Feb. 5, 1935. T. J. SMULSKI 1,989,828

ELECTRICAL SYSTEM, APPARATUS, AND METHOD

Filed April 19, 1930

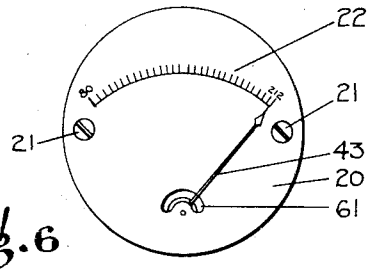


Fig. 6

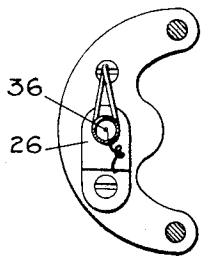


Fig. 7

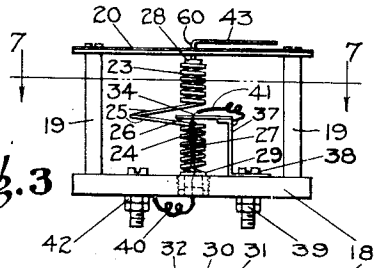


Fig. 3

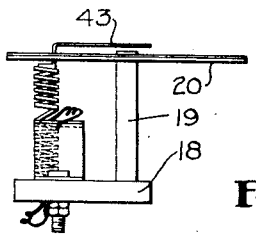


Fig. 4

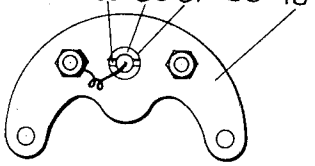


Fig. 5

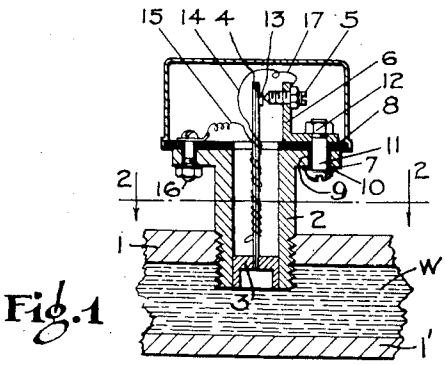


Fig. 1

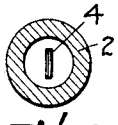


Fig. 2

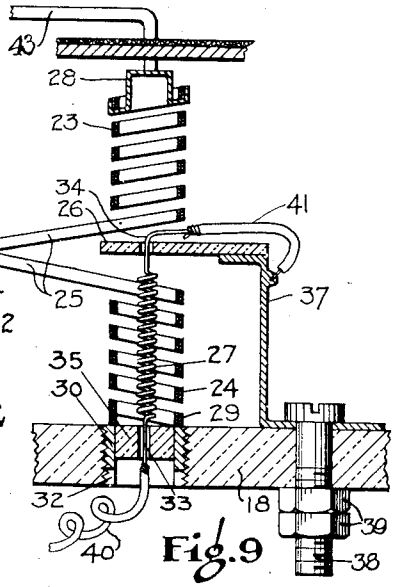


Fig. 9

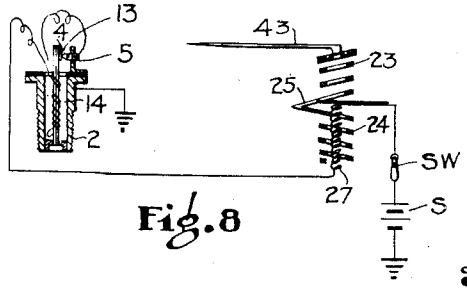


Fig. 8

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ELECTRICAL SYSTEM, APPARATUS, AND METHOD

Theodore J. Smulski, Gary, Ind., assignor to The Anderson Company, Gary, Ind., a corporation of Indiana

Application April 19, 1930, Serial No. 445,649

6 Claims. (Cl. 177—351)

My invention relates to electrical apparatus and particularly relates to electrical apparatus adapted to commensurably reproduce at a given point as a force or movement, forces or movements, existing at another point which may be disposed relatively remotely to the said first point.

Although my invention in its broader phases is susceptible of application to a wide variety of uses, it has a particular use in the indication at a remotely situated point or station of thermal effects, movements of an element, pressure effects or the like occurring at a more proximate point or station, and without requiring the transmission of motion directly between the two stations.

