

Dec. 23, 1952

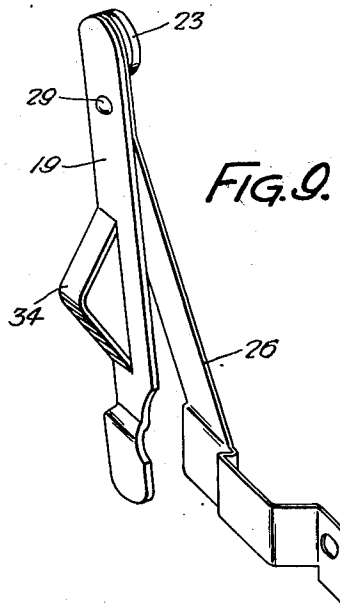
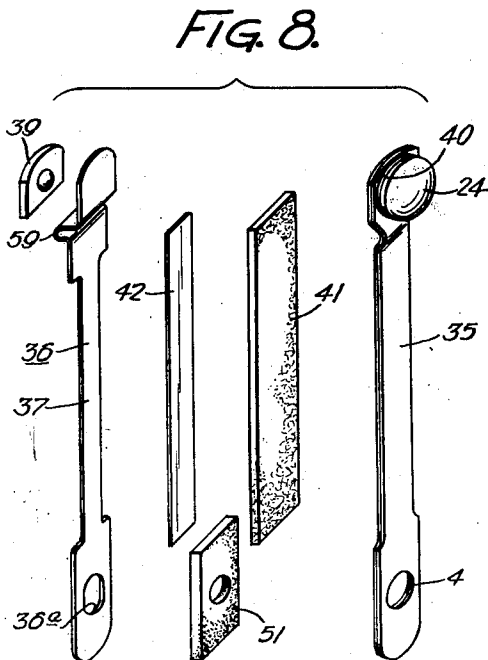
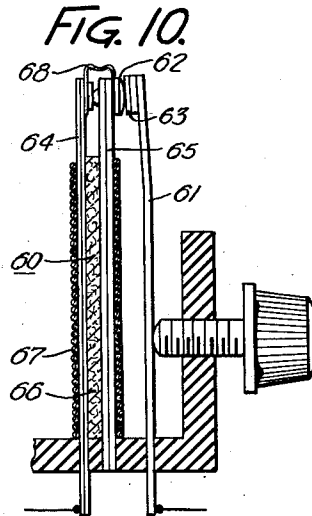
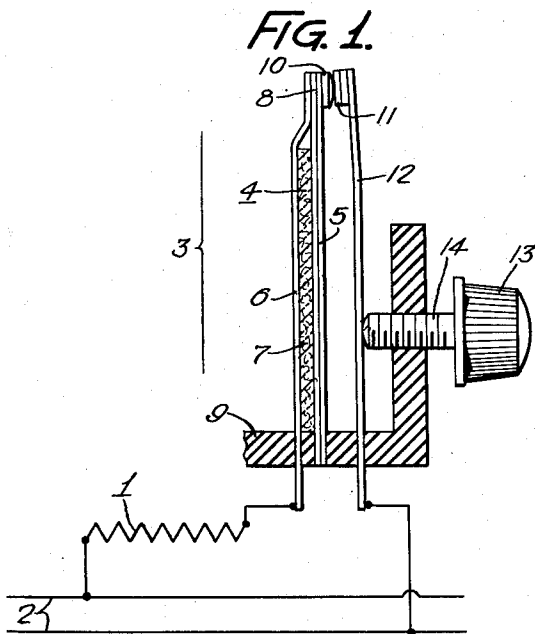
W. H. VOGELSBERG

