July 16, 1957 W. F. STUMP 2,799,748

THERMOSTATS

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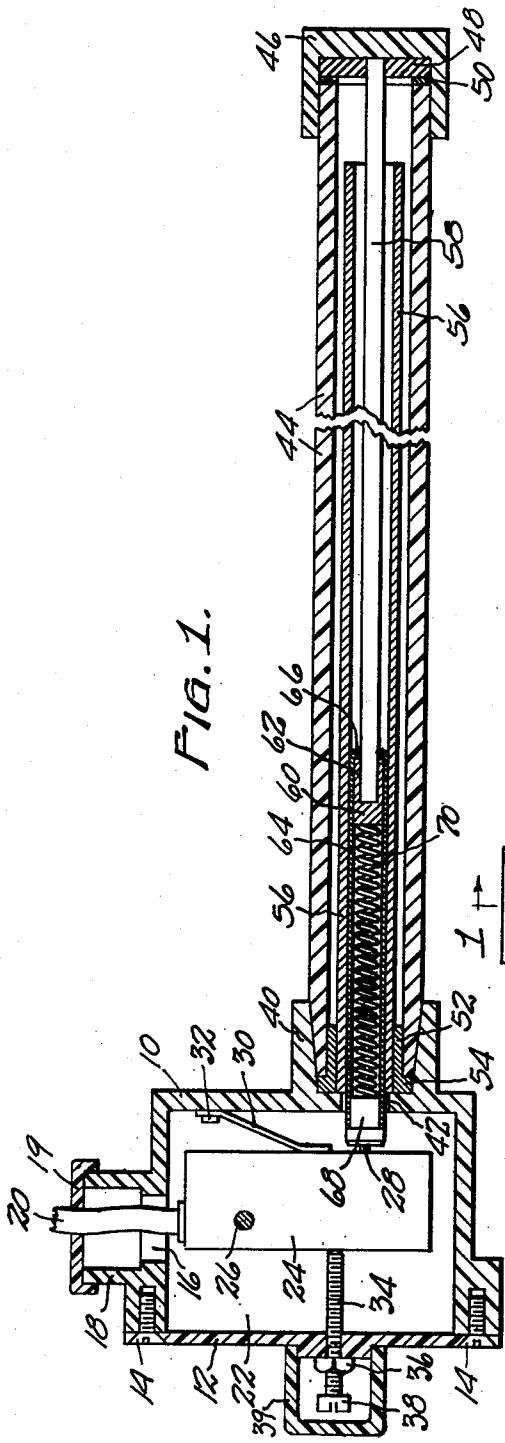


FIG. 1.

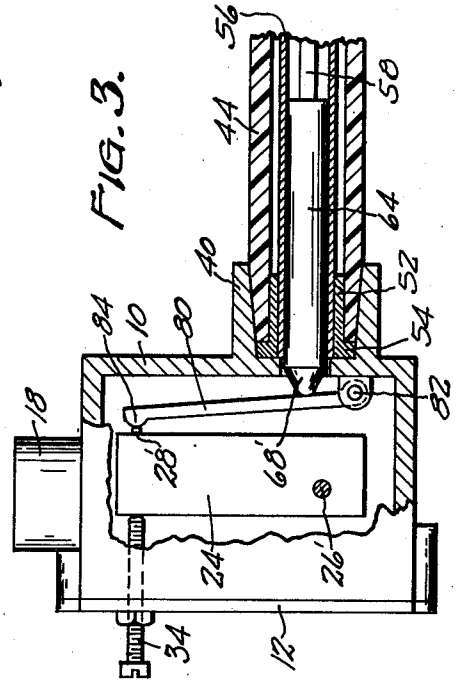


FIG. 3.

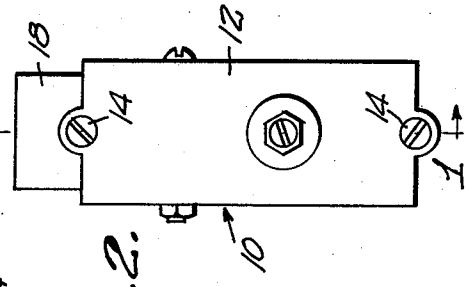


FIG. 2.

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THERMOSTATS

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This invention relates to improvements in thermostats, and more particularly to thermostats of the immersion type intended for controlling the temperature of liquids, such as electroplating solutions and other corrosive baths.

The primary object of this invention is to provide a thermostat of the immersion type having a temperature responsive element exposed to the liquid which possesses a high coefficient of thermal expansion and is capable of withstanding corrosive influences.