In my prior applications, Serial No. 133,426, filed September 3, 1926, Serial No. 147,076, filed November 8, 1926 and Serial No. 156,054, filed December 20, 1926, I disclosed apparatus of the general type operable in electrical systems for the above general purposes, and the present invention represents improvements in the apparatus and methods of my above said prior applications.

In the controlling and controlled elements of the systems disclosed in my above said applications, separated electrical heating elements are provided, in which an electrically effected temperature is commensurable with the change of energy, force or movement which it is desired to reproduce at the remote point. For instance, in the last listed one of my above said prior applications, where indications of temperature are provided to be effected at a point remote to the controlling element exposed to such temperature, the heating elements are caused to effect temperatures increasing commensurably with the increase of temperature to be indicated and at high temperatures, especially, the electrical heating elements often achieve a temperature considerably in excess of any temperature sought to be indicated.

In order to avoid excessive temperatures being effected by the heating elements, it is necessary to narrow the range of operation and at the same time to avoid difficulties in calibration between the actuating and actuated elements of the system which are often had.

It is an object, therefore, of my invention to provide an improved system for effecting actuation of a remotely disposed actuated mechanism to a degree which is commensurable to energy, force or movement occurring at a more proximate actuating point and which will not require excessive heating of heating elements at the actuating and/or actuated points of my improved system.

Another object of my invention is to provide an electrical system of the above general type wherein the electrical heating element at the actuating end of the system, may under all conditions of actual use maintain a constant temperature.

Another object of my invention is to provide an electrical system of the above general type wherein the electrical heating element at the actuating end of the system, may under all conditions of actual use maintain a constant temperature, and in which this temperature may be one readily achieved for calibration purposes, such as the temperature of boiling water.

Another object of my invention is to provide and improved method of effecting operations of relatively remote mechanisms, commensurable with operations of relatively proximate mechanisms wherein operations of the one mechanism are effected commensurably simultaneously with operations of the other mechanism.

Another object of my invention is to provide an improved system of the above general type wherein a variable temperature at the one mechanism may effect operation commensurably with such temperature at a remotely disposed mechanism in an improved manner.

Another object of my invention is to provide apparatus applicable to the purposes above related which may be manufactured, and preadjusted in an inexpensive simple manner, and which at the same time will be highly efficient in actual operation.

Other objects of my invention and the invention itself will become more apparent by reference to the accompanying specification wherein an embodiment of my invention is described, and in which reference is had to the accompanying drawing illustrating the said embodiment.

In the drawing:

Fig. 1 is a longitudinal medial section of a controlling mechanism which may be employed in a system embodying my invention;

Fig. 2 is a section taken on the line 2—2 of Fig. 1;

Fig. 3 is a side elevational view of an indicator mechanism which may advantageously be employed in the said system embodying my invention;

Fig. 4 is a side elevational view of the indicating mechanism of Fig. 3 taken from a position at right angles to that from which the view of Fig. 3 is taken;

Fig. 5 is a bottom plan view of an insulating mounting plate for the said indicator mechanism;

Fig. 6 is a plan view of the mechanism of Fig. 3, the view showing the indicator dial and movable hand therefor;

Fig. 7 is a section taken on the line 7—7 of Fig. 3;

Fig. 8 is a diagrammatic view of a system employing the controlling and indicator mechanisms of the foregoing figures, and which embodies my invention, said mechanisms being indicated as if in longitudinal medial sectional view;

Fig. 9 is a longitudinal medial sectional view of compensated thermostat mechanism and heating element therefor, together with associated parts relating to the indicating apparatus of Figs. 3 to 7, inclusive.

Referring now to the different figures of drawing, in all of which like parts are designated by like reference characters, the controlling mechanism of Figs. 1 and 2, and as shown diagrammatically in Fig. 8, is illustrated in the form of a temperature responsive controlling mechanism having a tubular support 2 adapted to be screw-threaded, for instance, into a wall 1 of a liquid conduit also having an opposite wall 1'. The conduit may be in the form of a water cooling jacket for an automobile engine, containing water indicated at W between the walls. The tubular support 2 is provided with a plug 3 at its extreme end secured in its bore in a leak proof manner and supporting a strip 4 of laminated bimetallic material. Such material is a common commodity in the trade and is variously known as sheet bi-metal, bi-metallic strips or the like and when made into the form of a strip such as that shown at 4 has the property of becoming deformed from an originally straight form as illustrated to a bowed or warped form upon being exposed to a change of temperature. The strip 4 will be understood as having its sheet metal lamina, which is as shown on the right side of the strip, toward the contact screw 5, of a more thermally expansible material, brass, for instance, than the less thermally expansible material on the opposite side of the strip, nickel steel, for instance.