2,623,137

ELECTRIC SWITCH

Filed April 25, 1950

3 Sheets-Sheet 1



Inventor:-
Walter H. Vogelsberg
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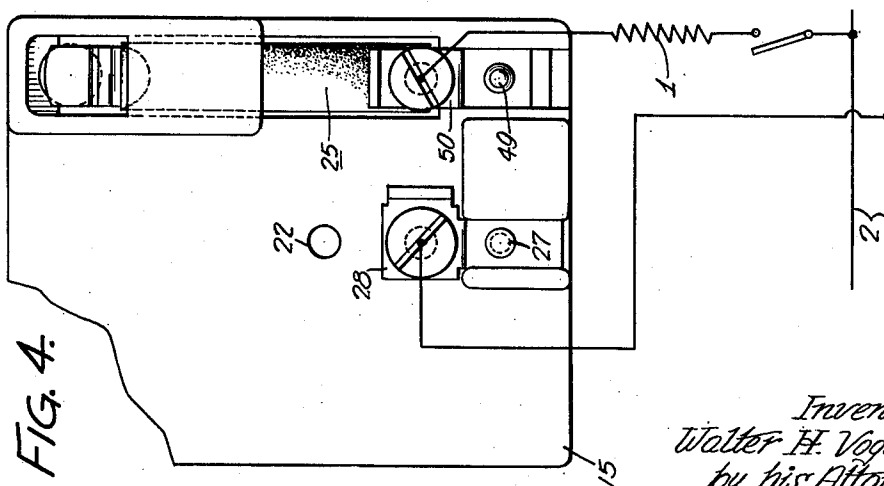
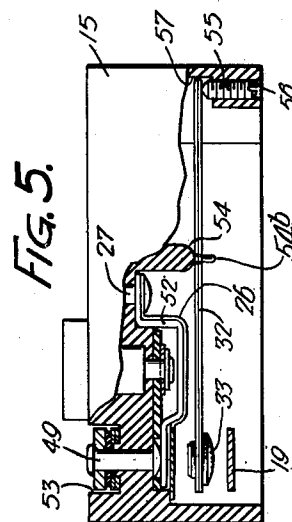
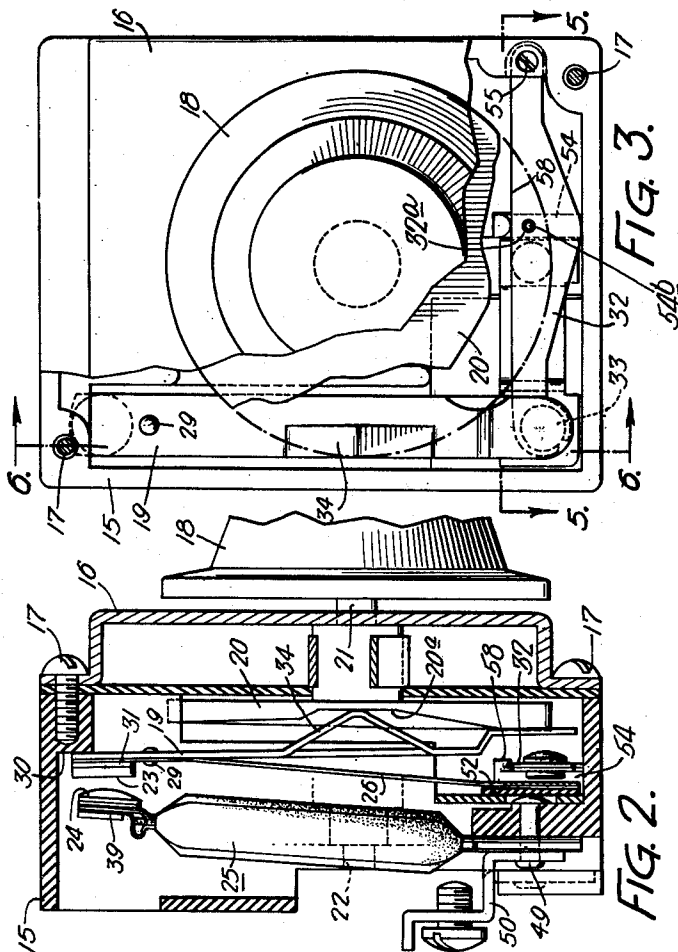
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W. H. VOGELSBERG
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3 Sheets-Sheet 2



Inventor:-
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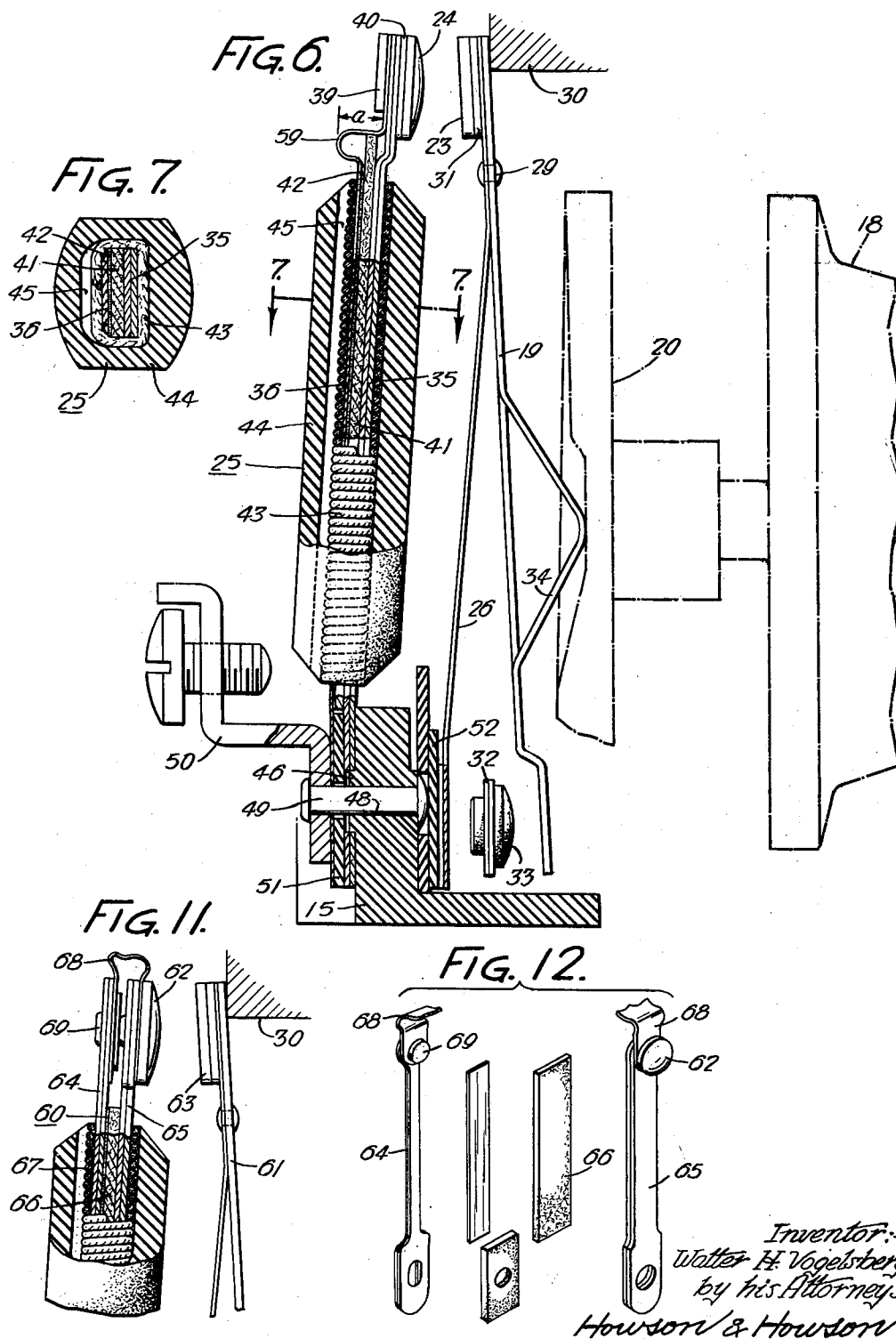
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W. H. VOGELSBERG
ELECTRIC SWITCH

