Oct. 31, 1950 F. R. QUINN 2,528,243

ELECTRIC CONTROL ELEMENT

Filed Oct. 12, 1949

Fig. 2.

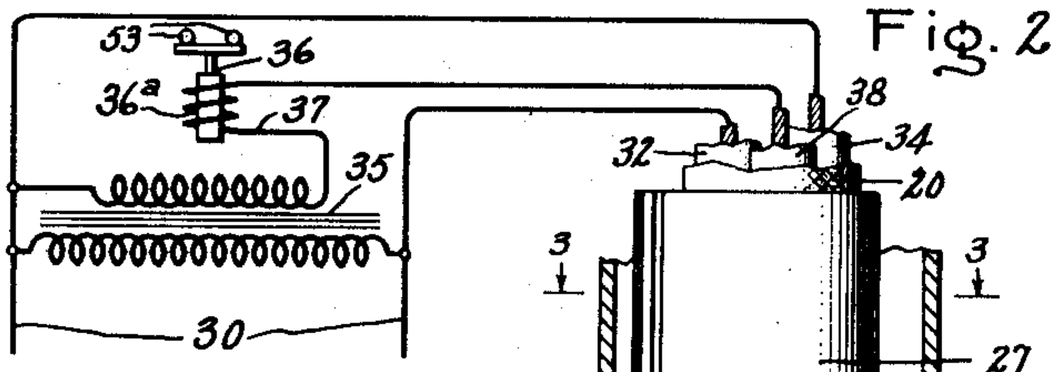


Fig. 1.

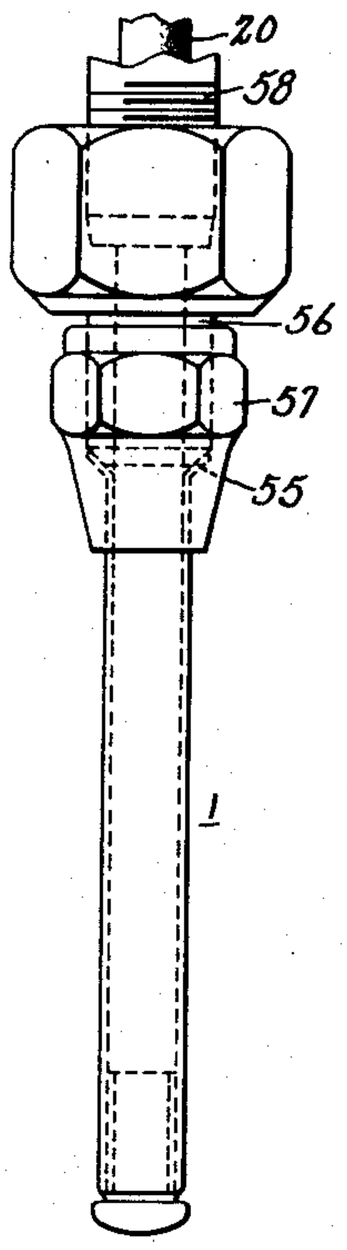
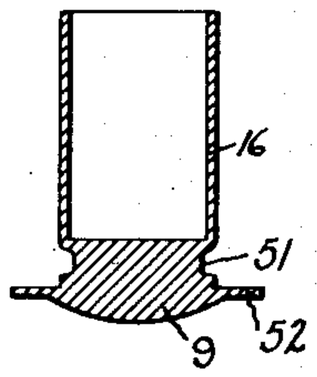


Fig. 5.



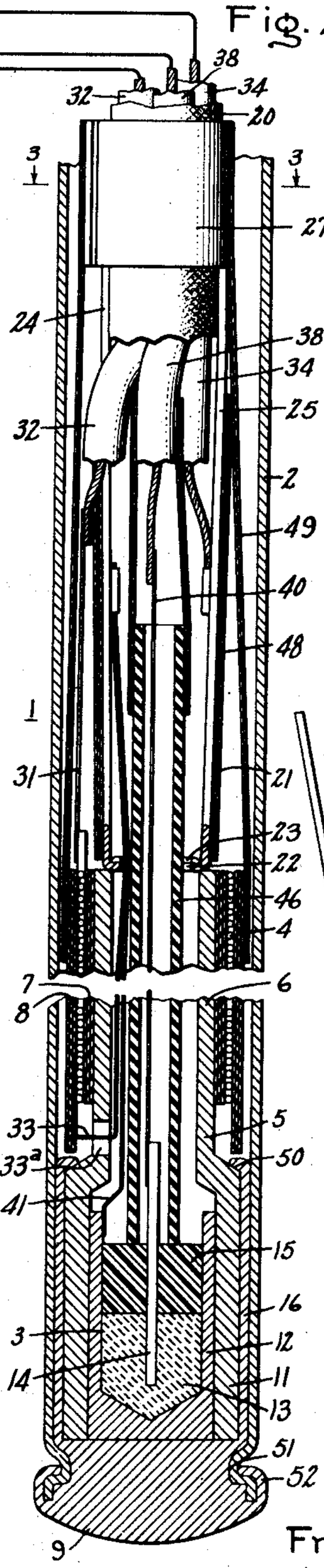


Fig. 3.