The contact screw 5 is adjustably mounted on an upright arm of an angular bracket 6 which is secured by a screw 11 and nut 12 to an outwardly extending annular flange 7 at the open end of the tubular support 2 and is insulated therefrom by the centrally perforated insulating disk 8, the bushing 9 and the washer 10 all of insulating material.

With the screw 5 adjusted to merely make but light contact with an electrical contact 13 carried on the free end of the strip 4, when the temperature of the water W is slightly less than a predetermined temperature such as a temperature slightly less than 212°, then upon a slight increase of temperature to 212°, the contact will be broken interrupting the circuit, which will be later explained as being controlled by said contacts.

In the operation of the device described, at some critical temperature, such as 212°, the contacts are open, being closed for all lower temperatures to which a strip 4 is exposed by heat conducted to it by the support 2 and plug 3. An electrical heating resistance consisting of a circuit conductor 14 is wound onto the strip 4, being suitably electrically insulated therefrom and terminates in a conductor 15 which leads to a binding post 16, which is carried on the support flange 7, but insulated therefrom, and a circuit conductor 17, which makes electrical connection with the contact screw 5.

Referring now to Figs. 3 to 7, inclusive, in which a form of the indicating mechanism of the system is illustrated, the parts shown may be mounted on a mounting plate 18 of insulating material. A pair of posts 19 secured to and extending in parallel relation from the support 18 carry a dial plate 20 secured to the posts by screws 21. The dial plate, preferably, is marked with dial indicia 22, some of the spaced marked divisions thereof being provided with numerals, which may, for instance, refer to degrees of temperature, Fahrenheit. The pointer hand 43 is supported by a thermostat comprising a pair of reversely coiled helices 23 and 24, which are integrally joined together by the contiguous ends 25 of the helices disposed in the form of a loop.

The two helices are axially aligned and preferably longitudinally spaced with a baffle plate 26 of heat insulating material, preferably disposed between the two to restrain the flow of heated air from the helix 24 to the helix 23, and from the heating element 27 which is axially disposed within the helix 24 for the purpose of heating it when the device is in operation as later herein described.

The baffle plate 26 is supported on a bracket 37 which is rigidly secured on the insulating base 18 by a screw 38 projected through the base of said bracket and said plate. The nuts 39 on the outermost end of the screw 38 provide a binding post for making connection by circuit conductors with the screw 38 and therefore with the bracket 37 to which a terminal of the heating element 27 is permanently connected.

The pointer 43 is secured to the outermost coil of the helix 23 in any suitable manner, such as by soldering the disk 28 to the center of which the pointer 43 is affixed, to the outermost convolution of the helix, or by effecting a frictional engagement therebetween. The hand 43 is joined to the disk 28 by a short arm 60 of the hand projected through an arcuate opening 61 of the dial plate. The remote end of the helix 24 terminates in a convolution 29, preferably formed as an annulus and rigidly affixed to a hollow screw 30 which is screwthreaded within the bore 31 of the insulating supporting plate 18.

The heating element 27 is axially suspended within the helix 24, being in the form of a resistance wire helix and is maintained in position by its leading-in wires 33 and 34 projected through the axial bore of a bored insulating plug 35 and an axially disposed aperture 36 of the baffle plate 26.

A preferably copper circuit conductor 40 of substantial gauge and a like circuit conductor 41 are joined to the leading-in wires 33 and 34, respectively, and are respectively connected to the similar binding posts 42 and 39, respectively, the latter through the bracket 37 to which the conductor 41 is preferably connected.

From the foregoing description, it will be understood that the helices 23 and 24 being oppositely wound and alike in the number of their convolutions and other dimensional characteristics and each being formed of a ribbon of bimetallic material, upon changes of temperature will tend to wind or unwind, in a manner well known for such helices, but in opposite directions and to the same degree, whereby for all ambient temperatures, any tendencies toward rotative movement of the hand 43 resulting from such changes of temperature will be thoroughly com-

pensated, each of the helices compensating for the other.

However, only the helix 24 is exposed to the effect of electrical heating, being provided with the electrical heating element 27 axially telescoped within it, and heat therefrom being substantially prevented as by the guard 26 from reaching the helix 23. When the heating element 27 is energized, the helix will tend to unwind to produce a rotative movement of its arm 25 and therefore of the carried helix 23 which supports the hand supporting disk 28. As a result of this electrical heating action, the hand 43 will advance along the scale 22 toward the left from its starting position at the right side of the dial.

