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ELECTRICAL APPARATUS

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FIG. 1.

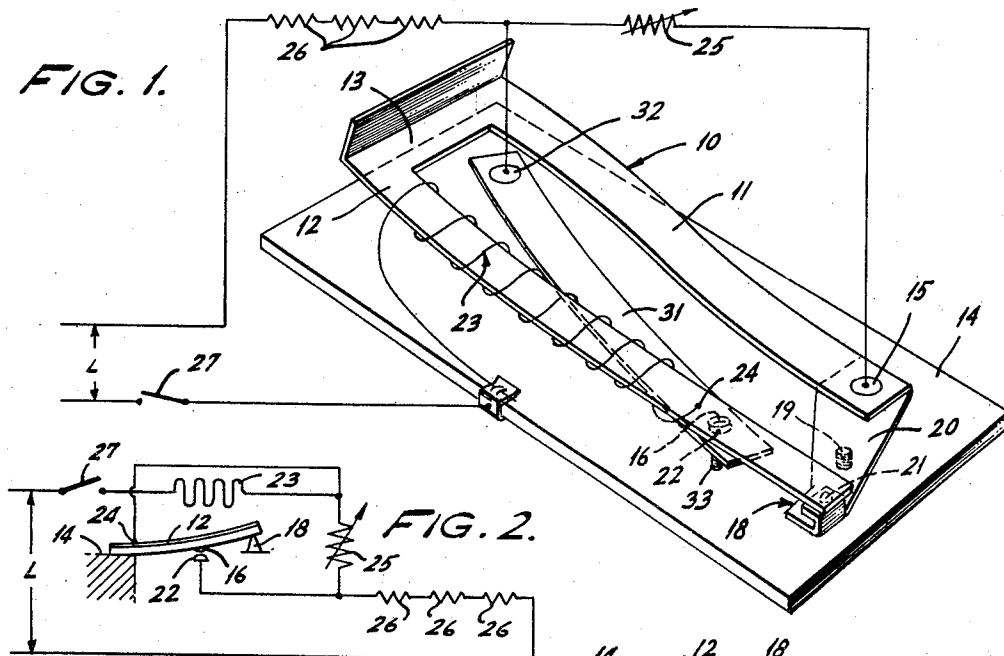


FIG. 2.

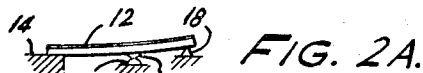


FIG. 2A.

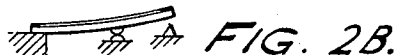


FIG. 2B.

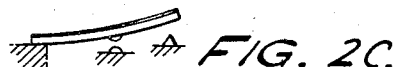


FIG. 2C.

FIG. 3.

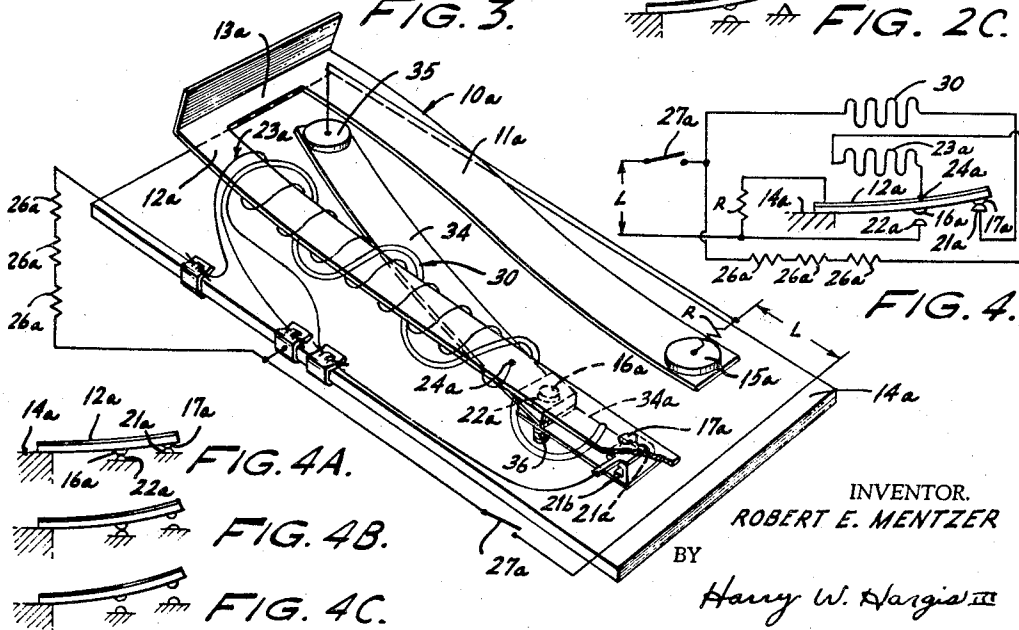


FIG. 4A.