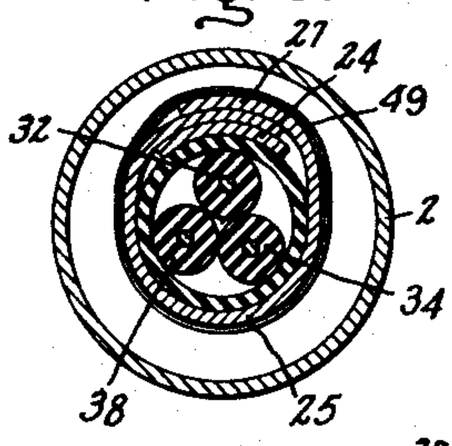
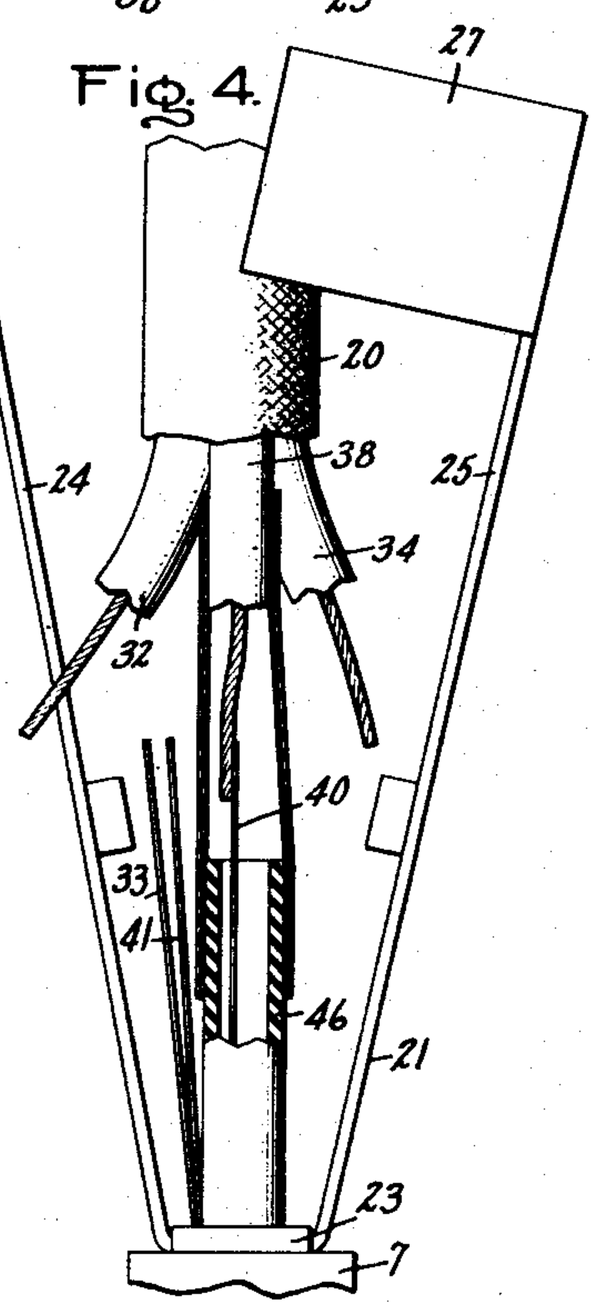


Fig. 4.



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Patented Oct. 31, 1950

2,528,243

UNITED STATES PATENT OFFICE

2,528,243

ELECTRIC CONTROL ELEMENT

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Application October 12, 1949, Serial No. 121,005

6 Claims. (Cl. 201—48)

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The present invention relates to a control element or device responsive to changes in ambient thermal conditions, that is, to changes in ambient temperature or heat transfer conditions. It is specifically concerned with an improved fluid level control device of the thermal responsive type.

A general object of the invention is to provide a new and improved thermally responsive control element of simple, compact and rugged construction which is responsive to changes in ambient thermal conditions.

For additional objects and features of the invention, reference is made to the following detailed description taken in conjunction with the accompanying drawing in which Fig. 1 is an elevational view of the device of the present invention; Fig. 2 is a longitudinal cross-sectional view thereof; Fig. 3 is a sectional view along lines 3—3 of Fig. 2; Fig. 4 is a view of certain components of the device in the partially assembled state; and Fig. 5 is a view of another part of the device prior to assembly.