A further object is to provide a device of this character which has a compensating spring therein to accommodate a wide range of temperature vibrations without destroying the calibration of the device or endangering breakage of the device due to constriction during cold weather, and which at the same time has a high degree of sensitivity in normal operation, so that it responds to small temperature variations during normal use.

A further object is to provide a thermostat employing a thermoplastic tube having a high coefficient of expansion as a thermally sensitive element, and to locate and mount said tube in the device for direct contact with the liquid whose temperature is to be sensed in order to obtain maximum temperature sensitivity while at the same time avoiding the danger of corrosion of the device by corrosive liquids constituting the bath and avoiding electrical conduction to metal parts of the device from the bath, such as an electroplating bath, in which electrical current flows.

Other objects will be apparent from the following specification.

In the drawing:

Fig. 1 is a longitudinal sectional view taken on line 1—1 of Fig. 2;

Fig. 2 is an end view of the device as viewed from the left in Fig. 1, with caps 19 and 39 removed; and

Fig. 3 is a fragmentary axial sectional view illustrating a modified embodiment of the invention.

Referring to the drawing, and particularly to Figs. 1 and 2 which illustrate one embodiment of the invention, the numeral 10 designates a housing having a removable cover plate 12 mounted thereon and secured thereto by means of screws or other securing means 14. The housing has an opening 16 defined partially by a projecting neck 18, which may be closed by a cap or bushing 19, and which provides for passage of one or more electrical conductors 20 into the chamber or cavity 22 of the device.

A micro switch 24 is mounted within housing 10 and is preferably pivoted eccentrically thereof by the pivot pin 26, so that the portion thereof adjacent to the plunger or actuator 28 thereof is free to swing bodily. The micro switch 24 may be of any suitable type or construction susceptible of quick throw between open circuit position and closed circuit position in response to a minute amount of movement of the plunger of actuator 28 thereof. Any suitable means may be provided for adjusting the position of the micro switch 24 within the housing 10. Thus, as here shown, a spring 30 is secured at 32 to the

housing 10 and bears against the casing of the micro switch at one side of and spaced from the pivot axis 26, and the opposite side of the micro switch casing is engaged by a screw 34, screw-threaded within an opening in the housing 10, as in the cover 12 of that housing. A lock nut 36 may be provided to maintain the adjustment of the screw as desired, and the head 38 of the screw will extend exteriorly of the housing to be readily adjustable. A removable cap 39 may enclose the portion of the screw exterior of housing 10. Thus it will be apparent that adjustment of the screw 34 will alter the pivotal position of the micro switch within the housing 10.

A collar or tubular projection 40 extends outwardly from the housing 10 in concentric relation to housing aperture 42 which confronts and is aligned with the micro switch plunger 28. An elongated rigid tube 44, preferably having a high coefficient of expansion, is mounted in the collar or sleeve 40, as by a pressed or threaded fit. For this purpose the bore of the collar 40 may be tapered and can be serrated, toothed or otherwise formed so that a firm securing anchorage of the parts can be obtained. The tube 44 is of any length desired, and preferably of a length of twelve inches or more.

The tube 44 is formed of a rigid material having a high coefficient of expansion. One such material is "Saran," a thermoplastic resin produced by the polymerization of the vinylidene chloride. Another polyvinyl chloride material which is well suited for this purpose is known in the trade as "Uscolite." These two materials have coefficients of expansion many times greater than the coefficient of expansion of stainless steel and possess the properties of resistance to corrosion in said electrical insulation, and in general possess all properties necessary for use in the present thermostat construction. It will be understood that any other material, such as other thermoplastic resins which possess the properties aforementioned, may also be employed, and that the housing 10 may be formed of such a material or of metal. A cap 46, preferably formed of thermoplastic material having the aforementioned properties is fixedly mounted upon the outer end of the tube 44, as by screw-threading or bonding thereof. A plug or plate 48 seats within the cap 46, and a washer 50 may be interposed between the same and the end of tube 44 for the purpose of insuring an effective seal of the tube end.

A spacer sleeve 52 fits within the tube 44, and has an annular flange 54 pressed against the wall of housing 10 by the end of the tube 44. The sleeve or collar 52 serves as a means to mount or support within the tube 44 one end of an elongated tube 56 which extends for the major portion of the length of the tube 44. Tube 56 serves to impart strength and rigidity to said tube 44 and to guide the movement of the switch actuator to be described hereinafter. Tube 56 is preferably formed of metal and is concentric with the housing opening 42.

