Dec. 15, 1942. C. H. HODGKINS 2,305,583

FLUORESCENT LAMP STARTER UNIT

Original Filed May 24, 1941

Fig. 1.

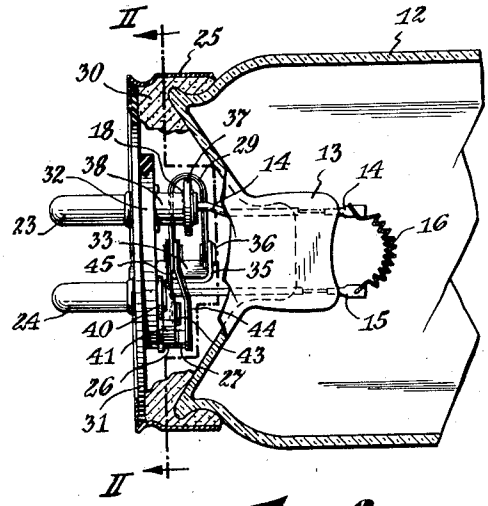


Fig. 2.

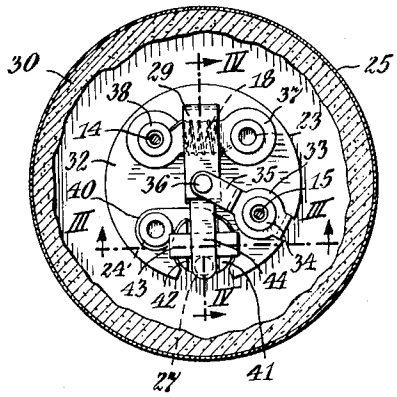


Fig. 3.

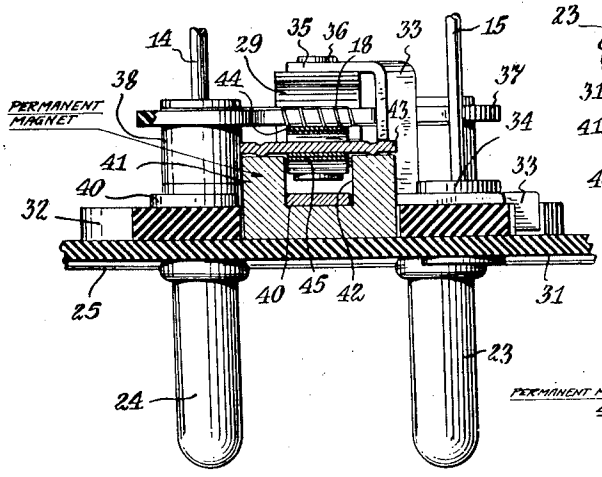


Fig. 4.

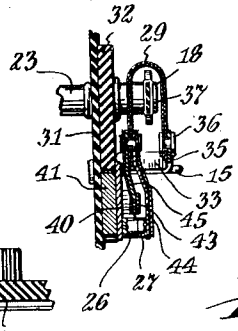


Fig. 5.

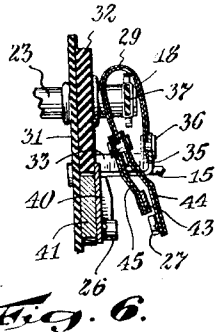


Fig. 6.

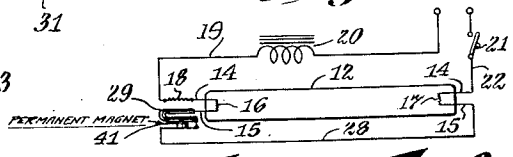


Fig. 7.

Fig. 8.

Fig. 9.