FIG. 4B.

FIG. 4C.

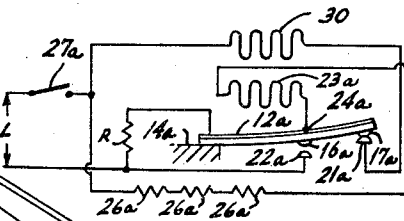


FIG. 4.

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1

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4 Claims. (Cl. 200-122)

This invention relates to electrical apparatus and more particularly to apparatus for regulating voltages. While of broader applicability, apparatus of the present invention has particular utility in the field of electronic equipment such, for example, as television receivers.

In the design of television receivers an important factor to be considered is the variation in line voltage to which a receiver is subject in the normal operation thereof. For example, the line voltage in a particular location characteristically varies between 105 and 130 volts. This variation of course necessitates the use of components capable of efficient operation within the range of such voltage values, as well as the provision of voltage control means for other components not readily adaptable to wide voltage variations. A particular example of such components as the latter are the electron tube filament circuits, wherein excessive voltages applied thereto produce deterioration of the tube filaments as well as premature vaporization of electron emissive surfaces of the cathode of the cathode ray tube.

The problem of voltage variations has been met by inclusion of voltage regulation devices comprising switch means provided with a bimetallic actuator arm operated by a resistance heater associated therewith and energized by the line voltage being controlled. Such devices, while helpful, have not provided a complete solution to the problem. The switch heater of the regulatory device is subject to unregulated power throughout its warmup interval and, in the event low voltage occurs at this time, the switch arm may undesirably delay movement of its contact to energize the electron tube filaments, and consequently unduly delay operation of the TV receiver.

It is therefore an objective of the invention to provide simple and effective improved voltage control apparatus overcoming the above described difficulties.

It is a particular objective of the invention to provide a thermally actuatable switch adapted for use in a variety of voltage control means.

It is still another object of the invention to provide an improved electro-mechanical device of the type utilizing a bimetallic element.

In accordance with the foregoing and other objectives the invention contemplates use of a temperature compensated bimetallic switch actuating element so thermally associated with a heater element—energizable by a voltage source to be controlled—as to provide predetermined time delay operation of the switch. The bimetallic switch actuating element includes a flexible and resilient bimetal strip anchored rigidly toward one end to suitable support means and biased transversely by a force applied to the strip in a region of its free end. According to one aspect of the invention a switch contact is disposed on the strip in a region intermediate the anchored end and the portion of the strip to which the initial flexing force is applied.

According to another embodiment of the invention initial flexing of the strip is achieved by applying the required force through a second pair of electrical contacts operably coupled with a second heater associated with the strip.

The manner in which the foregoing objects and advantages of the invention may best be achieved will be more fully understood from a consideration of the following

2

detailed description taken in light of the accompanying drawing, in which:

FIGURE 1 is a perspective showing of one form of thermally responsive switch made in accordance with the invention and including a somewhat diagrammatic showing of electrical circuitry adapted for use therewith;

FIGURES 2, 2A, 2B and 2C are diagrammatic showings of operational features of the thermal switch shown in FIGURE 1;

FIGURE 3 is a showing similar to FIGURE 1, but illustrating another form of switch made in accordance with the invention and including a diagrammatic showing of electrical circuitry adapted for use therewith; and

FIGURES 4, 4A, 4B and 4C are diagrammatic showings of operational features of the embodiment of the invention shown in FIGURE 3.

Referring now to the drawings, and particularly to FIGURE 1, a bimetallic element 10 comprises a pair of flexible and resilient legs or strips 11 and 12 interconnected by a transverse portion 13. Element 10 is mounted upon an insulative base 14 by a rivet 15 extending through the base and the free end portion of leg 11. Leg 11 extends slightly upwardly and away from base 14 so as to space transverse portion 13 and the other leg 12 from the base as shown.