An elongated rod 58 of metal or other thermally expansive rigid material, but having a different coefficient of expansion than that of the tube 44, is located within the tubes 44 and 56. Rod 58 is fixedly anchored at one end upon plate or plug 48, as by soldering or screw-threading thereof to the plug. Rod 58 extends in centered relation to the tubes 44 and 56, with substantial clearance in the tube 56. The rod 58 is of a length shorter than the length of the tube 44, so as to terminate spaced from the casing 10. A head 60 is mounted upon the inner or left-hand end of the rod 58 as viewed in Fig. 1, said head preferably including a skirt portion 62 surrounding a portion of the rod 58. The diameter of the head 60 and skirt 62 is preferably uniform externally, and is less than the diameter of the bore of the tube 56.

A tube 64 has a snug sliding fit within the tube 56,

and also has a snug sliding fit around the head **60**. One end of tube **64** has an inturned flange **66** which bears against the inner or right-hand end of the head **60**, **62**, as seen in Fig. 1. The other end of the tube **64** mounts a head or end member **68** which closes the tube **64** and serves to retain therein an elongated coil spring **70** whose opposite ends bear against the head of rod **58**, and the end or cap member **68** of the tube **64**. The force of the spring **70** exceeds the force of the spring (not shown) which presses outwardly the plunger **28** of the micro switch **24**, so that movement of the rod **58** in a direction to trip the plunger **28** of the micro switch will be effective for that purpose after initial contact has been established between the end member **68** and the switch plunger **28**. However, if this movement of the rod **58** continues after the switch plunger **28** has been actuated, and in particular after end member **68** engages a fixed part of the micro switch, the spring **70** will yield to accommodate lost motion of the parts, i. e., sliding of the head **60** within the tube **64** and away from the flange **66** of tube **64**.

In the preferred form of the invention, where the tube **44** is of a highly expansive material and the rod **58** is of a material of lesser expansive properties, it will be apparent that the use of spring **70** will compensate for contraction of the tube **44** when the device is subjected to a temperature condition substantially below that for which it has been calibrated. Thus, the device can be calibrated accurately at the factory for a given temperature range or setting, and then can be shipped in cold weather, i. e., subjected to temperatures much lower than the critical or switch-actuating temperature for which the device has been set, without danger of breakage due to great contraction of the tube **44** compared to that of rod **58**. The same condition offers the further advantage that the thermostat will not be subject to injury or damage of calibration in the event the temperature thereof is not maintained constant during periods when the device is not in use, as during periods of shut-down of a factory or the like. This is of great importance inasmuch as the usual micro switch constructions do not provide means to take up a substantial amount of over-travel. Thus, conventional micro switches do not accommodate a long stroke or throw of an actuator and, particularly, do not have a range great enough when used in a thermostat to take up the contractions occurring upon substantial temperature changes within elongated temperature sensitive members, such as a tube **44** formed of a material having a high coefficient of expansion and of substantial length, for example, lengths of from twelve to thirty inches, or even more. Therefore, by virtue of the lost motion of the switch actuating device and the use of the spring **70**, the present device secures the advantages of great temperature sensitivity due to its elongated thermally expansible parts, and the great accuracy and sensitivity to small motions which characterize a micro switch, without endangering the micro switch when the temperature range for which the device is set exceeded substantially, as during freezing weather or in subfreezing atmospheres.

One of the important characteristics of the device is the fact that the temperature sensitive tube **44** is in direct contact with the liquid whose temperature is to be controlled. This results in obtaining maximum temperature sensitivity in the device. The use of plastic material for the tube **44** and the end cap **46** and other parts permits direct contact thereof with acids and other corrosive liquids, and also insures against electrical conduction of currents from the liquid to the metal parts of the device, such as the metal rod **58**, the tube **56**, and associated parts. The device is thus particularly suited for use in electroplating, and in other acidic solutions, and particularly for liquids operating at temperatures in a range below the softening point of the thermoplastic. In this connection, electroplating solutions commonly operate at temperatures between 120° F. and 140° F., and thermoplastic material is effective for its intended purpose at that temperature range. The operating range of the instrument is approximately from 60° F. to 170° F. or more. The temperature setting of the device is readily controlled by adjustment of the screw **34** to locate the micro switch **24**, so that the latter will operate at the critical temperature selected or desired.

Because of the high coefficient of expansion of the thermoplastic tube **44** compared to that of the rod **58**, and because of the sensitivity of the micro switch, it is possible to control the temperature of a liquid very accurately. Thus, in cases where the tube is submerged in a liquid to a depth of approximately eighteen inches, it is possible by this construction to operate the device with a fixed or maximum differential of about 1° F.

The micro switch **24** may be either of the single throw type of the double throw type. Where a micro switch of the double throw type is employed, the thermostat can be used for either heating or cooling applications, that is, to control the liquid to prevent heating thereof above a predetermined point or oppositely to control the liquid to prevent cooling thereof below a predetermined temperature.