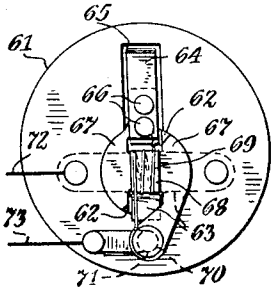
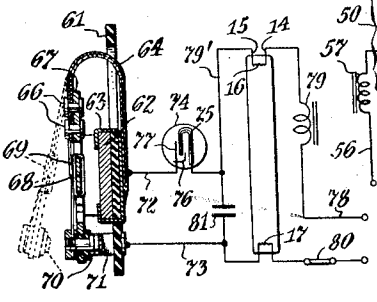
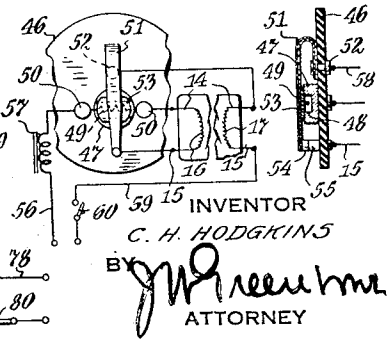


Fig. 10.





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UNITED STATES PATENT OFFICE

2,305,583

FLUORESCENT LAMP STARTER UNIT

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Original application May 24, 1941, Serial No. 395,013. Divided and this application August 27, 1941, Serial No. 408,411

4 Claims. (Cl. 200—122)

This invention relates to automatic circuit controllers, and more particularly to circuit controllers which automatically interrupt or re-establish a circuit by thermal activation and constitutes a division of my co-pending application, Serial No. 395,013, filed May 24, 1941, and assigned to the same assignee as the present invention.

Various electrical devices, such as gaseous discharge or fluorescent lamps, utilize for one purpose or another, a plurality of circuit paths and require automatic selective means for directing the current to the appropriate path under certain existing conditions. For instance, gaseous discharge or fluorescent lamps include spaced filamentary electrodes of electron emitting character within a gas-filled tube, and the desired main current path for securing luminosity of the lamp is by way of an arc struck along the electron path from electrode to electrode. One of the characteristics of lamps of this type is the difficulty in starting a discharge between the electrodes. The voltage necessary to strike the arc is ordinarily higher than that required to maintain the arc after it is once established, and as it is desirable to economically employ voltage of the usual domestic line potential for maintenance of the arc, starting means to initiate or strike the arc are ordinarily employed. For that purpose, a shunt circuit is provided across the electrodes connecting them in series, that circuit having an automatic controller to interrupt the shunt circuit when the electrodes are raised to electron emitting temperature, since the electrodes will then be heated by the discharge itself. Sudden opening of the shunt circuit after the electrodes are emitting electrons profusely, produces a high voltage surge which suffices to strike the arc across the electrodes along the electron path.

Various devices have heretofore been employed for the purpose of interrupting the shunt circuit connecting the electrodes in series, but those devices have been of a character necessitating physical disassociation from the lamp and have also functioned so rapidly that the circuit is opened before the electrodes have reached sufficient temperature to be effectively emissive of electrons to enable the arc to be initiated or maintained.

It is accordingly an object of the present invention to utilize a combined thermal and magnetic actuation of the make and break mechanism of the automatic circuit controller which will not only obtain the desired delay in circuit interruption, but will obtain a rapid separation or break between contacts when the break starts.

A further object of the invention is to provide an automatic circuit controller adapted to be and which is physically associated with a gaseous discharge lamp and adapted to be situated within the lamp base.

Another object of the invention is to provide an improved automatic circuit controller having delay action that will insure adequate electron emission to be attained from the electrodes before opening of the shunt circuit takes place.

Still further objects of the invention will appear to those skilled in the art as the description progresses, both by direct statement thereof and by implication from the context.