2,623,137

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3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

2,623,137

ELECTRIC SWITCH

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Application April 25, 1950, Serial No. 157,932

18 Claims. (Cl. 200—122)

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This invention relates to a thermally actuated switch device for controlling the wattage input to an electric heating load. The thermally actuated switch is of the type that is remotely located from the load and cyclically opens and closes to supply a predetermined average wattage to said load. The switch is particularly adaptable to the control of heating loads such as a surface unit of an electric range.

Motor-operated devices are available which will control the wattage input to a heating load by cyclically making and breaking the circuit from a supply line to the load at some preselected average rate. To obtain wattages of an increasingly higher magnitude, these devices are arranged to maintain the load energized for a greater percentage of the time, while full wattage input is usually obtained by continuous energization. These devices are usually adjustable for obtaining a continuous variation of input from zero to maximum continuous energization. These devices, however, have disadvantages, for usually they lack compensation for changes in voltage thereby resulting in an error in the average wattage input for the particular setting of the device, and, in addition, they are space-consuming and expensive.

Thermal devices have also been provided for use as wattage input controllers for remotely connected heating loads. These devices are usually inherently self-compensating for changes in line voltage, but when designed to give reliable operation over an extended period of time with controlled and consistent lengths of cycle above a practical minimum value, they usually result in cumbersome and expensive devices.

A primary object of this invention is to provide a novel thermostatic wattage controller that will inherently give long cycles of substantially constant length at a particular setting, will be capable of continuous adjustment from a minimum to a maximum input wattage, and will be of simple compact construction, easy to manufacture, and extremely reliable and consistent in operation.

A further object of the invention is the provision of a novel combination of thermomotive means and circuit elements in said controller which will provide greatly increased contact pressure when the control contacts are first made and will effect a greatly augmented opening when the contacts first separate. This type of action lends toward reliability of contact opening and closing and helps eliminate buzzing or humming and other spurious effects.

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Further objects and features of the invention will be apparent from the following detailed description with reference to the accompanying drawings, wherein:

Fig. 1 is a simplified and diagrammatic illustration of one form of the novel controller and an associated load;

Fig. 2 is a cross-sectional view of a physical embodiment thereof;

Fig. 3 is a front view of the same with portions of the casing structure broken away for the purpose of illustration;

Fig. 4 is a rear view of the device, with the controlled load shown diagrammatically;

Fig. 5 is a partial sectional view taken along line 5—5 of Fig. 3;

Fig. 6 is an enlarged sectional view taken along line 6—6 of Fig. 3;

Fig. 7 is a sectional view taken along line 7—7 of Fig. 6;

Fig. 8 is an exploded perspective view showing the elements of the thermostatic control assembly;

Fig. 9 is a perspective view of the spring mount for one of the switch members;

Fig. 10 is a simplified illustration of a modified form of the invention;

Fig. 11 is a fragmentary sectional view of the modified form; and

Fig. 12 is a fragmentary perspective view of certain parts thereof.

In Fig. 1 there is a diagrammatic showing of a heating load 1, which may be the surface unit of an electric range energized from the line 2 and controlled by a control device 3 as provided according to this invention. This device includes a composite thermomotive member 4 made up of two legs or struts 5 and 6 of materials having different thermomotive characteristics with a strip of thermal insulation 7 disposed between said legs. Leg 5 will be referred to as the primary element and is shown here as a bimetallic element arranged with the high expansion side toward the right. Leg 6, which will be referred to as the secondary element, is a current-carrying member and forms a heater for thermally actuating thermomotive member 4. The two legs 5 and 6 are fastened together at their free ends, as shown at 8, and are rigidly fixed to a support block 9 which may be formed of a suitable insulation material. At the free end of the thermomotive member 4 there is secured a contact 10 which cooperates with an adjustable contact 11 mounted on a flexible current-carrying blade 12 which is also fixed to the supporting member 9. When

the contacts 10 and 11 are engaged, a circuit is established from the supply line 2, through adjustable blade 12, contacts 10 and 11, through heater 6, to the heating load 1 and thence to line 2. When the contacts 10 and 11 are separated, the heating load is deenergized. A control knob 13 or some other suitable manual adjusting means is provided on the control device 4 for selecting the desired input to the heating load. The adjustment is effected by the manipulation of the flexible blade 12 through a screw member 14.