The embodiment of the invention illustrated in the drawing comprises a metal casing or housing 1 including a metal tube or sleeve 2 and a cap 9, which housing encloses a temperature-responsive resistance element 3 and a heating coil 4. The resistance element and heating coil are supported in heat interchange relationship by a metal tube 5 which is preferably of copper or other metal having good heat transfer properties. The tube 5 which extends concentrically within the sleeve 2 and spaced from the walls thereof, comprises an upper portion 6 about which the heater coil 4 is wound. The coil is insulated from the tube 6 and held in place thereon by means of layers of insulation 7 and 8. For maximum heat resistance the insulating layers preferably comprise glass fiber tape impregnated with an organo-polysiloxane resin.

The lower portion 11 of the copper tube is of somewhat larger diameter than the upper portion and is adapted to contain the element 3. In the illustrated modification, the element 3 comprises a metal cup-shaped case 12 forming one contact and containing a mass of temperature responsive resistance (thermistor) material 13 in which is embedded a second contact in the form of a wire 14. The temperature responsive resistance material 13 is preferably a mixture of metal sulfides of the type described and claimed in my copending application Serial No. 106,293, filed July 22, 1949, and assigned to the same assignee as the present invention. A preferred

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material consists of a sintered mixture of 15 to 35 percent by weight of calcium sulfide, 0.03 to 10 percent molybdenum disulfide, balance silver sulfide. The open top end of the case 12 is sealed by a suitable insulating material 15 such as a heat-hardenable polysiloxane resin. The interior diameter of the lower portion 11 of the tube and the exterior diameter of the case 12 are such that the element snugly fits within this part of tube 5 along most or all of its length. The portion 11 of the tube is in turn enclosed within the cylindrical portion 16 of cap 9, which portion extends a substantial distance within sleeve 2 so that the resistance element is in good heat exchange relationship with a metal cap 9 as well as heating coil 4. By this arrangement heat supplied by the coil 4 to element 3 is dissipated by cap 9 and the adjacent portions of sleeve 2 at only a moderate rate when the cap end of the device is surrounded by air or other gas but at a substantial rate when immersed in a fluid, which term is intended to cover both liquids and finely divided solids such as coal dust, sand, etc.

Three-wire cable 20 provides means for connecting the heater and thermistor element to a source of power and to the remaining components of a suitable control system. The end of the cable extending into the upper end of the housing 1 is secured to the tube 5 by a strain relief member 21. This member, as is shown particularly in Fig. 4, includes an annular center section 22 engaged by a pair of peened-over ears 23 on the upper end of tube 5 and a pair of upwardly extending arms 24 and 25, both of which overlap the outer sheath of cable 20 and one of which has a pair of ears 27 wrapped around the cable in clamping relationship.

One end of heating coil 4 is connected to electric current supply 30 by a conductor 31 spot-welded to the coil and to wire 32 of cable 20 while the other and lower end of the coil is spot-welded to a ribbon conductor 33 which passes through aperture 33*a* in tube 5 and upwardly through the tube with the upper end thereof connected as by spot-welding to arm 24 of the metal strain relief member 21. The other arm 25 of this member is in turn electrically connected to wire 34 which in turn is connected to the current supply 30 to complete the circuit for the heater.

The thermistor element is preferably but not necessarily operated on a low voltage circuit so that the power supply for the circuit including this element suitably comprises the current from the low voltage winding of transformer 35. The control device is in series with coil 36*a* of a relay

36 with the circuit comprising conductor 37 connecting the relay with the transformer, wire 38 of cable 20 connected through ribbon conductor 40 to the center contact wire 14 of the thermistor element 3, and ribbon conductor 41 connecting the case 12 of element 3 to arm 24 of the stress relief member 21 which in turn is electrically connected through conductor 34 to the transformer 35.

Additional features of construction of the device will best be understood from a consideration of the manner in which it is assembled.

Heater coil 4 is first wound on the upper portion of tube 5 and leads 24 and 31 attached to the ends of the coil. The strain relief member is then connected to the upper portion of the tube by peening-over ears. The thermistor element 3 with ribbon leads 40 and 41 attached thereto is then inserted into the bottom portion of tube 5 with a glass insulating tube 46 surrounding the center lead 40 and extending upwardly through the top of the tube 5. Heater coil connector 33 and thermistor lead 41 are spot-welded to arm 24 and lead 40 connected to wire 38. A glass fiber tape sleeve wound between glass tube 46 and the insulation on wire 38 completely insulates lead 40 from adjacent parts of the device. The strain relief member 21 is then secured to cable 20 by wrapping ears 27 about the cable and a second layer or sleeve 48 of glass fiber tape applied about the lower portion of the strain relief member to enclose part of this member and wires 34 and 38 leaving conductor 32 outside the sleeve to permit connection thereof to heater lead 31. A final insulating layer 49 of glass tape is then applied from the heater coil insulation 8 upwardly to enclose all of the strain relief member 20.