In the accompanying drawing, wherein like numerals of reference indicate similar parts throughout the several views and wherein the invention is disclosed in combination with a gaseous discharge or fluorescent lamp:

Figure 1 is a longitudinal section of one end portion of a lamp envelope ar d base showing the automatic circuit controllers in edge elevation therein;

Figure 2 is a cross-sectional view on line II—II of Figure 1, showing the automatic circuit controller in facial elevation;

Figure 3 is a sectional view on line III—III of Figure 2, but upon larger scale than the showing of Figure 2;

Figure 4 is a sectional view on line IV—IV of Figure 2, showing the shunt-circuit contacts closed;

Figure 5 is a sectional view similar to Figure 4, but with the shunt-circuit contacts open;

Figure 6 is a circuit diagram of the circuits involved in connection with a gaseous discharge lamp;

Figure 7 is a face view similar to Fig. 2 showing a modified construction of controller and showing wiring connection to a gaseous discharge lamp;

Figure 8 is a vertical central section of the controller of Figure 7;

Figure 9 is a face view of a further modified construction of controller; and

Figure 10 is a vertical central section thereof, and showing wiring connection to a gaseous discharge lamp.

In the specific embodiment of the invention illustrated in said drawing, and with attention directed initially to Figures 1 to 6 thereof, the reference numeral 12 designates in general a gaseous discharge or fluorescent lamp having the usual transparent or translucent sealed envelope with re-entrant stems 13 at each end thereof and integrally formed therewith. In the process of

manufacture, the envelope is evacuated and then filled with an inert or rare gas, such as argon, neon, etc., at a few millimeters pressure and with an ionizable medium such as a few drops of mercury, sodium or other readily volatile material also included in the envelope. Likewise in process of manufacture, lead-in wires are sealed through the stems for constituting terminal connections 14, 15 in pairs through each stem with each pair mounting a coiled filamentary electrode in series therewith within and crosswise of the envelope. The structure accordingly provides electrodes 16, 17 at opposite ends of the envelope and it is between these electrodes that the desired arc for illuminating purposes is to be initiated and maintained. As is usual in such lamps, the electrodes are of a refractory metal, such as tungsten or the like and rendered copiously electron emissive by appropriate use therewith of an electron emissive material, such as an oxide of barium, strontium or the like. These structural features of the lamp likewise exist in the lamp indicated in Figures 7 and 10, except that each electrode of the lamps of Figures 6 and 7 are intended for about 40 to 50 watt consumption whereas higher wattage may be consumed with showing of Figure 10.

As shown in Figure 6, one terminal 14 of electrode 16 is connected through a heater coil 18 hereinafter described and located and thence by an exterior conductor 19 connects through an inductance 20 to one side of the source of supply of the customary domestic potential of 115 or 230 volts. Likewise, one terminal 14 of the other electrode 17 is connected through an external switch 21 by conductor 22 to the opposite side of the domestic source of supply. Switch 21 is the one manipulated by the user for turning the lamp on or off.

It is furthermore usual practice in lamps of this character to cap the envelope at each end with a metal base from each of which protrudes a pair of terminal prongs or pins suitably insulated from each other. It is an object of the present invention to maintain this physical aspect of the lamp that the lamp of my invention may be employed in fixtures of the prior art. Each end of the lamp of Figures 1 to 6 accordingly has protruding terminal prongs 23, 24 and an end base 25. It is a further object of the present invention to include my improved circuit controller within one of the bases. The end of the lamp having the base 25 including the controller is the one more particularly illustrated in the drawing.

The specific disclosure of controller forming the subject matter of this description respecting Figures 1 to 6 provides a fixed electrical contact 26 and a movable contact 27 normally in engagement for closing a shunt circuit 28 connecting the filaments therethrough in series. The movable contact 27 is carried by one arm of a U-shaped flexible thermal-responsive member 29. Preferably said member comprises two U-shaped strips of dissimilar metals secured flatwise together and having different co-efficients of expansion such that a rise of temperature will result in a bending of the member, and as here shown the relation of the particular metals used will obtain a swinging of the legs of the member toward each other when the temperature is increased.

The normal relationship of contacts 26 and 27 is that of physical and electrical engagement, and to cause disengagement thereof the heretofore mentioned heater 18, such as the resistance coil shown, is provided in proximity to the said thermal responsive member 29. Since this heater coil is in series between the source of power and the filament it begins to generate heat and continues so to do as soon as switch 21 is closed for lighting the lamp and as long as there is a current flow either through the lamp or the shunt circuit.