The operation of this particular thermostatic device can be explained by following a typical cycle of closing and opening of the contacts 10 and 11. Assume that the contacts 10 and 11 are separated and that the thermomotive means 4 is cooling. In this condition, the free end of the thermomotive member 4 moves to the right. Upon engagement of contacts 10 and 11, current flowing through the heater leg 6 will cause it to heat rapidly, expand longitudinally and force the free end of the thermomotive member 4 farther to the right. As the leg 6 continues to heat, the bimetal leg 5 will receive heat therefrom and will begin to flex and move the contact 10 toward the left. This motion will continue until the contacts separate, thereby deenergizing the heating load and discontinuing the current supply to the leg 6. Immediately upon separation of the contacts 10 and 11, the leg 6 will quickly cool, contract and so force the thermomotive member 4 farther to the left. Further cooling of the thermomotive member 4 will cause the bimetallic leg 5 to return toward its unflexed position, permit the contacts 10 and 11 to be reengaged and thus start another cycle of operation.

It will be observed that both the bimetal 5 and heater 6 contribute to the thermomotive action of the switch but that the thermomotive effect of the primary element 5 is always arranged to supersede the effect of the secondary element 6. That is to say, the primary element 5 is the more active or more effective in that it always ultimately dominates the action of the secondary element 6 in effecting opening and closing of the switch contacts on heating and cooling respectively. The effect of the additional thermomotive action offered by the heater 6 is to provide a differential between the opening and closing temperatures of the bimetal 5 which in turn effects a greatly increased cycle length. The length of the time cycle is now made up of the undershoot and overshoot of the bimetal plus the increased cycle length due to the action of the heater. It should be noted that if the heater were not mechanically connected with the bimetal, no differential would exist and the entire cycle would consist of the time necessary for the bimetal to overshoot and undershoot.

The utilization of the thermomotive action offered by the heater is considered of maximum importance in the application of this device, and particularly when this device is to be used in conjunction with the flashing or the overenergizing of an electric heating unit so that it can attain its operating temperature quickly. In my copending application, Serial No. 81,938, filed March 17, 1949, systems and devices are shown which utilize a single thermal wattage controller to control the length of the overenergization period and also to control the input during normal energization by cyclically opening and closing of the circuit to the electric heating unit. A wattage controller so adapted must meet many severe

requirements. First, it must possess those features so essential in the application of the device as an ordinary wattage controller; it must be reliable, simple to manufacture, etc., and it must have moderately long cycles. Secondly, to meet the requirement of adaptability to a flashing system as above mentioned, it must heat and cool at substantially the same rate as the heating unit it is controlling. Thus it must be a thermal prototype of the electrical load (i. e., the heating unit) it is controlling. In these flashing systems, the heater for the wattage controller has an energization rate proportional to that of the heating unit. During the overenergization interval, the wattage controller acts to time the duration of the overenergization. When the controller attains a temperature proportional to the desired operating temperature of the heating unit, the contacts open and terminate the flash interval. Thereafter the controller, having a reduced energization rate proportional to the reduced energization rate of the heating unit acts to control the wattage input level to said unit by cyclically opening and closing the circuit thereto. The ability of the wattage controller to track the heating unit thus permits it to act as a safety device if a reflash is attempted, for the temperature which the controller must attain is reduced an amount corresponding to the temperature of the heating unit at the time a reflash is attempted, thereby preventing successive reflashings for extended periods of time which might result in dangerous overheating of the heating unit.

A unique problem is presented when it is desired to provide a thermal controller that will give long cycles as well as have the ability to track the heating unit, without resorting to snap-action switches. To obtain moderately long cycles in the past it was necessary to increase the thermal mass of the switch, thereby increasing the undershoot and overshoot of the associated thermal element in a manner well known in the art. To cause the controller to track the heating unit, it is necessary that the thermal capacity and the thermal dissipative capacity of the thermal element of the controller be of the proper magnitudes. These two requirements are not consistent with one another, it being only a fortuitous combination of circumstances or severe compromises that would permit previous arrangements to be used. However, by using the present invention wherein the thermomotive action of the heater 6 is used to obtain the long cycle independent of the heat storage capacity of the mass associated with the thermal element, wide latitude is permitted in designing a controller with the correct prototype characteristics.

A physical embodiment of the above described form, adapted to a control device of the character disclosed in my copending application Serial No. 157,933, filed April 25, 1950, is shown in Figs. 2 to 9. Only that part of the device involving the present invention need be described.

In these figures, there is shown a control device comprising a control box or casing 15 onto which is fixed a cover member 16 by means of screws 17. A control knob 18 serves to control the position of an adjustable blade 19 through a control cam 20 carried by a shaft 21 which is rotatably supported by cover 16 and the rear of the casing 15 in a pilot hole 22. The adjustable blade 19, a relatively heavy metallic member, has affixed to its free end a contact 23 which cooper-

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ates with a contact 24 affixed to the free end of a thermomotive means 25.