Strip or leg 12 has affixed to its lower surface an electrical contact 16 disposed intermediate the free end of leg 12 and the transverse portion 13. An adjustable stop member 18 is disposed upon base 14 and forcibly engages the free end of strip 12, applying force thereagainst in an amount sufficient to bow the strip concavely upwardly as shown and position contact 16. Adjustment of stop member 18 is achieved by set screw 19 supported by insulative base 14. Stop member 18 includes a flat spring portion 20 mounted also upon base portion 14 by rivet 15, and adapted to bias set screw 19 in any of its adjusted positions, and an electrically nonconductive stop 21 disposed between strip 12 and spring portion 20. While strip 11 provides temperature compensation for strip 12 up to contact 16, the biasing spring 20 is of such material as to provide temperature compensation for the portion of strip 12 between contact 16 and its free end.

An additional electrical contact 22 is mounted on the base beneath contact 16 carried by strip 12, contact 22 being disposed and adapted for engagement by contact 16 in response to flexing movements of strip 12, as will hereinafter be more fully explained. Electrical contact 22 is mounted upon base 14 by means of a flat spring 31 affixed to the latter by a rivet 32. Relative positions of contacts 16 and 22 are also adjustable by a set screw 33 mounted in the base and engaging the end of spring 31, the latter being disposed and adapted to bias the set screw 33 in any of its positions.

A resistance heater 23 is wound about strip 12, and is thermally coupled to the latter while being so constructed and arranged as not to interfere with flexing movements of the strip. One end of heater 23 is connected to a voltage source L, through a switch 27, and the other end of the heater is connected to electrically conductive strip 12 of bimetallic element 10 as seen at 24. One side of a thermistor 25 also is electrically connected to heater 23 through rivet 15 and element 10, and the other side of the thermistor is connected in series with an electron tube filament string designated generally by the numeral 26. Filament string 26 is connected at its other end to line L. Thus, heater 23, thermistor 25, and filament string 26 are in series circuit with line L, as shown in FIGURES 1 and 2. Contact 16 is electrically connected to strip 12 and its mating contact 22, on spring 31, is connected through rivet 32 to a point of interconnection between thermistor 25 and filament circuit 26.

3

By virtue of these latter electrical connections, movement of the strip 12 to the position shown in FIGURE 2A effects electrical connection of contacts 16 and 22 with one another, which connection shunts out thermistor 25 from the circuit, leaving only switch 27, heater 23, and filament string 26 in-series with one another.

In particular accordance with the invention, initial flexing movement of strip 12 is in the nature of bending about stop member 18 as best shown diagrammatically in FIGURE 2A. Additional flexing of strip 12 moves it to the position shown in FIGURE 2B, and finally to the position shown in 2C. Flexing of strip 12 through the successive positions seen in FIGURES 2, 2A, 2B and 2C is brought about by increased heating of bimetallic strip 12 by heater 23.

A still better understanding of the invention will be had from a detailed explanation of the operation of the hereinabove described embodiment. Closing of switch 27, to energize the filament circuitry 26 shown by way of example as the load, causes current to flow through the bimetal heater 23, thermistor 25, and filament string 26. Since the resistance of thermistor 25 is characteristically relatively high upon first energizing the circuit, the initial current through the filament string 26 and through heater 23 is held to a relatively low value. Consequently initial high surges of current are prevented by the thermistor from flowing through the filaments until such time as the bimetal regulatory switch can come up to its operating temperature range. As the thermistor warms, its resistance decreases permitting a higher current to flow therethrough, and also through the heater 23 and filaments 26. As heater 23 receives more current it heats bimetal strip 12 sufficiently to flex the same to the position shown in FIGURE 2A, closing contacts 16 and 22 thereby shunting thermistor 25 from the circuit. Continued energization of heater 23 causes the free end of strip 12 to flex upwardly thereby disengaging the said end from stop member 18 (FIGURE 2B). Thereafter any increase in current due to excessive surges of voltage will cause the bimetal strip 12 to curl further and reopen contacts 16 and 22 (FIGURE 2C), thereby placing thermistor 25 again in the circuit as protection. As the surge subsides strip 12 returns to the position shown in FIGURE 2B, closes contacts 16 and 22 again shunts thermistor 25.