The particular arrangement of parts preferably employed for compactness and for incorporating the same within the base will now be described. The metal base 25 is of collar-like construction attached by cement 30 or other plastic in place concentrically on the end of the envelope, a flange on said base and said cement also retaining an insulating disc 31 within the outer end of the base. On the inner side of disc 31 is a mounting piece 32 shown as a smaller and concentric reenforcing insulating disc as an internal means for mounting various parts of the controller. Extending radially inwardly from one edge of this mounting piece or disc 32 is a foot portion of a bracket 33 riveted at 34 to the discs. Said bracket bends to provide an upstanding portion at right angles to the face of the disc in a direction toward the envelope and then bends again in the same general radial direction to provide an offset portion 35 parallel to the disc and spaced therefrom and extending far enough to be substantially over the center of the disc. One leg of the aforementioned U-shaped thermal responsive member 29 is riveted substantially above the center of the disc at 36 to this offset portion of the bracket, but extends in a different diametric direction and with said member arranged to situate its other leg in closer proximity and parallel to the disc and passing radially outwardly beyond the upstanding portion of the bracket entirely clear thereof substantially as far as the edge of the disc.

Crosswise of the U-shaped member 29, and also parallel to the disc, is a bridge 37 of insulating material which passes between the legs of said member next the U-bend thereof. On this bridge is wound the aforementioned heater coil 18 at the part of the bridge directly between the legs of the member so that heat from the heater affects a considerable portion of the U-member by its close proximity thereto. Furthermore, the parts are so arranged that one end of the bridge is mounted on the inner end of one terminal prong 23, whereas the opposite end of the bridge is secured in place by a mounting stud 38 riveted thereto and to the mounting piece or disc 32. Terminal connection 14 to the filament is also attached to mounting stud 38 thereby placing the filament in series with the heater coil. The other end of the filament, by interposition of connection 15 which is physically attached to bracket-securing rivet 34, is in series with said bracket and U-member 29. With contact points 26, 27, closed, the circuit then is carried through a bus bar 40 to the other prong 24. That prong 24 is connected through the fixture (not shown) by aforementioned exterior conductor 28 to a prong at the other end of the envelope, its connector 15, filamentary electrode 17, to the other connector 14 and its prong and thence through switch 21 back to the source of power.

The physical disposition of the prongs and rivets mentioned is preferably such that the prongs, in end view are at points substantially on a diameter of the disc 32 and that diameter is diagonal with respect to another diameter substantially on which the rivets 34 and stud 38 are

situated, these latter being also attaching points for the filament connections. The prongs and said stud and rivet just mentioned are at substantially equal distances from the center of the disc and are thus symmetrically disposed with respect to each other.

In the area adjacent the fixed contact 26 is situated a permanent magnet 41 here shown as substantially cylindrical and axially perpendicular to the insulating discs with its outer end engaging flatwise against the inner wall of outer insulating disc 31 and the adjacent cylindrical end portion located in a circular cut-out next one peripheral portion of the inner insulating disc 32. The magnet, however, projects above the said inner disc, and is diametrically slotted at its projecting end, as at 42, in juxtaposed relation to the movable contact leg of the U-shaped member so as to receive said leg in part in said slot. Aforementioned bus bar 40 enters at one end of the slot nearest the center of the disc, extends along the bottom of the slot to the outer end thereof, and there supports the fixed contact 28 with the exposed face of the contact below the exposed end face of the magnet.