This assembly is next inserted into sleeve 2 until the lower end of the tube 5 extends beyond the lower end of the sleeve. After applying a layer of varnish such as a polysiloxane resin varnish to the exterior surface of the portion 11 of tube 5, cap 9 originally having the construction shown in Fig. 5 is slid over this portion and anchored thereto by upsetting the rim of part 16 of the cap over the shoulder 50 on tube 5. A coating of resin is then applied to the outer surface of the cylindrical part 16 and the cap inserted into the sleeve. To seal the sleeve and cap, the lower rim of the sleeve is spun into recess 51 of the cap and flange 52 of the cap spun back over the sleeve to provide a pressure-tight joint, as shown in Fig. 2.

As thus assembled, the control device is adapted to be connected by means of its flared upper end 55 (Fig. 1) to a conical nipple 56 by means of nut 57. The nipple in turn can then be connected to a fluid-tight pipe or conduit 58 of a length suitable to permit suspension of the device into the container holding the liquid whose level is to be controlled.

For most control applications the thermally responsive element preferably comprises a material 13 having a low or zero resistance at an elevated temperature and a high resistance at the temperature of the liquid, the level of which is being controlled. In operating such a device, a constant quantity of heat is supplied to the element 3 by heater coil 4. When the control device is suspended in air as, for example, into a container above the surface of a body of liquid whose maximum depth is to be controlled, the heat from the coil is sufficient to reduce the resistance of material 13 to a minimum so that

relay 36 in series with the element is energized to close or maintain closed contacts 53 of a circuit (not shown) energizing, for example, a motor driving a pump for supplying liquid to the container. When the lower cap end of the device is immersed in the liquid, heat is conducted away from the element and its temperature lowered to a point where its resistance approaches a maximum value sufficient to deenergize the relay, thereby opening the motor circuit and stopping the pump. By employing a thermistor material of the above-mentioned sulfide type and a stainless steel cap for the housing with the cap in direct heat exchanging contact with a substantial portion of the thermistor element, the element reacts very quickly and positively to a change in ambient temperature or heat transfer conditions.

While a specific embodiment has been shown for purposes of illustration, it is obvious that the invention is not limited thereto and the appended claims are intended to cover all such modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A control device responsive to changes in ambient thermal conditions comprising a housing having a closed end portion composed of a heat conducting material, a heat conducting support within said housing and having a tubular end portion in contact with the closed end portion of said housing, a temperature responsive resistance element in said tubular end portion of said support in heat exchange relationship with the closed end portion of said housing and heating means surrounding the upper end of said support.

2. A control device responsive to changes in ambient thermal conditions comprising a tubular housing having a closed end composed of a heat conducting material, a heat conducting tubular member concentrically arranged within said housing and having one end in contact with the closed end of said housing, a temperature responsive resistance element in said one end of said tubular member and in heat exchange relationship with the closed end of said housing, and heating means surrounding the other end of said tubular member.

3. A control device comprising a tubular housing member, a cap of heat conductive material closing one end of said housing member and having a cylindrical portion extending into said housing, a heat conducting support member within said housing, a temperature responsive resistance element supported within one end of said support member in heat exchange relationship with said cap, and heating means adjacent the other end of said support member and arranged to heat said resistance element continuously and at a fixed rate.

4. A liquid level control device comprising a housing including a tubular member, a cup-shaped metal cap closing one end of said member with the walls thereof extending into said member, a metal tube within said housing and having a lower end portion surrounded by and in contact with said walls of said cap, a temperature responsive resistance element within said end portion of said tube and heating means adjacent the upper end of said tube.

5. A liquid level control device for controlling the level of a liquid comprising a housing including a metal sleeve, a metal cap closing one

end of said sleeve and comprising wall portions extending into said sleeve, a metal tube concentrically arranged within said sleeve with the lower end thereof surrounded by and in contact with the wall portions of said cap, a temperature responsive resistance element located within and in contact with the lower end of said tube, heating means surrounding the upper end of said tube for maintaining the resistance element at an elevated temperature, contact of said cap with a liquid serving to cool said element below said temperature.

6. A liquid level control device for controlling the level of a liquid comprising a housing including a metal sleeve, a metal cap closing one end of said sleeve and comprising wall portions extending into said sleeve, a metal tube concentrically arranged within said sleeve with the lower end thereof surrounded by and in contact with the wall portions of said cap, a temperature

responsive resistance element consisting of a sintered mixture of 15 to 35 percent calcium sulfide, 0.03 to 10 percent molybdenum disulfide, balance silver sulfide, said element being located within and in contact with the lower end of said tube, heating means surrounding the upper end of said tube for maintaining the resistance element at an elevated temperature, contact of said cap with a liquid serving to cool said element below said temperature.

FREDERIC R. QUINN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,156,638	Simmons	Oct. 12, 1915