around an opening 16 in the top of conduit 11. A seal 17 formed across the bore of nipple 14 prevents the fluid medium from escaping into chamber 18 which contains a reed switch 19 held in place by supports 21.

A paddle 24 is rotatably mounted on hinge 25 which in turn is supported within nipple 14 to be aligned perpendicular to the direction of normal flow of the fluid medium through conduit 11. A torsional spring 26 is wrapped around hinge 25 and adapted to urge paddle 24 in a direction opposite the normal flow of the fluid medium. A stop 27 or other conventional means may be used to establish a convenient index or rest position for paddle 24. A magnet 28 is affixed to the upper end of paddle 24 above hinge 25. When the paddle 24 is in its rest position magnet 28 lies directly below reed switch 19. Preferably the material of which seal 17 is made is chosen to have a magnetic permeability such that the influence of magnet 28 on the elements 29 of reed switch 19 is greatest when paddle 24 is in this rest position and falls off rapidly when paddle 24 is deflected thereby displacing magnet 28 laterally of reed switch 19.

Fluid flow indicating means responsive to reed switch 19 are connected to reed switch 19 through chamber 18 and may be placed in housing 13 or at some remote location.

In this embodiment of the invention a heating element 33 in the form of a matrix of high-resistance electrical conductors is formed within paddle 24 and connected by conventional means through heater power leads 34 to alternating current power line 35. Paddle 24 is constructed of a heat conducting material and is heated uniformly across both of its faces by the passage of electric current through heating element 33.

In operation with the flow indicator (not shown) calibrated to indicate the absence of the flow in the fluid medium when paddle 24 is at rest against stop 27 and magnet 28 is lying directly below reed switch 19, any flow of the fluid medium through conduit 11 sufficient to overcome the torsional force exerted by return spring 26 will displace paddle 24 in the direction of arrow 12, thereby causing the indicator to reflect such flow. As stated earlier, in specially designed switches utilizing more sophisticated components the amount of deflection can be determined and utilized to measure the rate of flow of the medium through the conduit. When the flow ceases, as long as the medium remains in a fluid state, spring 26 will return paddle 24 to its rest position against stop 27, thereby causing the indicator to reflect this condition. However, if the temperature or other characteristic within conduit 11 should be such as to cause the medium to congeal or harden while paddle 24 was in a deflected position, conventional mechanical displacement type flow switches would continue to show the medium in motion, even though all flow had in fact ceased.

With the subject invention on the other hand, as the rate of flow of the medium past paddle 24 is reduced, an ever greater concentration of the heat given off by heating element 33 and the two faces of the paddle 24 is absorbed by medium which is in contact with, and in the region immediately adjacent the faces of paddle 24. By adjusting the heating characteristics of element 33 and paddle 24 for the particular medium and the worst environmental conditions anticipated, the temperature of the medium in the envelope designated by the numeral 37 adjacent paddle 24 may be maintained sufficiently high to insure that the medium in this region remains in a fluid state.

Thus paddle 24 is at all times able to respond to the flow or cessation of flow in conduit 11, even through the consistency of the medium elsewhere in conduit 11 is substantially solid.

FIG. 3 illustrates another form of paddle 24 for use in a switch embodying the subject invention. Here the paddle 24 is simply a relatively heavy lavalier pivotally mounted on supports 41 in the flow stream indicated by the arrow 12. This type of paddle is particularly useful for applications in which the medium is not flowing through an enclosed conduit, but rather through an open channel or in an open vessel. Supports 41 may take any convenient form to maintain hinge 25 in a fixed position above the flowing medium, and direct reading means such as indicator arm 45 connected to the upper end of paddle 24 above hinge 25 and indicator dial 47 may be used to indicate the presence or cessation of flow in the medium. As an alternative to forming paddle 24 around an internal heating element as shown in the embodiment of FIGS. 1 and 2, the same results may be achieved by attaching a heater 49 to either or both of the faces of paddle 24. Conventional wiring means may be used to connect the heater 49 through heater power leads 33 to the source of either alternating or direct electric current.