The mounting for the adjustable blade 19 (see Fig. 9) consists of a flexible L-shaped member 26 of a material of good current conductivity and good spring properties (such as an alloy of silicon and copper) fixed to the casing 15 by means of a rivet 27 which also holds a terminal member 28 in position (Fig. 5). The free end of member 26 is riveted at 29 to the adjustable blade 19 and biases the contact 23 toward the normally open position against a shoulder 30 (Fig. 2) on the casing 15 when the controller is in the "off" condition. The contact 23, the member 26, and the adjustable control blade 19 are welded together simultaneously using a steel backing at 31 on contact 23 to facilitate this process. The lower end of the adjustable blade 19 cooperates with the free end of a bimetallic compensator blade 32 through an insulating button 33 mounted thereon to isolate the control blade electrically and thermally from said compensator. Near the center of the adjustable blade 19 is a lanced projection 34 which coacts with the surface of the control cam 20.

The construction and the arrangement of the masses as shown for the component parts of the adjustable blade and mounting 19, 26 have proven quite satisfactory in eliminating excessive vibration prevalent in devices that have extremely flexible contact support members. The construction is also advantageous because it permits a very convenient way of instituting the compensating action and in addition the factory adjustment, which will be explained hereinafter.

It should be mentioned that the details of the cam 20 are described at length in the aforementioned copending application. Of particular interest is the cam program that provides a continuous selection of inputs from some low value to a full 100% input position. In that application the circuit in which the wattage controller is used does not require that the contacts 23 and 24 carry the continuous 100% load, an auxiliary path being provided therefor. The present invention is capable of application to this type of circuit or an arrangement where the contacts are maintained closed by the cam throw to give the 100% input. The cam is further provided with a recessed "off" position at 20a, insuring a generous electrical clearance at this particular switch conditioning.

The thermomotive means 25 (see Figs. 6 to 8) consists of a substantially straight control bimetal 35 and a heater element 36 of high temperature material, such as a nickel chrome alloy, having a narrow section 37 which extends a greater portion of its length. The bimetal 35, the heater element 36, and the electrical contact 24 are welded together using a steel button 39 and a steel backing 40 on the contact 24 to facilitate the welding. Disposed between the heater element 36 and bimetal 35 is an insulating medium preferably comprising a strip of asbestos 41 and a thin layer of mica 42 adjacent the heater element. The strip of asbestos 41 is of substantially greater thickness than the mica strip 42, providing the greater part of the heat storage and heat transmitting functions. The mica strip provides a hard smooth surface to facilitate any relative movement between the heater element and the insulating medium during the cyclic heating and cooling of the thermomotive means 25.

A wrapping of glass cord 43 is placed around 75

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the heater 36, the insulating strips 41, 42 and bimetal 35 to hold these members in fixed spaced relation and to provide a reliable transmission of the forces (due to contraction and expansion of the heater) to the bimetal. This wrapping makes possible the use of a relatively thin heater, for it prevents the inherent buckling that would be evident when such a member is placed in compression. A controlled tension is used when winding the glass cord wrapping to govern the ease of sliding between the heater and the mica strip 42 without permitting separation between the surfaces of these two members due to the aforementioned buckling action.

A sleeve 44 made of heat resistant rubber is placed over the assembly of heater, bimetal, insulating medium and glass cord wrapping, chiefly to control the overall heat storage capacity of the thermomotive means. As mentioned previously, this characteristic is of paramount importance when the device is used in a flashing system. It will be noted from the cross sectional illustration of the sleeve in Fig. 6 that a smaller volume of material is associated with the heater 36 than with the bimetal 35, and that an air space 45 is provided adjacent the heater to allow it to heat and cool rapidly.

The assembly of the thermomotive means onto the casing 15 is shown in Fig. 6. A projection 46 formed on the casing 15 is provided with an outer diameter of such dimension as to accurately receive the control bimetal 35 through a hole 47 provided therein. Concentrically disposed in relation to said projection is a hole 48 to receive a rivet 49, the latter being provided for holding a terminal member 50, the lower part of the heater 36 and an insulator strip 51 onto the casing. The heater 36 is provided with a hole 36a which is elongate in shape to allow for variations in length of the various members due to production tolerances. The rivet 49 is used to hold the heater 36 in non-varying mechanical relationship with the control bimetal 35 and supporting structures without relying on the restraint provided between the rivet and the side of the hole 36a. The insulator strip 51 provides a preset and constant separation between the roots of the heater strip and the control bimetal and in addition acts to electrically insulate one from the other. It will be noted that an insulator strip 52 is interposed between the head of the rivet and the spring member 26 to isolate the latter electrically from the other parts of the thermomotive means, and further that a recess 53 (Fig. 5) is formed in the casing to prevent the thermomotive means from moving in a direction other than in its plane of deflection for securing thermomotive effect.

The mounting for the compensator 32 is shown in Figs. 3 and 5 as having a fixed pivot at 54 and a factory adjusting screw 55 threaded into the casing at 56. The active end of the bimetal compensator, as explained heretofore, coacts with the lower end of control blade 19. The compensator is designed so that the controlled wattage is maintained substantially constant regardless of changes in ambient temperatures to which the device is exposed. The bimetal compensator is disposed with its high expansion side inward, i. e., toward the left as viewed in Figs. 2 and 6. When the general temperature of the device is increased, the free end of the compensator deflects toward the right as viewed in Figs. 2 and 6. The control blade 19 is thereby rotated about the portion 34 which fulcrums on the control

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surface of control cam 20 and so rotates the free end of the control blade toward the left.