In calibrating the instrument, should it be found that the heating helix 27 produces more than the predetermined amount of heat, and therefore deflects the needle 43 to an excessive degree, the portion of the helix 27 disposed within the thermostat helix 24 may be reduced by grasping the circuit conductor 40 with a suitable tool and pulling the leading-in wire 33 to draw some of the wire of the heating element 27 into and/or through the bore of the insulating plug 35 to reduce the length of the heating element disposed within the thermostat helix. Such an adjustment may be employed where great accuracy is required and as a final adjustment.

The helix 27 is preferably wound with considerable closeness between the successive convolutions which are of a small diametrical dimension so that the mass of the heating element per cubic inch of space occupied is relatively large. This arrangement is conducive toward providing a substantial amount of heat storage capacity in the helix 27, whereby the helix will not rapidly lose its heat between impulses of heating electrical current directed through the helix.

Referring now to the diagrammatic representation of the system as shown in Fig. 8, the method of operating the embodiment of my invention disclosed herein will be readily understood. Assuming that the threaded end of the support 2 is immersed in water W, Fig. 1, of an automotive engine water cooling jacket and therefore is maintained substantially at the temperature of such water and changes its temperature in accordance with changes of temperature of the water, such a temperature will be communicated to the fixed end of the bi-metalic strip 4 and will so warp the strip as to move its free end which carries the electrical contact point 13 toward the left, that is, to break the electrical circuit between the contact 13 and the contact point supported by the end of the contact screw 5.

In view of the adjustment given the parts, it will be assumed that such breaking of the contacts can only occur when the threaded end of the support 2 achieves a temperature of approximately 212°, Fahrenheit. For any lesser temperature of the support 2, except for electrically produced heat, as later related, the contacts 13 and 5 would remain in engagement to close an electrical circuit therebetween and in which electrical circuit there is serially included the source of current S, the indicator heating element 27, the controlling mechanism heating element 14, and the engaged contacts 13 and 5.

However, closure of such a serial circuit by the engaged contacts 13—5 will effect a flow of current from the source S, simultaneously through the heating elements 27 and 14 with the result that the thermostat elements comprising the helix 24 at the indicator and 4 at the controlling mechanism will be energized, with the result that the strip 4 will accumulate heat, and as it accumulates heat, it will be deformed, to warp its free end toward the left, as shown in Figs. 1 and 8, to withdraw its carried contact 13 from engagement with the contact screw 5, thus breaking the said energized circuit.

Immediately after this occurs and before the contacts have been greatly separated, heat will be lost from the strip 4 and it will tend to be restored to its form wherein the contacts 13 and 5 are again in engagement, whereupon reheating of the two heating elements will occur and the cycle will be periodically repeated ad infinitum, so long as the electrical switch, shown at SW is closed. The result of the periodic energization of the heating element 27 is that it will achieve a given temperature and will be maintained approximately at such temperature as will also the thermostatic helix 24 heated by it. These parts lose their heat but slowly and therefore will not lose a substantial amount of heat during non-heating intervals wherein no electrical current is flowing through the heating elements.

Therefore the hand 43 will be advanced toward the left to such a position on the scale 22 as is commensurable to the square root of mean square value of the current impulses passing through the heating element 27 and the hand will not vibrate noticeably responsive to the timing of the impulses due to the heat storage effected by the elements 24 and 27.

The connecting loop 25 being relatively long and slender will communicate but little heat from the thermostat 24 to the thermostat 23, so that the thermostat 23 will but slightly oppose the effect of the thermostat 24 on the hand 43.

In order to convey a full and clear understanding of the foregoing description of the apparatus and the foregoing operation of the system of my invention, it may be stated that whenever, due to a decrease in temperature of the tube to substantially below that of boiling water, the contacts 13—5 will be closed and then periodically slightly reopened and reclosed in order to electrically supply the deficiency of heat to the thermostat 4, which is not supplied by the water W acting through the support 2, to bring the temperature of the thermostat 4 up to 212°.

It may also be explained that in no case does the temperature of the element 4 resulting from the sum of the heating effects of the water and the electrical current produce a temperature in the thermostat 4 substantially in excess of 212°.

