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S. A. STEVENS ET AL

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THERMOSTATIC APPARATUS

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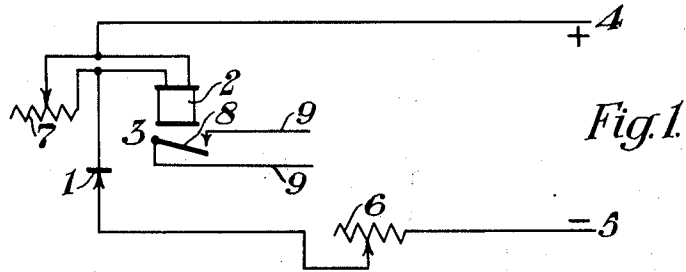


Fig. 1.

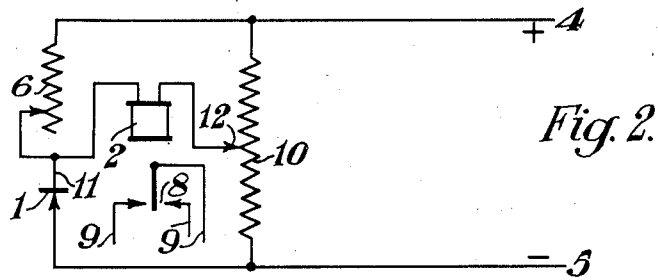


Fig. 2.

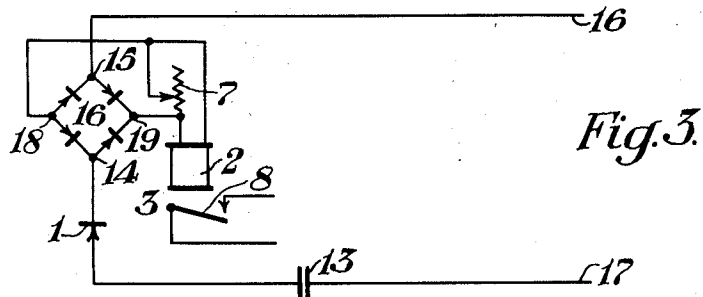


Fig. 3.

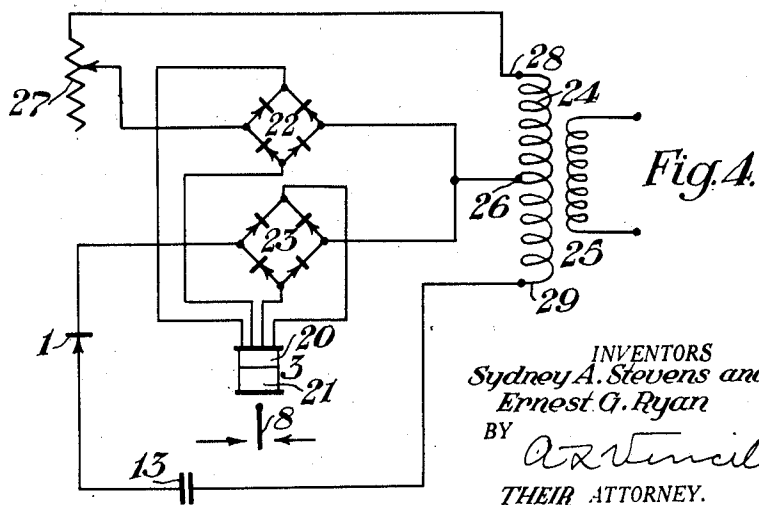


Fig. 4.

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THERMOSTATIC APPARATUS

Application filed August 23, 1932, Serial No. 630,066, and in Great Britain June 22, 1931.

This invention relates to thermostatic apparatus of the kind adapted to control the flow of current in an electric circuit in accordance with the temperature to which the thermosensitive device of the apparatus is subjected and has for its object to provide improved apparatus of this character.

The invention utilizes the fact that the resistance of a current rectifying element composed of a metal compound in contact with a metal varies in response to variations in temperature, this variation in resistance being particularly marked in the case of current traversing the element in the reverse or high resistance direction of flow.

According to the principal feature of the invention the thermostatic apparatus essentially comprises a thermosensitive element comprising a rectifying element composed of a compound of a metal in contact with a metal, this element being included in circuit with a suitable source of electric current and a relay, indicator or other electrically operated or controlled device.

The invention is illustrated by way of example in the accompanying drawing of which Figs. 1 and 2 are diagrammatic views showing two direct current circuit arrangements embodying the invention, Figs. 3 and 4 being similar views of alternating current circuit arrangements also embodying the invention.

Referring now first to the arrangement of Fig. 1 it will be seen that a thermosensitive element 1 consisting for instance of a copper body having a layer of cuprous oxide formed directly thereon is connected in series with the energizing winding 2 of a relay 3 across the terminals 4, 5, of a source of direct current in such a manner that current from the source will traverse the element 1 in its high resistance direction. An adjustable resistance 6 is also connected in the circuit so as to enable the voltage impressed upon the element 1 to be adjusted as desired and thus to effect the operation of the element under suitable conditions as regards its electrical and thermal characteristics.

An adjustable resistance 7 is also preferably connected in parallel with the relay winding 2 for the purpose of adjusting the

energizing current traversing this winding and thereby causing the relay 3 to be operated at any desired temperature.

In operation the voltage impressed upon the thermosensitive element 1 is adjusted by means of the adjustable regulating resistance 6 so that at the normal temperature to which the element 1 is subjected the resistance of the element will be decreased to the maximum or desired extent for a given increase in temperature.