Carried by the leg of the U-shaped member which traverses the magnet, is a cross-bar or keeper 43 of soft iron adapted to come into contact with the magnet while the contacts 26 and 27 are in engagement with each other. Said keeper is shown with burrs on its side toward the magnet face which will prevent extensive surface contact and "sticking" of the keeper to the magnet. Furthermore, in order that the keeper may not act to prevent contacts 26 and 27 from engaging, the forward end of the under leg of the U-shaped member is preferably constructed as two spring arms 44, 45, the first above the second, with the upper one 44 longer than the under one and carrying the contact piece 27 next its outer end and beyond the end of the under arm 45. The under arm 45 carries the aforementioned cross-bar or keeper 43 as a fixed part thereof. Furthermore, it is possible to construct the spring arms 44, 45 of bimetal in reverse order to the assembly of the bimetal of the main portion of the U-shaped member, if desired, which will thus obtain a tendency for the keeper supporting spring arm 45 and movable contact supporting arm 44, to bend downward under influence of heat at the same time that the main part of the under leg of the U-member tends to bend upwardly. By this construction I compensate for the increased ambient temperature that develops in the space enclosed by the base with the lamp in operation. This will accordingly assure normal engagement of movable contact with the fixed contact and of keeper with magnet notwithstanding ambient temperature and until the heater acts upon the U-member to obtain a definite and material deflection of the lower movable leg.

The above-described structure of contacts, spring arms, thermal member and magnet obtain several important results. The time taken for the U-shaped bimetal member to build up sufficient tension from heat of the heater to overcome the magnetic pull on the keeper will realize a delay sufficient to give adequate and proper preheating of the lamp electrodes. Therefore the lamp will positively start on the first separation of the contacts to interrupt the shunt circuit, and accordingly increases the life of the lamp. Furthermore the structure provides a contacting arrangement which is positive both in make and break functions. It may be pointed out that there is a rapid loss of influence of a magnetic field with increase of distance from the magnet, namely the attracting force is inversely proportional to the square of the separating distance. Accordingly, while the magnet holds the keeper as tension builds up in the thermal member, the moment that tension obtains the least separation of keeper from magnet, the attracting force of the magnet exerts so much less influence on the departing keeper that the contacts are separated with great rapidity. A quick opening of the contacts materially reduces arcing therebetween, and to further reduce arcing, the contacts, when contiguous to each other where that arcing may occur, are within the slot in the magnet, thereby taking advantage of the magnetic field as an aid in snuffing the arc. This tends to prolong the life of the contacts in addition to promoting the desired quick circuit interruption of the inductive circuit to cause the high voltage surge across the electrodes to establish the main lamp circuit with the opening of the shunt circuit. Again, the structure obtains a quick closing of the contacts when the current to the lamp is discontinued, since the keeper comes into the influence of the magnet as the bimetal tension subsides, and the magnetic influence becomes stronger as the bimetal thermal tension becomes weaker due to the approach of the keeper to the magnet. The lamp may accordingly be relit promptly after being turned off.

Referring now to the modification of Figures 7 and 8, the same construction of envelope, electrodes and lead-in wires and terminal connections are in accordance with the preceding description, and the same reference numerals are accordingly applied. The controller here shown provides an insulating piece 46 on the inner face of which is mounted a permanent magnet 47 shown as cylindrical with one face engaging the mounting piece 46 and with its other face diametrically slotted as at 48. A coiled or other electrical resistance heater 49 passes longitudinally through the said slot free from engagement with the magnet. The ends of the heater are supported at opposite sides of the magnet by supporting posts or studs 50. At right angles to the said slot is a U-shaped thermal responsive member 51 having a short leg riveted at 52 to the mounting piece 46, this leg making no contact with the magnet but extending from adjacent the periphery thereof away from the magnet, bending in U-shape upwardly away from the mounting piece so as to provide an overlying longer leg passing across the upper face of the magnet at right angles to the slot in said magnet. Where this overlying leg of the thermal member crosses the magnet, a cross bar or keeper 53 is provided as a fixed part of said leg. This keeper, as in the showing of Figure 3, provides a limited surface contact with the magnet while the supporting leg is in normal position.

