

July 27, 1948.

M. A. BABB ET AL
STARTING AND OPERATING UNIT AND CIRCUIT FOR
GASEOUS ELECTRIC DISCHARGE DEVICES

2,445,989

Filed May 22, 1945

3 Sheets-Sheet 1

Fig. 8.

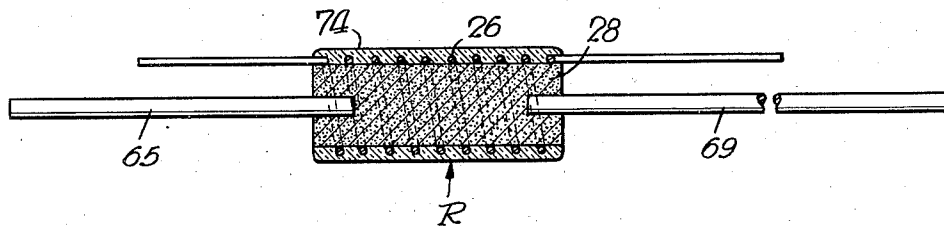


Fig. 1.

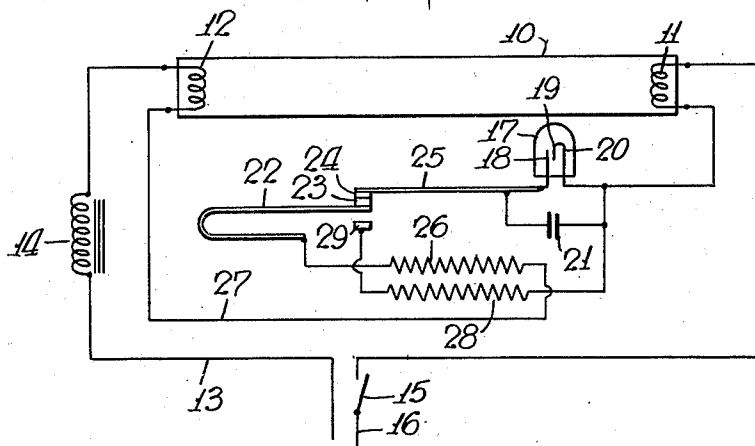
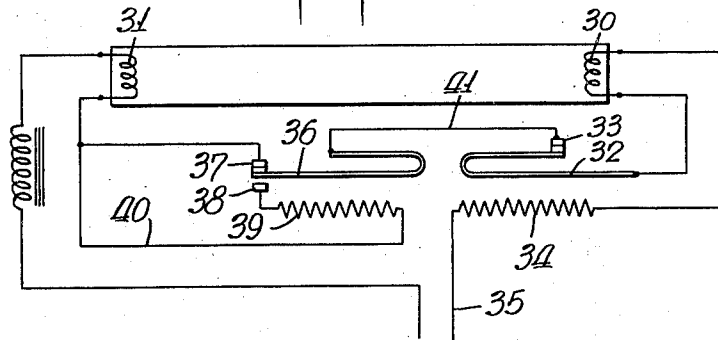


Fig. 2.



INVENTOR
Maynard A. Babb
Arnold E. Hayes
BY
Dean Fairbank & Misch
ATTORNEYS

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FIG. 3.

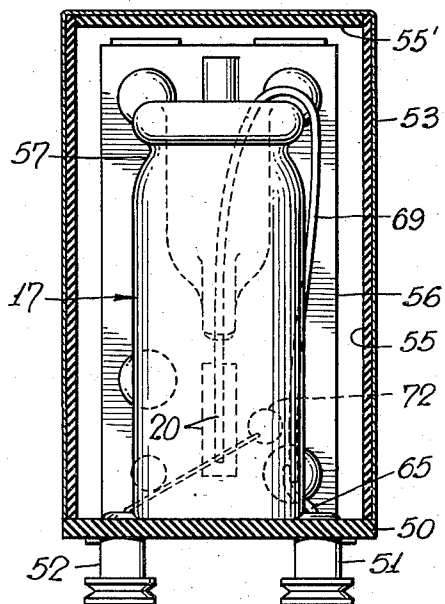


FIG. 4.

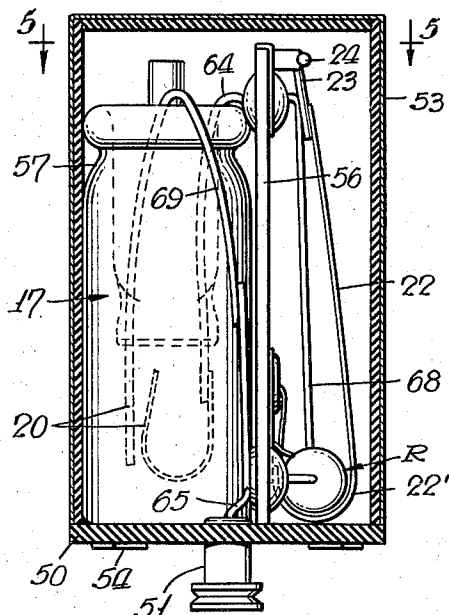


FIG. 6.