To the best of my knowledge no thermostat has been available for use in acidic or electroplating solutions heretofore. Instead, temperature responsive valve controllers have been employed, the same being of the type requiring a capillary pressure responsive element, such as a Sylphon bellows and a connected capillary tube and bulb. The Sylphon bellows or other pressure responsive elements usually are formed of metal and, therefore, it has been necessary that acid contacting parts thereof be coated or sheathed in lead. This has resulted in a low sensitivity of prior constructions, so that differential temperatures have existed in the order of about 5° F. Applicant's device employing a thermoplastic tube **44** thirty inches in length, immersed for eighteen inches and employing a micro switch responsive to a pressure of approximately one and one-half ounces, has operated satisfactorily with a differential temperature operation of approximately 1° F.

In the modified form of the invention illustrated in Fig. 3, parts similar to those in Figs. 1 and 2 bear the same reference numerals. In this construction, the micro switch **24** is inverted from the position of Fig. 1, so that its pivot axis **26'** is located adjacent to and in substantial alignment with the head **68'** mounted on the tube **64** carried by the rod **58**. The plunger or sensing member **28'** of the micro switch is located remote from the head **68'**, and the adjusting screw **34** is located substantially in alignment with the feeler **28'** of the micro switch. In this construction a lever **80** is pivoted at **82** to the housing **10** adjacent to the head **68'**. The free end of the lever may include a contact portion **84**, such as a rounded head, adapted to contact the micro switch feeler or plunger **28'**. The spacing between the pivot axis **82** and the point of contact with the member **68'** will be much less than the spacing between the point of contact with the member **68'** with the lever **80** and the point of contact of the lever end **84** with the switch part **28'**.

By this construction it is possible to secure, in the thermostat having thermally sensitive elements of comparatively short length, a sensitivity comparable to that of a device employing elements of much greater length. Thus, the lever **80** serves to multiply the movement produced by or occurring at the tip of the member **68'**. Hence, it is possible to operate the device at a very low temperature differential in cases where the physical travel of the member **68'** during such temperature differential is too small to normally operate the micro switch. Observe in this construction also that the spring **30** can be omitted if desired, it being understood that the spring **30** may also be omitted from the Fig. 1 construction if desired.

While the preferred embodiments of the invention have been illustrated and described, it will be understood that changes in the construction may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A thermostat adapted to be immersed in liquid, comprising a housing, an elongated expansible tube secured to said housing, means sealing the outer end of said tube, an elongated member anchored to the tube adjacent to its outer end and extending therethrough with clearance and into said housing, said member including an elongated compressible coil spring, means for positioning said member relative to said tube said member and tube having different coefficients of expansion, a microswitch pivoted in said housing and having an actuating part remote from said pivot axis and engaged by said member, and means for positioning said microswitch in said housing.

2. A thermostat as defined in claim 1, wherein said tube is formed of a thermoplastic material having a high coefficient of expansion and capable of resisting corrosion by acid.

3. A thermostat as defined in claim 1, wherein said elongated member includes a pair of spring pressed parts having a lost motion connection.

4. A thermostat of the immersion type comprising a housing, a micro switch pivoted in said housing and including an actuator part remote from its pivot, an adjustable stop for limiting pivoting of said micro switch in said housing in one direction, and a pair of outer and inner elongated members interfitting with clearance and having different coefficients of expansion, means for positioning said members in selected relation, the outer member being fixed to said housing, and being sealed to prevent entry of liquid therein, and the inner member having a part anchored to the outer free end of the outer member and a second part shiftable relative to said anchored part and an elongated coil spring pressing said second part to a limit position relative to said anchored part, said second part engaging said actuator part to normally press said micro switch against said stop.

5. A thermostat as defined in claim 4, and a spring pressed contact member carried by the free end of said inner part and engaging said actuator part.

6. A thermostat as defined in claim 4 wherein said inner member comprises a rod having a head at its free end, a tube slidably encircling said head, stop means on said tube engaging said head to limit sliding of said tube on said head in one direction, a coil spring in said tube, and a contact member carried by said tube, said contact member being engaged by said spring and pressed against said actuator part.

7. A thermostat as defined in claim 6, and a guide for said tube carried by said housing.

8. A thermostat as defined in claim 4, wherein said outer member is formed of a thermoplastic resin having a higher coefficient of expansion than said inner member.

9. A thermostat as defined in claim 4, wherein said housing and outer member are both formed of acid resisting thermoplastic resin material.

10. A thermostat as defined in claim 4, and a spring carried by said housing and engaging said micro switch opposite said adjustable stop.

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