At the extreme end of the overlying leg of member 51 is a movable contact point 54 normally in engagement with a fixed contact 55 carried by the mounting piece 46 as described with respect to the preceding figures. The U-shaped thermal responsive member 51 is of bimetal so that the heat will exert a tension between the two metals employed and obtain a bending of the overlying leg away from the other leg and mounting piece. Accordingly, when heat becomes effective upon the bimetal of this showing, the contacts 54, 55 are separated as soon as suffi-

cient tension is developed to overcome the magnetic attraction and retention of magnet 47 upon keeper 53, and the opening or separation of those contacts is rapid when once started as will be readily understood from the explanation given with respect to the preceding figures. The situation of the heater within the slot of the magnet below the keeper, necessitates the heat to first affect the keeper and then affect the bimetal by conduction from the heater thereto. Accordingly, the delay for the heat to thus develop and become effective upon the bimetal introduces the desired delay in the opening or separation of contacts 54, 55.

The wiring of the controller of Figures 7 and 8 is similar to the wiring heretofore described with respect to Figs. 1 to 6. Briefly, a connection 56 from one side of the source of domestic potential carries the current through an inductance 57 and thence to one heater post 50, through the heater 49 to the other post 50, thence to electrode connection 14 at one end of the lamp, through electrode 16 and the other electrode connection 15 therefor and back to the controller making connection with the contact 55. Assuming the contacts to be closed, the current path continues through movable contact 54, U-shaped member 51 to its rivet mounting 52 which has a wire connection 58, to the other end of the lamp and through the terminal connection 14 thereat, filament 17 and other terminal connection 15 to the wire 59, switch 60 and thus arrives back at the source of domestic potential.

The showing of Figures 9 and 10 likewise includes a mounting piece 61 carrying a permanent magnet 62 cylindrical configuration arranged endwise upon the mounting piece and secured by a metal clip 63 end portions of which project through the mounting piece next the periphery of the magnet at diametric opposite parts thereof and bend inwardly into a diametric slot across the front face of the magnet. A U-shaped bimetal thermal responsive member 64 is associated with the magnet, said member being here shown as having one leg at the back of the mounting piece and secured in place by being brazed or otherwise secured to the said clip 63. Next to and longitudinally of the secured leg of member 64, the mounting piece is slotted, at 65, to pass the curving part and front leg of the U-shaped thermal member to the front side of the magnet.

Secured to this front leg of the U-shaped member, as by rivets 66, is a soft iron keeper 67. This keeper is a flat piece of metal presenting side segments connected by a cross portion or shank 68 integral with the said segments and having a longth substantially equal to the width of the slot in the magnet. The segments of the keeper are provided with limited surface engagement with the face portion of the magnet on opposite sides of the slot and the shank portion 68 extends across the slot. Insulation is provided on the surface of the shank, and a heater coil 69 is wound around the insulation. One end of this heater coil is grounded to the U-shaped member as by engaging it under one of the rivets 66 connecting the keeper to the U-shaped member. The other end of the heater wire is insulated from the keeper and U-shaped member, and is attached to a movable contact 70 carried upon an extension of one of the segments of the keeper beyond the magnet. Said movable contact is also insulated from said keeper. It will be observed that in the present showing, the heating coil moves with the leg on which the movable contact is mounted, and that heat from the coil has to be transmitted by conduction through the keeper to the bimetallic thermal responsive U-shaped member. A fixed contact 71 is carried by the mounting piece 61 for engagement by the movable contact. The circuit through the controller enters by suitable connection 72 with the U-shaped thermal responsive member and after passing through the heater 69, movable contact 70 and fixed contact 71 passes out of the controller through another connection 73.