By virtue of this novel bimetallic switch arrangement a thermistor serves the combined functions of a voltage surge protector and regulator resistor. Once operating as a voltage regulator, it is seen that the free end of bimetal strip 12 is clear of engagement with the stop member 18 and plays no part in the operation of the device. As the line voltage drops at L, and the current flowing through filaments 26 decreases, the contacts will permanently open at some current value significantly lower than the selected minimum operating current of filaments 26.

Use of the above described bimetallic structure advantageously provides filament surge protection, as well as regulation, because during the initial warm-up interval the surge current is reduced by the thermistor in series with the filaments. After the initial warmup interval, the thermistor assumes a low resistance value and is switched in and out of the series circuit by the bimetallic switch, thereby maintaining the filament current at an average value.

In the embodiment of the invention shown in FIGURES 3 to 4C, bimetal device 10a is substantially the same as that illustrated in FIGURES 1 to 2C, being comprised of mounting strip 11a, movable strip 12a, interconnecting portion 13a, insulative base 14a and a rivet 15a mounting strip 11a to base 14a. Electrical contacts 16a and 17a are provided on electrically conductive strip 12a each contact being disposed upon the lower side of the strip and opposite respective contacts 22a and 21a provided upon base 14a. Contact 22a is carried by a resilient conductive

4

strip 34 mounted upon base 14a by a rivet 35. A temperature-compensating extension 34a of strip 34 carries contact 21a. Contact 22a is disposed in direct electrical contact with strip 34, whereas contact 21a is insulated from extension 34a by electrically non-conductive spacer 21b. Biasing of strip 12a is provided by a set screw 36 carried by the base and which screw is biased by spring 34. Temperature compensation for the strip 12a up to contact 16a is provided by strip 11a while temperature compensation for the portion of strip 12a between contacts 16a and 17a is provided by strip 34a.

A heater 23a is thermally associated with strip 12a and is electrically connected to the latter as seen at 24a. A second heater 30 is thermally associated with strip 12a.

Strip 12a is connected to one side of line L through the agency of interconnecting portions 13a, strip 11a, and resistor R. Heater 30 is disposed for connection across line L in series electrical circuitry with line switch 27a, contacts 21a, 17a, strips 11a, 12a, 13a and resistor R. Heater 23a is disposed for alternate connection across line L either in series electrical circuitry with switch 27a, filament string 26a, strips 11a, 12a, 13a, and resistor R, or in series electrical circuitry with switch 27a, filament string 26a, strip 12a and contacts 16a, 22a. Bimetal device 10a as shown is used to control, as will be hereinafter more fully explained, voltages applied to filament string 26a of a television receiver (not identified), filament string 26a being disposed in circuitry hereinabove described and energized by line L.

Referring now with particularity to FIGURES 4 to 4C, the bimetal strip 12a is initially flexed to assume the position diagrammatically shown in FIGURE 4 wherein contacts 16a and 22a are open and contacts 17a and 21a are closed. Upon closing switch 27a to energize the circuitry, it will be seen that boost heater 30, filament string 26a, heater 23a and resistor R are energized immediately. As strip 12a is rapidly heated it is flexed to the position shown in FIGURE 4A to close contacts 16a and 22a. This shunts out resistance R and energizes filament string 26a and heater 23a to a higher power level. Shortly thereafter strip 12a continues to flex or curl to the position shown in FIGURE 4B, wherein it is seen that contacts 17a and 21a are opened and boost heater 30 deenergized while operating heater 23a and filament string 27a remain energized. Note that resistor R is shunted out due to its parallel circuitry with contacts 16a, 22a. In this position of the switch means 10a any excessive increase of voltage effects increased heating of heater 23a and causes the strip 12a to flex still further to the position shown in FIGURE 4C, which disposes resistance R in series with filament string 26a and heater 23a, thereby reducing the power supplied to the filament string and heater. As a result of the reduction in power supplied to the heater, the strip 12a returns to the position shown in FIGURE 4B, whereupon contacts 16a and 22a again close and resistor R is deenergized, increasing the power to the heater and filaments. This cycle is repetitive in nature and provides a desired regulated average power supply to the filament string. In the event of extreme voltage applied through line L, the switch will remain in the position shown in FIGURE 4C.