The adjustable regulating resistance 7 is also adjusted so that at the normal temperature the current traversing the relay winding 2 will be insufficient to cause its operation while when the required predetermined increase of temperature has occurred the relay 3 will be operated to effect any desired action or indication. The contacts 8 of the relay 3 are shown as connected to circuit conductors 9 so as to effect the control of any desired indicating or other electrically actuated device connected to the conductors 9.

Referring now to the modified arrangement shown in Fig. 2 the thermosensitive element 1 is connected in series with an adjustable regulating resistance 6 to the terminals 4, 5, of the source of direct current, another resistance 10 being connected across these terminals. The relay winding 2 is in this case connected between the junction 11 of the regulating resistance 6 and the thermosensitive element 1 and an adjustable contact 12 adapted to engage with any desired point in the resistance 10, so as to constitute a bridge circuit.

In operation the contact 12 is so adjusted that at the normal temperature at which it is desired that the relay 3 should be inoperative the point 11 and the contact 12 to which the relay winding is connected are points of equal potential in the bridge circuit. An increase or decrease of temperature will evidently cause a corresponding current to flow in one direction or the other through the relay winding 2 and by the adjustment of the regulating resistance 6, the relay 3 can thus be caused to operate at any desired variation of temperature from the normal.

Since the direction of flow of current will

depend upon whether the variation in temperature is above or below the normal value it will generally be necessary for the relay 3 to be of the polarized type as illustrated 5 so as to indicate the nature of the variation or to cause any desired action to correct the change in temperature. In cases in which an increase only or a decrease only in temperature is required to effect the operation 10 of the relay, the latter may take the form of a neutral relay having a current rectifying device suitably connected in series with the energizing winding of the relay.

Referring now to the alternating current 15 arrangements shown in Figs. 3 and 4 a condenser 13 of suitable capacity is preferably connected in series with the circuit of the thermosensitive element 1 so that the R. M. S. value of the alternating current traversing 20 the element 1 and the condenser 13 is equal to twice the R. M. S. value of the reverse current flowing through the element 1 during the reverse half cycle only. By means of condenser 13, the voltage across element 1 25 is adjusted to a value which results in a substantial current ratio, such as above, and furthermore, the use of condenser 13 aids to increase the temperature sensitivity of the system through the neutralizing effect upon 30 the inductance of relay 3 and the resulting improvement in the power factor of the circuit which includes the thermosensitive element.

In the arrangement shown in Fig. 3 the 35 input terminals 14, 15 of a full wave rectifier 16 preferably of the dry metal compound type are connected in series with the thermosensitive element 1 and the condenser 13 across the terminals 16, 17, of the source of 40 alternating current, the output terminals 18, 19 of the rectifier being connected to the relay winding 2 in parallel with an adjustable regulating resistance 7. The relay 3 is thus operated by rectified alternating current 45 supplied from the full wave rectifier 16 as will be readily understood without further explanation.

In the arrangement shown in Fig. 4, the 50 relay 3 is of the differential type provided with two energizing windings 20, 21, the winding 20 being connected to the output terminals of a full wave rectifier 22, and the relay winding 21 being connected to the output terminals of a full wave rectifier 23. Alternating current is arranged to 55 be supplied to the relay 3 from secondary winding 24 of a transformer 25, the winding 24 being provided with a central tapping 26. The input terminals of the rectifier 22 are 60 connected in series with an adjustable regulating resistance 27 between the terminal 28 of the transformer winding 24 and the central tapping 26, while the input terminals of the other rectifier 23 are connected in 65 series with the thermosensitive element 1 and

the condenser 13 between the central tapping 26 and the other terminal 29 of the transformer secondary winding 24.

With this form of apparatus the relay 3 as 70 in the case of the apparatus for direct current operation illustrated in Fig. 2 is rendered operative in one direction or the other in the event of a temperature variation above or below the normal temperature.

So long as the thermosensitive element 1 is 75 maintained at the normal temperature the currents supplied to the two windings 20, 21, of the relay 3 from the corresponding rectifiers 22 and 23 will be equal and opposite to one another so that the relay 3 is inopera- 80 tive. In the event of a temperature variation, however, the current in one or the other of the relay windings 20, 21, will predominate and the relay 3 will be rendered operative in a corresponding direction. 85

In a modification of the apparatus shown in Fig. 4 the circuit including the thermo- 90 sensitive element 1, condenser 13 and the input terminals of the rectifier 23 are arranged to be connected to the terminals 28, 29 of the transformer 25, the other circuit including the regulating resistance 27 and the input 95 terminals of the rectifier 22 being connected to the same transformer winding terminals 28, 29 so that the central tapping 26 is unnecessary. The operation of this arrangement is substantially the same as that of the 100 apparatus of Fig. 4 and will be obvious without further explanation.

The invention is evidently not limited to 105 the particular arrangements described and illustrated by way of example which may be varied in many respects without exceeding the scope of the invention.

Having now particularly described and as- 110 certained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:

1. In thermostatic apparatus of the kind 115 described, the combination with a thermosensitive element which comprises a copper oxide rectifier, a circuit including a source of alternating current and said element and a relay, and a condenser included in said circuit for neutralizing the inductive reactance 120 of said relay whereby a small change in the resistance of said element due to a change of temperature causes a relatively large change in the current flowing in said relay.

2. In combination, a source of alternating 125 current, a relay having two windings and capable of assuming one or another condition according as one or the other winding is more strongly energized, a circuit for energizing said one winding from said source, and a second circuit for energizing said other winding from said source, said second circuit including a thermosensitive element comprising a 130 copper oxide rectifier and a condenser for neutralizing the inductive reactance of said

other winding whereby a small change in the resistance of said element due to a change in temperature causes a relatively large change in the current flowing in said other winding thus altering the energization of said other winding to cause the relay to assume said one or said other condition.

In testimony whereof we affix our signatures.

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