FIGS. 4 through 9 illustrate several preferred embodiments of the subject invention in the poppet type mechanical displacement flow switch.

In FIG. 4 poppet 51 is mounted on stem 52 for reciprocating motion in the normal flow path of the fluid medium through intake 53. The upper end of stem 52 is inserted into sleeve 54. Rings 55 may be employed to reduce or eliminate the seepage of fluid and, if necessary, a passage 79 provided so that any fluid trapped in the chamber 56 above the upper end of the sleeve can return unimpeded to the main body of flowing media. Alternatively, in installations in which such seepage is not a significant factor, chamber 56 may simply be ported to the atmosphere.

Flow switch housing 58 is provided with an internal seat 59 adapted to receive poppet 51. An expanding return spring 61 urges poppet 51 downwardly into a rest position against seat 59. Stop 63 formed near the upper end of the bore of sleeve 54 may be provided to limit the upward travel of poppet 51.

Magnet 28 is positioned near the upper end of stem 52 to register with the elements 29 of reed switch 19 which is mounted on the outside of sleeve 54.

Heating elements 33 are formed in the upper end of intake 53 and the throat of flow switch housing 58 surrounding seat 59, and are connected to a source of electrical power. For remote installations this may be a direct current source such as battery 65. When a battery is used the heating circuit is preferably connected through a master switch 66 and elements 29 of reed switch 19.

With spring 61 previously adjusted for the particular flow and environmental conditions anticipated, the flow of the fluid medium through intake 53 will displace poppet 51 upwardly. Reed switch 19 is constructed so that its elements 29 remain closed, allowing current to flow through the heating circuit when master switch 66 is likewise closed, as long as the upward displacement of poppet 51 maintains magnet 28 adjacent reed switch 19. When poppet 51 returns to its rest position on seat 59 magnet 28 is moved out of alignment with reed switch 19, thereby allowing elements 29 to open and break the heating circuit.

As in the case of the embodiments of the invention illustrated in FIGS. 1, 2 and 3, heating element 33 is adapted to maintain the temperature of the medium in the path of the displaced mass (here poppet 51) well above the congealing or solidifying temperature of the medium, thereby allowing the mass to return to its rest position when the flow ceases even though the medium has thickened or hardened elsewhere in the system.

FIG. 5 illustrates the embodiment of the subject invention in which the poppet 51 rather than the intake 53 and flow switch housing 58 is heated. Here the heating element 33 is contained within the body of poppet 51 and is energized by heater power

leads 34 passing through the stem 52 directly to the power supply.

The heating element 33 may also be linked to the power source 95 by means of a magnetic induction device comprising as shown diagrammatically in FIG. 5, secondary coil 91, core 92 and primary coil 93. This arrangement has the advantage of eliminating the need for a direct electrical connection between the heater leads and the power source. This device can also be used to determine the displacement of the poppet and, from this displacement, the flow rate of the media to at least a first approximation.

Whereas in the previously illustrated embodiments of the subject invention either the displaced mass or the body of the switch has been heated, FIG. 6 illustrates an embodiment of the invention in which both are heated. In the device shown here the stem 52 of poppet 51 is supported for reciprocating movement in a sleeve 54 positioned in the path of flow of the medium in intake 53 at the end of support arm 71 attached to the inner wall of intake 53 at the end of support arm 71 attached to the inner wall of intake 53. Expanding return spring 61 urges poppet 51 downwardly toward its rest position on seat 59. Typical means are employed to indicate the displacement of poppet 51 from seat 59 under the influence of the flowing medium.

Heating element 33a is provided in sleeve 54 to heat stem 52 and poppet 51 by conduction. Additional heating element 33b located in the wall of switch housing 58 is adapted to heat the slow moving or halted medium in the region surrounding the upper end of intake 53 and seat 59 through convection within the medium, thus insuring the fluidity of the medium in the region between the underside of poppet 51 and seat 59.