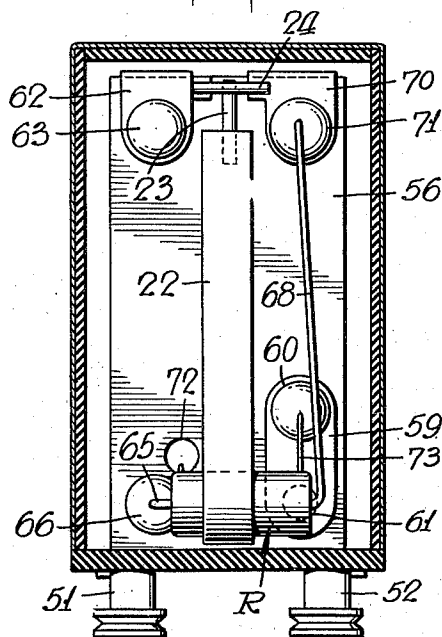


FIG. 5.

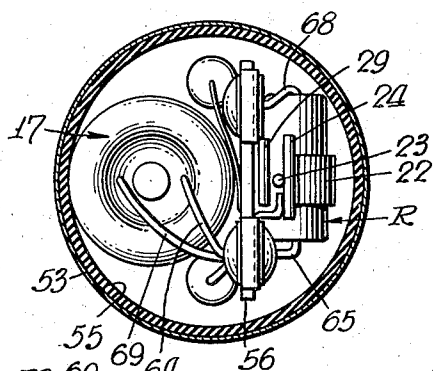
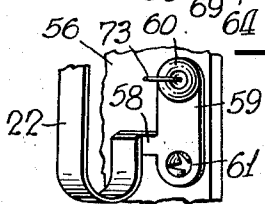


FIG. 7.



INVENTOR
Maynard A. Babb
Arnold E. Hayes
BY

Dean Fairbank & Hinch
ATTORNEYS

July 27, 1948.

M. A. BABB ET AL
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FIG. 9.

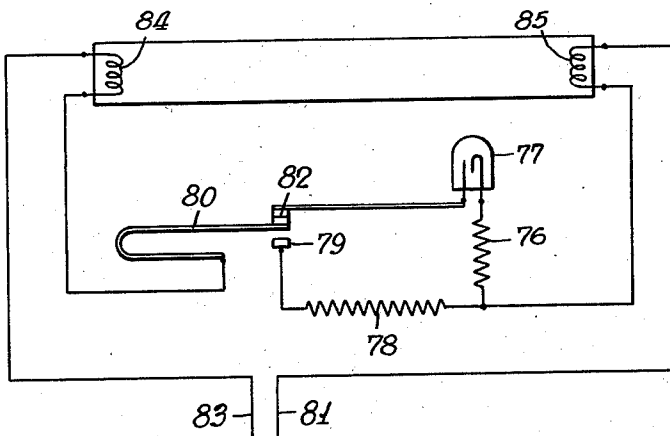
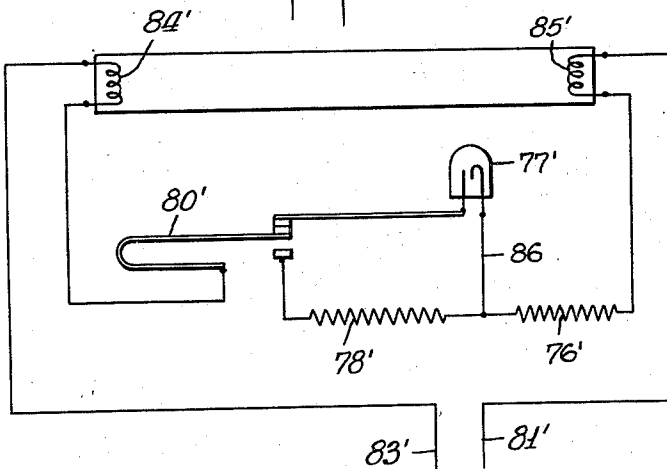


FIG. 10.



INVENTOR
Maynard A. Babb
Arnold E. Hayes
BY
Dean Fairbank & Hirsch
ATTORNEYS

UNITED STATES PATENT OFFICE

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STARTING AND OPERATING UNIT AND
CIRCUIT FOR GASEOUS ELECTRIC
DISCHARGE DEVICESMaynard A. Babb, Elkins Park, and Arnold E.
Hayes, Philadelphia, Pa., assignors to Maxwell
M. Bilofsky, Newark, N. J.