Conversely, the sum of such heating effects is never substantially less than 212°. In other words, when little heat is supplied by the water W, a correspondingly greater amount of heat is supplied by the heating element 14, and should the temperature of the support 2 become in excess of 212°, then in such case, the indicator hand 43 will rest in its normal position adjacent the temperature of 212°, and only upon a subsequent cooling of the support 2 below that of 212° will the hand advance toward the left to indicate such lower temperature.

Having thus described my invention, I am aware that numerous and extensive departures may be made from the embodiment herein illustrated and described and that the apparatus described herein may be adjusted and calibrated to operate over different temperature ranges than that herein described, but without departing from the

spirit of my invention, which is applicable to many and widely varied uses.

I claim:

1. The method of remotely effecting a manifestation, continuously quantitatively related, substantially at all times, to the temperature of a heated body receiving heat from a variable source of heat, consisting in variably supplying heat to the body to cause it to approximately maintain a predetermined high temperature and simultaneously communicating heat to a remote heat responsive element in amounts always substantially commensurable to the amounts of heat required to be additively supplied to the body to increase its temperature to achieve the said predetermined temperature.

2. The method of remotely indicating the variable temperature of a heated body consisting in continuously communicating heat therefrom to an element which is thermally responsive according to its temperature, and in maintaining the element substantially at an average predetermined maximum temperature by continuously independently supplying heat thereto in addition to the heat received thereby from the body, at such rates as are required to maintain the element at said maximum temperature, and simultaneously supplying energy at rates commensurable to the rates at which the additional heat is independently supplied to said thermally responsive element as above related, to a remotely disposed electro-responsive indicating element.

3. The method of remotely effecting a manifestation, continuously quantitatively related, substantially at all times to the temperature of a heated body receiving heat from a variable source of heat, consisting in continuously communicating heat therefrom to an element which is thermally responsive according to its temperature, and in maintaining the element substantially at an average predetermined maximum temperature by continuously independently supplying heat thereto in addition to the heat received thereby from the body, at such rates as are required to maintain the element at its said maximum temperature, and simultaneously supplying electrical energy in amounts commensurable to the amounts of additional heat independently supplied to said thermally responsive element as above related, to a remotely disposed electro-responsive element.

4. In an electrical indicating system, a pair of separated thermostats, a set of electrical contacts under the control of one of said thermostats, an indicator mechanism operable by the other thermostat, a pair of separated electrical heating elements, one for each of said thermostats, means to communicate heat from a variable source of heat to the first thermostat, a source of current, and electrical circuit conductors interconnecting said source, said heating elements and said contacts to effect a flow of current from said source to both said heating elements to effect energization thereof under the common control of said contacts, said first thermostat being thermally responsive to the total heat accumulatively received from said variable source of heat and from its associated electrical heating element, to operate said contacts to effect a change in the flow of current through both said elements and to cause consequent reduction of the heating effect of the heating element of the first thermostat when said first thermostat is heated to a predetermined maximum contact operating temperature.

5. In an electrical system, a pair of separated thermostats, means to communicate heat from a variable source of heat to the first thermostat, a set of electrical contacts under the control of one of said thermostats, a mechanism operable by the other thermostat, a pair of separated electrical heating elements, one for each of said thermostats, a source of current, and electrical circuit conductors interconnecting said source, said heating elements and said contacts to effect a flow of current from said source to both said heating elements to effect energization thereof under the common control of said contacts, said first thermostat being thermally responsive to the total heat accumulatively received from said variable source of heat and from its associated electrical heating element, to operate said contacts to effect a change in the flow of current through both said elements and to cause a consequent reduction of the heating effect of the heating element of the first thermostat when said first thermostat is heated to a predetermined maximum contact operating temperature.

6. In an electrical system, a pair of separated thermostats, means to communicate heat from a variable source of heat to the first thermostat, a set of electrical contacts under the control of one of said thermostats, a mechanism operable by the other thermostat, a pair of separated electrical heating elements, one for each of said thermostats, a source of current, and electrical circuit conductors interconnecting said source, said heating elements and said contacts to effect a flow of current from said source to both said heating elements to effect energization thereof under the common control of said contacts, said first thermostat being thermally responsive to the total heat accumulatively received from said variable source of heat and from its associated electrical heating element, to operate said contacts to substantially interrupt the flow of current through both said elements and to cause a consequent reduction of the heating effect of the heating element of the first thermostat when said first thermostat is heated to a predetermined maximum contact controlling temperature.

THEODORE J. SMULSKI.