The compensator 32 is prevented from movement other than that to achieve the compensating action. A recess 57 provided in the casing, a projection 58 adjacent the fixed pivot or fulcrum 54 and a pin 54b through a hole 32a in the compensator 32 locate the compensator in the lower portion of the casing. The adjusting screw 55 permits control of the controller calibration by varying the position of the lower end of the control blade 19. Thus if the inputs to the heating unit are in excess of what they should be for a particular setting of the control knob 18, it would be necessary to decrease the temperature or deflection at which the control contacts 23 and 24 separate. This would mean that the initial position of contact 23 would have to be disposed farther to the right, as viewed in Figs. 2 and 6, which can be achieved by backing off the adjusting screw 55 thus allowing the compensator to pivot clockwise (Fig. 5) about fulcrum 54, displacing the lower end of the control blade 19 toward the left.

The electrical and thermal operation of this device is similar to that shown diagrammatically in Fig. 1. The current path is through the terminal member 28, through the rivet 27, through the mounting spring 26, the control blade 19, contact 23 and contact 24, through the heater 36, rivet 49 and out through the terminal member 50. The mechanical operation can be followed in Fig. 2. Rotation of the control knob 18 to one of the "on" positions will cause translation of the adjustable blade 19 toward the left with consequent establishment of the circuit through contacts 23 and 24. The adjustable blade is manipulated through the lanced portion 34 and engages at its upper end the contact 24 of the thermomotive means 25, while at its lower end it engages the insulating button 33 of the compensator. During the heating cycle of the thermomotive means 25 the adjustable blade through contact 23 follows the motion of contact 24 until separation is effected. Under this condition and throughout the "off" portion of the cycle the blade takes up an equilibrium position as determined by the cam 20, the compensator 32 and the positioning effect of the mounting spring 26.

Of importance in the design of the thermomotive means 25 is the offset 59 provided on the heater 36. It has been found that this feature constitutes (a) a convenient means for preventing overstress in the heater during its expansion and contraction; (b) a means to vary the amount of mechanical influence of the heater on the bimetal which in turn effects the length of the time cycle; e. g. increasing the offset while still maintaining the spacing between the heater and bimetal the same will decrease the length of the cycle; (c) a means of preventing overstressing of the top fibres of the glass cord wrapping by reducing the lateral force during compression of the heater.

In one particular structural embodiment of this invention, the bimetallic member 35 was made from a material having a high expansion side of 72% manganese, 18% copper, and 10% nickel, while the low expanding side was of Invar. A third layer of nickel was provided between the high and low expansion sides to give a desired low electrical resistance to the entire bimetal. The length from the center line of the mounting rivet 49 to the top of the bimetal was approximately

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2¼", the width along the major portion of the length at .218" while the thickness was .030".

The heater 36 was made from a material composed of 80% nickel and 20% chromium which was annealed after being formed into the shape shown in Fig. 6. The width along the greater part of its length was .096" with a thickness of .005", the effective length of this necked-down portion measuring 1½". The offset dimension "a" as shown in Fig. 6 was ¼". The thickness of the insulating medium was .034" for the asbestos strip 41 and .001" for the mica strip 42. The asbestos was selected from a long fibre stock of .042" in thickness which was subsequently compressed to the aforementioned thickness.

The particular load used with this wattage controller was such as to pass approximately 5 amperes through the heater.

The compensator bimetal 32 was selected from a material having the high expansion side of 72% manganese, 18% copper and 10% nickel, while the low expanding side was of Invar. Its width at the widest point was .340" having a thickness of .022" with an effective length of approximately 1⅞", with the fulcrum at the widest point located about 1⅞" from the center of the button 33.

A modified form of the invention is shown in Figs. 10 to 12 to comprise a thermomotive member 60 and an adjustable member 61 having co-operating contacts 62 and 63 mounted thereon. The thermomotive member of this embodiment comprises two parallel bimetallic members 64 and 65 held in spaced relation and placed with their low expansion sides facing each other. An insulating and separating member 66 is disposed between these bimetallic members and a glass cord wrapping 67 is provided around these members to maintain the mechanical and thermal relation to one another. Electrical connection is ensured between the tops of bimetals 64 and 65 by means of the flexible conductor 68 held under the contact 62 on bimetal 65 and through a rivet 69 to bimetal 64. Aside from the modifications shown the device is similar to the previously described form.

The operation of the thermomotive member 60 is substantially the same as the above-described device, for as the contacts first make, the bimetal 64 which also acts as the heater forces the free end of the primary bimetal 65 farther to the right. The thermomotive action of the bimetal 64, however, results from the flexing due to its regular bimetallic action rather than from a change in its overall length. As heating continues, the bimetal 65 will flex to the left, overcoming the force exerted by the heater bimetal 64, and eventually effect separation of the contacts 62 and 63. Upon first separation of the contacts the heater bimetal will cool rapidly, exerting a force toward the left through the glass cord wrapping thereby substantially augmenting the contact separation. Here as in the previous embodiment the thermomotive effect of the secondary or heater element is arranged to be superseded by that of the primary element.