Application May 22, 1945, Serial No. 595,212

12 Claims. (Cl. 315-100)

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The present invention is concerned with safety starting units and with circuits incorporating the same, for the protection of gaseous electrical discharge devices such as fluorescent lamps of the hot cathode type.

It is among the objects of the invention to provide a unit of the above type, which is compact and relatively inexpensive, which lends itself for use with fluorescent lamps and the conventional fixtures thereof, as a replacement for glow starters of conventional type and in which inhere certain added utilities, including the prompt elimination of the intermittent flashing on and off of a defective lamp and thereby not only avoiding the annoyance of such flashing but also safeguarding the starter unit itself from the destructive strain imposed thereon by such intermittent starting.

Another object is to provide a starter unit of the above type, the safety circuit of which operates dependably, promptly to preclude the application of starting current to a defective lamp and reliably to maintain the lamp from flashing, and automatically restores itself to permit normal operation of a new lamp when substituted for the defective one.

Another object is to provide a safety starter circuit and unit of the above type which, in the normal operation of the lamp, involves not the slightest use of power or current beyond what is consumed in the operation of the same lamp in the absence of the safety feature.

A feature of the invention is a switch arm in series with the conventional starting contacts in the starting connection between the electrodes of a gaseous electric discharge device, said switch arm being displaced in response to the prolonged starting current in the attempted starting of a defective lamp and being maintained in displaced position by current operated means that is connected into circuit by the displacement of the switch arm. In the preferred embodiments shown, the switch is heat responsive and is actuated by the heat evolved in a resistor through which the starting current flows and when in displaced position connects into circuit a second resistor which alone, or preferably in series with the first resistor, evolves sufficient heat to keep the switch arm in said displaced position until the circuit is opened.

In the accompanying drawings in which are shown one or more of various possible embodiments of the several features of the invention,

Fig. 1 is a circuit diagram indicating one form of safety starter circuit,

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Fig. 2 is a similar view of an alternative form of circuit,

Fig. 3 is a view showing the casing in longitudinal cross section of the front elevation of one embodiment of glow starter unit incorporating the circuit of Fig. 1,

Fig. 4 is a view similar to Fig. 3 showing a side elevation,

Fig. 5 is a view in transverse cross-section taken on line 5-5 of Fig. 4,

Fig. 6 is a view similar to Fig. 3 showing a rear elevation,

Fig. 7 is a fragmentary perspective detail view,

Fig. 8 is a detail sectional view of the composite resistor unit,

Fig. 9 is a fragmentary circuit diagram of a modification, and

Fig. 10 is a view similar to Fig. 9 of another modification.

Referring now to the drawings, there is shown in the diagrammatic view of Fig. 1, a conventional gaseous electric discharge device 10 of the hot cathode type, such as a fluorescent lamp, including a pair of electrodes 11 and 12 at opposite ends thereof. One of the mains 13 has the ballast coil 14 therein, and the main switch 15 is shown in the other main 16. The starting circuit between said electrodes includes a conventional starter 17 of the thermal, magnetic or glow switch type. In Fig. 1 the glow switch type of starter is illustratively shown, the contacts 18 and 19, one of which is carried by a bimetal strip 20, are shunted by a condenser 21 to minimize arcing.

The starting current passes across the open gap between the contacts 18 and 19 and the heat of the glow discharge therebetween causes the bimetal strip 20 to deflect and close the gap, so that the full voltage is applied through the lamp electrodes 11 and 12, in series, whereupon the bimetal strip 20 cools and the gap reopens to permit a surge from ballast coil 14 to strike the arc in the lamp, or the cycle repeats until such arc is actually struck, whereupon the glow switch 17 remains open. The contacts thus separated to effect starting of the lamp will be designated the starting contacts.

According to the present invention, there is connected in the series circuit across the electrodes 11 and 12 and in series with starter 17 a thermally responsive time delay switch arm 22 bearing a contact 23 engaging and closing circuit to contact 24 in lead 25 from the starter switch 17. These contacts will be designated the safety contacts. The time delay switch is de-

sirably of the bimetal type and is constructed and arranged to become heated sufficiently under excessive or abnormal current conditions for deflection away from contact 24 by the current flowing therethrough. Preferably the bimetal switch 22 is heated by a resistor 26 adjacent thereto and in series therewith in the starting circuit, the lead 27 from which extends to the electrode 12.