FIG. 7 illustrates a poppet type switch similar to that shown in FIG. 4, but employing a mechanically linked flow indicator 75 connected to the upper end of stem 52 by means of linkage 77 in place of the reed switch 19 described earlier. In this form of the invention the heating element 33 is located in sleeve 54 and heats stem 52 and poppet 51 by conduction. The heat from poppet 51 is transferred to the medium adjacent its upper and lower surfaces through convection within the medium and, as previously explained, maintains the medium between poppet 51 and seat 59 in a fluid condition thereby allowing poppet 51 to move freely to its rest position under the influence of spring 61 when the medium ceases to flow.

FIG. 8 illustrates another embodiment of the invention in which heating elements 33a and 33b are formed in the sleeve 54 through which stem 52 is journaled and the switch housing 58 and the region surrounding poppet 51, respectively.

In this instance, heat is transferred by conduction through the stem 52 and the poppet 51, and at the same time through the housing 58 surrounding the poppet. Thus the medium is heated both from within and without, so that convection currents set up in the medium will insure its fluidity in the path of all of the moveable switch elements. As indicated earlier, either alternating or direct current may be used for heating purposes, and provision may be made for the automatic cutoff of current to the heating elements 33a, 33b whenever poppet 51 returns to its rest position against seat 59.

FIG. 9 illustrates an embodiment of the subject invention employing a hot fluid such as steam or hot water circulating through a jacket 78 formed within the walls of sleeve 54 to heat stem 52 and, through it, poppet 51. By properly designing the water jacket 78 and the hot water intake 81 and return 82, this heating means may be utilized to heat the switch housing 58 as well as poppet 51, thereby allowing the flow switch of the subject invention to be tailored for a variety of applications.

From the foregoing descriptions it will be appreciated that the essence of the maintaining invention resides in the provision of heating means for maintaining the medium in a fluid state in a region adjacent the displaced paddle or poppet, thereby providing for freedom of operative movement of the paddle or poppet through the medium. Although the invention has been described with a certain degree of particularity, it

should be understood that the illustrations chosen were selected only by way of example, and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

I claim:

1. In a fluid flow responsive device having a movable mass element disposed in the flow path of a fluid medium to be displaced by the force of flow resistance in accordance with the existence, variation or cessation of fluid medium flow, wherein said medium has a tendency to thicken or congeal below a given temperature, the improvement comprising:
 a movable mass element having a sensing surface disposed within said flow path to be impinged upon by the flow of said fluid medium;
 means supporting said movable mass element to be displaced in accordance with the force exerted against the sensing surface by the impinging flow from a normal position indicative of the absence of flow;
 indicating means responsive to the displacement of said movable mass element from said normal position for registering the flow of the fluid medium past said movable mass element; and
 heating means mounted in heat exchange relationship with said movable mass element and the volume of said fluid medium in said flow path adjacent thereto to maintain the fluid medium adjacent said movable mass element above

said given temperature.

2. The improvement of claim 1 wherein:
 said heating means is mounted within said movable mass element, and said movable mass element is made of a thermally conductive material.
3. The improvement of claim 2 wherein:
 the heating means comprises an electrically conductive heating element embedded in the thermally conductive material comprising said movable mass element.
4. The improvement of claim 2 wherein:
 said heating means comprises electrical heater elements mounted on said movable mass element in thermal communication with the fluid adjacent said sensing surface.
5. The improvement of claim 2 wherein:
 the heating means comprises heater elements for heating said supporting means, and wherein said supporting means is made of a thermally conductive material in thermal communication with said movable mass element.
6. The improvement of claim 1 wherein:
 said heating means comprises means for heating the volume of said fluid medium in the flow path adjacent said movable mass element.
7. The improvement of claim 2 wherein:
 the heating means comprises an electrical power source, and electromagnetic current induction means coupling the power from said source to said heating means.

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