In a physical embodiment, the material for bimetal member 65 was similar to that used for bimetallic member 35 having the same general dimensions, while the secondary bimetallic member 64 was of .020" thick material of the same composition as the compensator bimetal 32. The narrowed section of the secondary member 64 had an approximate effective length of 1⅞" and a width of ⅞". The insulating medium 66 was

substantially similar in characteristics and dimensions to that of members 41 and 42, except that the total thickness was approximately .030" instead of .035" as with the first embodiment. The current load carried by the device was also about 5 amperes.

It is also envisioned that there are many variations in the above constructions, for example, in the arrangement of the contacts or the mounting of the component thermomotive elements, that come within the scope of this invention.

I claim:

1. In an input control switch, thermomotive means having a free end and a fixed end, said means comprising two thermomotive members of thermomotively dissimilar materials disposed in substantially parallel spaced relation, with mechanical connections between said members adjacent the fixed end and at least at one point along the length of said members, thermal insulating means disposed between said members, and electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to the less active of the two members to rapidly heat the same during each cycle, the more active member receiving heat from the less active member, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member causing rapid movement in opposition to the movement of said more active member on cooling.

2. In a current-operated thermal switch, thermomotive means having a free end and a fixed end, said means comprising a current-conductive heater member and a bimetallic control member disposed in substantially parallel spaced relation, with rigid mechanical connections between said members at two points, thermal insulating means disposed between said members, and electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to said heater member to rapidly heat the same during each cycle, said bimetallic control member receiving heat from said heater member, the initial heating of said heater member causing a rapid thermomotive action in opposition to the thermomotive action of said bimetallic member on heating, and the initial cooling of said heater member causing rapid movement in opposition to the movement of said bimetallic member on cooling, the thermomotive action of said bimetallic member on heating and cooling ultimately dominating the thermomotive action of said heater member on heating and cooling respectively.

3. In a current-operated thermal switch, thermomotive means having a free end and a fixed end, said means comprising two oppositely-acting bimetallic members disposed in substantially parallel spaced relation, with a mechanical connection adjacent the fixed ends of said members and mechanical connection at least at one point along the length thereof, thermal insulating means disposed between said members, and electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to one of said members to rapidly heat the same during each cycle, the other member receiving heat from the first member, the initial heating of said first mem-

ber causing a rapid thermomotive action in opposition to the thermomotive action of said second member on heating, and the initial cooling of said first member causing rapid movement in opposition to the movement of said second member on cooling, the thermomotive action of said second member on heating and cooling ultimately dominating the thermomotive action of said first member on heating and cooling respectively.

4. In an input control switch, thermomotive means having a free end and a fixed end, said means comprising two thermomotive members of thermomotively dissimilar materials disposed in substantially parallel spaced relation, with rigid mechanical connections between said members at two points, thermal insulating means disposed between said members, electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to the less active of the two members to rapidly heat the same during each cycle, the more active member receiving heat from the less active member, and means associated with the less active member for preventing overstressing thereof, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member causing rapid movement in opposition to the movement of said more active member on cooling.

5. In an input control switch, thermomotive means having a free end and a fixed end, said means comprising two thermomotive members of thermomotively dissimilar materials disposed in substantially parallel spaced relation, with rigid mechanical connections between said members at two points, thermal insulating means disposed between said members, electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to the less active of the two members to rapidly heat the same during each cycle, the more active member receiving heat from the less active member, and means for controlling the differential between the temperatures of the more active member at opening and closing of said electrical connections, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member causing rapid movement in opposition to the movement of said more active member on cooling.

6. In an input control switch, thermomotive means having a free end and a fixed end, said means comprising two thermomotive members of thermomotively dissimilar materials disposed in substantially parallel spaced relation, with rigid mechanical connections between said members at two points, thermal insulating means disposed between said members, electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to the less active of the two members to rapidly heat the same during each cycle, the more active member receiving heat from the less active member, the less active member being of relatively small cross-section, means securing said members together along their length between said two points to prevent buckling of said less active member and to maintain a close constant association between said members while permitting relative sliding motion

between said members, the less active member having an offset to prevent overstressing thereof and to control the differential between the temperatures of the more active member at opening and closing of said electrical connections, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member causing rapid movement in opposition to the movement of said more active member on cooling.

7. In an input control switch, thermomotive means having a free end and a fixed end, said means comprising two thermomotive members of thermomotively dissimilar materials disposed in substantially parallel spaced relation, with rigid mechanical connections between said members at two points, thermal insulating means disposed between said members, electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to the less active of the two members to rapidly heat the same during each cycle, the more active member receiving heat from the less active member, and means for holding said members and the associated thermal insulating means in close constant association with one another, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member causing rapid movement in opposition to the movement of said more active member on cooling.

8. In an input control switch, a thermomotive means having a free end and a fixed end, said means comprising two thermomotive members of thermomotively dissimilar materials disposed in substantially parallel spaced relation, with rigid mechanical connections between said members at two points, thermal insulating means disposed between said members, electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to the less active of the two members to rapidly heat the same during each cycle, the more active member receiving heat from the less active member, the latter member being relatively thin so as to have low mass and high electrical resistivity, and means associated with the latter member to prevent buckling thereof, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member causing rapid movement in opposition to the movement of said more active member on cooling.