It will be therefore understood that by the latter embodiment of the invention there is advantageously provided means associated with the bimetallic strip which ensures overcoming the thermal inertia of the protective device 10a upon closing of switch 27a. Thus the desired protection of the filament string 26a is afforded almost immediately upon energization of the circuitry.

From the foregoing description of the two illustrated embodiments of the invention it will be understood that there is achieved differential movements of a bimetallic element whereby one or more switching functions are provided, by a single such element, and the same bimetallic device may be used in different circuits for different purposes. In this regard it is pointed out that the bi-

5

metallic switch as shown in FIGURES 3 and 4 to 4C, may be used in the circuitry shown in FIGURES 1 and 2 to 2C, in which event outer contacts 17a, 21a would not be used but would function only as a stop member.

I claim:

1. In thermally actuatable switching apparatus: a bimetallic current-carrying strip affixed to supporting means toward one end thereof and adapted to flex about said one end in response to temperature changes; first and second heater elements thermally associated with said strip; and contact means electrically associated with said heater elements and operative by said strip as it is flexed, said first heater element being energizable initially with said second heater element to heat said strip to its operating temperature, said first heater element thereafter being deenergizable upon initial flexing of said strip, the strip thereafter being thermally actuatable by said second heater element alone to open and close said contact means.

2. In thermally actuatable switching apparatus: a bimetallic current-carrying strip affixed to supporting means toward one end thereof and adapted to flex about said one end in response to temperature changes; first contact means disposed in forcible engagement with said strip initially to flex the latter in the direction of flexing induced by increasing temperature; second electrical contact means carried by said strip intermediate its supporting means and said first contact means; and first and second electrical heater means thermally associated with said strip and initially operative together to raise the temperature of the strip to flex the same and sequentially to move said second contact means in one direction, while said strip is flexed to disengage it from said first contact means, said first heater means and said first contact means being so electrically connected that the recited strip movement deenergizes said first heater means, said second electrical heater means being operative thereafter to flex said strip to move said second contact means in the direction opposite to its recited first movement.

3. Electrical circuit means for effecting a predetermined time delay for the energization of a filament of an electron tube or the like and for providing surge protection thereafter, said circuit means comprising: a source of energy; a bimetallic current-carrying strip supported in cantilever fashion, said strip being adapted to flex about its support in response to temperature changes; stop means disposed and adapted to engage said strip and initially to flex the same in the direction of flexing induced by increasing temperature; electrical contact means for said strip disposed intermediate the support for the same and said stop means; an electrical resistor; an electrical heater disposed in thermal exchange relation with the bimetallic strip, said heater, said resistor and said filament being disposed in series electrical circuit with said source of energy when said bimetallic strip is in its initially flexed position in which its contact means is open, the construction and arrangement being such

6

that, sequentially, upon initial heating of said strip by said heater, said contact means is moved to closed position whereby said resistor is shunted out of the circuit and there is provided a series electrical circuit comprising the electrical heater and the tube filament, and upon continued heating of said strip said contact means is moved to open position, in the opposite direction, with accompanying disengagement of said strip from said stop means, whereby said resistor is again placed in series electrical circuit with said source of energy, said heater, and said tube filament.

4. Electrical circuit means for effecting a predetermined time delay for the energization of a filament of an electron tube or the like, and for providing surge protection thereafter, said circuit means comprising: a source of energy; bimetallic current-carrying strip means fixed to supporting means toward one end and free to move at the other end in response to temperature changes; first and second electrical heaters operatively associated with said bimetallic strip means; a first electrical contact carried in the region of the free end of said strip means operative to control circuit means including said first heater upon movement of said strip means in response to operation of said first and second heaters; a second electrical contact carried by said strip means intermediate the ends thereof and operative to control said circuit means upon movement of said strip means in response to operation of said second heater; an electrical resistor disposed in series electrical circuit with said source of energy, said strip means, said first electrical heater, and said first electrical contact, and said second electrical heater being disposed in series electrical circuit with said electron tube filament, said strip means, and said resistor, the construction and arrangement being such that upon energization of said circuit means said first electrical contact is closed and said second contact is opened whereby a parallel electrical circuit is energized, one side thereof comprising said second electrical heater, said tube filament, and said resistor, and the other side thereof comprising said first electrical heater, said strip means, and said resistor, continued energization of said circuit effecting opening of said first contact and closing of said second electrical contact, whereby only said one side remains energized.

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