While this controller is adaptable to use for breaking a shunt circuit as in the preceding instances, I am using this opportunity of illustrating applicability of my invention in any one of the forms to use with a secondary delay means where greater delay is required than will be normally obtained by my improved controller alone. Where a lamp employs electrodes of higher wattage consumption and where the lamp is accordingly of greater length and the electrodes thus further separated a greater delay in the opening of the shunt circuit is necessary in order that the electrodes may become sufficiently heated and electrons profusely enough emitted to accomplish the ionization and striking of the arc between the more distant electrodes. It is accordingly feasible to combine my controller with other known or preferred control means. By way of example, I have illustrated my controller in Fig. 10 coupled in series with the elements of an auxiliary relay discharge tube 74, details of which are set forth in prior U. S. Patent 2,200,443 of May 14, 1940, to E. C. Dench. Briefly, the showing provides a gas filled envelope having therein a bimetallic electrode 75 which is, in this case, normally open with respect to a contact 76 in the container. A cathode 77 is associated with electrode 75, and as explained in the aforementioned patent, applied voltage obtains slow discharge and heat development which ultimately distorts the bimetallic electrode 75. After a trifling period of no consequence to this description, sufficient glow discharge in the relay to cause its bimetallic electrode 75 to distort, that electrode completes its short circuiting contact with contact 76. The I^2R effect in the electrode 75 keeps it hot and deflected. At such time, a sufficient current flow takes place to heat the heater 69 of my controller and thus injects the desired initial delay of current flow through the lamp electrodes 16 and 17, pending separation of contacts 70, 71 of my controller. The desired additional delay is obtained by magnetically deterring the contacts in their closed relation.

In the showing of Figure 10, I have included wire connection 78 from one side of the domestic potential supply, through an inductance 79 to terminal connection 14 of the lamp, lamp electrode 16 and other terminal connection 15 to the line 79' leading to the bimetallic thermal responsive element 75 of the auxiliary relay discharge tube 74, and on the return passage from my controller through connection 73, the current passes to the other lamp filament 17 and out through switch 80 back to the source of supply. The said relay discharge tube and my controller are normally in series and form a shunt circuit for the main arc circuit of the lamp, with the relay operating to close this shunt circuit as a preceding step to functioning of my controller heater to introduce its delay action of opening the shunt circuit to the lamp electrodes. A capacitance 81, such as an .006 mg. condenser is preferably in-

serted in the shunt circuit parallel to the series connected controller and auxiliary discharge tube 74, as an aid in producing the arc-striking surge when the shunt circuit is opened by my controller.

Obvously other detail changes and modifications may be made in the construction and use of my improved controller, and I do not wish to be understood as limiting myself to the precise showing herein made except as set forth in the following claims when construed in the light of the prior art.

I claim:

1. An automatic circuit controller comprising a fixed contact and a movable contact separation of which interrupts the circuit controlled, means associated therewith tending to move the movable contact and separate said contacts in consequence of current flow other than through said contacts and which continues after said contacts are separated, and magnetic means opposing separation of said contacts and delaying ultimate separation thereof.

2. An automatic circuit controller comprising a U-shaped bimetal thermal responsive member one leg of which is movable in response to heat variation, compensating bimetal arms on the movable leg of said member, one arm mounting a keeper and the other arm mounting a movable contact, a fixed contact normally in engagement with the movable contact, and a magnet associated with said keeper and tending to keep the movable contact in engagement with the fixed contact in opposition to the separating tendency imposed by functioning of the movable bimetal leg under influence of rising temperature.

3. An automatic circuit controller comprising a U-shaped bimetal thermal responsive member having one leg movable in response to heat variation and having a keeper on said leg, a slotted magnet adjacent said leg and keeper tending to keep the movable leg drawn toward the magnet in opposition to the separating tendency imposed by functioning of the movable bimetal leg under influence of rising temperature, and a fixed heater extending through the said slot of the magnet for transmitting heat to the keeper and said leg of the thermal responsive member.

4. An automatic circuit controller comprising a U-shaped bimetal thermal responsive member having one leg movable in response to heat variation and having a keeper on said leg, said keeper having a heater mounted thereon and movable therewith, and a fixed magnet adjacent said keeper and heater and functioning in opposition to tendency of the bimetal leg to move the keeper and heater away from the magnet as heat from the heater raises the temperature of said bimetal leg.

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