9. In an input control switch, thermomotive means having a free end and a fixed end, said means comprising two thermomotive members of thermomotively dissimilar material disposed in substantially parallel spaced relation, with rigid mechanical connections between said members at two points, thermal insulating means disposed between said members, electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to the less active of the two members to rapidly heat the same during each cycle, the more active member receiving heat from the less active member, means for holding said members and the associated thermal insulating means in close constant association with one another, and

means to facilitate relative motion between the less active member and said thermal insulating means, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member causing rapid movement in opposition to the movement of said more active member on cooling.

10. In an input control switch, thermomotive means comprising a pair of oppositely-acting bimetallic heat-expansive members having different degrees of heat expansivity, said members being disposed in substantially parallel spaced relation and being rigidly connected together at one end, means securing said members together along substantially their entire length while permitting relative sliding therebetween, current-controlling contacts controlled by said thermomotive means and adapted when closed to effect current heating of the member having the lower heat expansivity, the member having the higher heat expansivity receiving heat from the member having the lower heat expansivity, and said contacts being controlled by conjoint action of said members.

11. In an input control switch, thermomotive means comprising a pair of thermomotively dissimilar members, said members being disposed in substantially parallel spaced relation, with mechanical connections between said members adjacent the fixed ends and at least at one point along the lengths of said members, a contact carried by said thermomotive means and electrically connected to the member having the lower heat expansivity, a manually-adjustable contact arranged cooperatively with said first contact, said contacts when closed effecting current heating of the member having the lower heat expansivity, the member having the higher heat expansivity receiving heat from the member having the lower heat expansivity, and said contacts being controlled by conjoint action of said members, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member causing rapid movement in opposition to the movement of said more active member on cooling.

12. In an input control switch, thermomotive means comprising a pair of thermomotively dissimilar members, said members being disposed in substantially parallel spaced relation, with mechanical connections between said members adjacent the fixed ends and at least at one point along the lengths of said members, a contact carried by said thermomotive means and electrically connected to the member having the lower heat expansivity, a manually-adjustable contact arranged cooperatively with said first contact, means including a compensator element for positioning said second contact according to ambient temperature, said contacts when closed effecting current heating of the member having the lower heat expansivity, the member having the higher heat expansivity receiving heat from the member having the lower heat expansivity, and said contacts being controlled by conjoint action of said members, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member caus-

ing rapid movement in opposition to the movement of said more active member on cooling.

13. An input control switch according to claim 12, including means for effecting initial adjustment of said compensator element.

14. An input control switch according to claim 12, including a spring support for said second contact, an adjusting arm connected to said support and movable by said compensator element, and a manually-adjustable cam engaging said arm.

15. An input switch according to claim 14, wherein said compensator is disposed at a right angle to the adjusting arm.

16. An input controller for supplying a predetermined average wattage input to a remotely connected heating load, comprising: circuit controlling connections including contacts adapted to be cyclically closed and opened, the relative lengths of the close and open intervals determining the average wattage input to said load; means for initially effecting closure of said contacts to start an input control function; thermomotive means operative to cyclically open and close said contacts, said thermomotive means comprising a primary thermal-responsive member having a relatively high thermomotive characteristic and a relatively high effective thermal mass operable upon heating to effect opening of said contacts and operable upon cooling to effect closing of said contacts, and an oppositely-acting secondary thermal-responsive member having a relatively lower effective thermomotive characteristic and a relatively lower effective thermal mass mechanically coupled to said primary member for conjoint thermomotive action of the two members and for transfer of heat therebetween; said circuit controlling connections being arranged to effect heating of said secondary member when the contacts are closed, thereby to effect an initially rapid thermomotive action of said secondary member tending to maintain said contacts closed and lengthen the on cycle, and subsequent greater thermomotive action of said primary member, in response to heat transferred thereto from said secondary member, effective to open said contacts, whereupon the heating of said secondary member is interrupted and the latter cools rapidly effecting augmented opening of said connections and lengthening of the off cycle.

17. An input controller according to claim 16, wherein said thermomotive means comprises a

bimetal primary member having a movable portion, and a rapidly expansible and contractible current-conducting secondary member having one end fixed to said movable portion, said secondary member serving, by its rapid expansion and contraction, to effect the desired secondary thermomotive action.

18. In an input control switch, a thermomotive means having a free end and a fixed end, said means comprising two thermomotively dissimilar members disposed in substantially parallel spaced relation, said members being rigidly connected together at two points, thermal insulating means disposed between said members, electrical connections including contacts cyclically operable by the free end of said thermomotive means for supplying energy to the less active of the two members to rapidly heat the same during each cycle, the more active member receiving heat from the less active member, the latter member being relatively thin so as to have low mass and high electrical resistivity and having a rectangular cross-section with the broader surface thereof disposed parallel to said more active member, and means securing said less active member to said more active member along their entire length between said two points to prevent buckling of said less active member and to maintain a close constant association between said members while permitting relative sliding motion between said members, the initial heating of said less active member causing a rapid thermomotive action in opposition to the thermomotive action of said more active member on heating, and the initial cooling of said less active member causing rapid movement in opposition to the movement of said more active member on cooling, the thermomotive action of said more active member on heating and cooling ultimately dominating the thermomotive action of said less active member on heating and cooling respectively.

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