According to the invention, a second resistor 28, normally out of circuit is connected to the electrode 11 and has a contact 29 in the path of deflection of switch arm 22, said resistor 28 being also arranged relative to said arm 22 to maintain the same heated whenever said resistor is in circuit.

In operation, when the main switch 15 is closed, the current will flow through electrode 11 through glow switch 17, lead 25, contacts 24 and 23, thermally responsive switch arm 22, resistor 26 and lead 27 to the companion electrode 12. With a normally operative lamp, when the arc has struck the glow switch 17 will be open, interrupting the series connection between electrodes 11 and 12 and as long as the arc is maintained, said switch remains open.

Should the lamp be defective and be incapable of maintaining the arc but tend to flash on and off intermittently, the bimetal switch 22 will become excessively heated by the heat evolved in resistor 26, after a few of such abortive starting operations have taken place. As a consequence, the bimetal switch 22 will open the series circuit at contact 24 and will engage contact 29, so that the circuit now will be from electrode 11 through resistor 28, contacts 29, bimetal switch arm 22, resistor 26 and lead 27 to the companion electrode 12. The resistor 28 is of resistance so high that the series connection now established across the electrodes 11 and 12 cuts down the current to negligible values. The heat evolved by the two resistors 26 and 28 in series, which are adjacent the bimetal switch arm 22, is sufficiently intense to keep said arm in the deflected position against contact 29 and thereby to preclude flashing of the lamp as long as the main switch 15 remains closed. When said switch 15 is opened, the bimetal switch arm 22 returns by its natural bias to the position shown in Fig. 1, so that the circuit automatically returns to its normal position to protect a new or replacement lamp and without need for manual resetting. If the defective lamp is not replaced, it will flash on and off through a few cycles whenever the main switch is again closed, to apprise of the need for replacement, but will then remain dark as above set forth.

In Fig. 2 is shown the application of the circuit to a thermal type of starter, in which the series starting connection between the electrodes 30 and 31 includes the bimetal switch arm 32 normally closed against contact 33 and adapted to open by the time the lamp has arced over in the ordinary operation of a perfect lamp, under the moderate heat evolved in an adjacent resistor 34 in circuit between the main 35 and the electrode 30. According to the present invention, there is connected in series with the bimetal starter switch 32, by way of lead 41, a bimetal safety switch 36 normally closed against contact 37. This safety switch is also subjected to the heat evolved in resistor 34, but is less sensitive than the normal starter switch 32 so that it will not become deflected in the normal operation of a perfect lamp.

In the operation of a defective lamp, however, excessive heat would be evolved in resistor 34

under the repeated abortive starting operations, and this would deflect the safety bimetal switch 36 away from contact 37 toward contact 38, thereby cutting into circuit an auxiliary resistor 39 adjacent the safety switch 36, and connected by lead 40 electrode 31. Once the safety switch 36 has operated after the initial abortive starting impulses upon a defective lamp, the current will pass from main 35 through resistor 34, electrode 30, starter switch 32, contact 33, lead 41, safety switch 36, contact 38, resistor 39 and lead 40 to the other electrode 31. Under the heat of resistor 39 combined with that of starting resistor 34, the safety switch 36 stays in deflected position as long as the circuit remains closed. Resistor 39 cuts down the current in the safety circuit to such an extent that no arcing can occur across electrodes 30 and 31.

In Figs. 3 to 7, inclusive, is shown a desirable glow starter unit incorporating starting and safety controls of the circuit shown in Fig. 1, although obviously a similar device may readily be devised to incorporate the starting and safety controls of the circuit of Fig. 2. The reference numerals in the circuit of Fig. 1 will be used to designate the corresponding elements of the structure of Figs. 3 to 7.

The unit involves the conventional insulating base 50 with its two terminal posts 51 and 52 and with a metal cap 53 having tabs 54 to secure it to the base 50. The cap 53 has insulating lining 55 covering its side wall and further insulating lining 55' for its top wall. In the unit is enclosed the insulating upstanding panel 56 affixed with respect to one of the terminal posts 51, to one side of which is mounted the glow starter switch 17. That switch may be of conventional construction involving a neon-filled glass tube 57 with electrodes 20, one of which is U-shaped and of bimetal. The control devices are disposed at the side of the panel 56 opposed to the glow tube 17. The bimetal switch 22 preferably in the form of a leaf, is affixed as by welding one end thereof to a finger 58 on a metal clip 59 riveted as at 60 to the panel 56 and preferably upset at one end 61 into the panel to preclude rotary shifting of the clip about the rivet. The bimetal leaf 22 extends upward the length of the panel and has a wire contact 23 at its end, which engages a wire contact 24 spaced from the panel 56 and mounted on a clip 62 affixed as by rivet 63 to the upper end of the panel 56, the rear of said rivet 63 being connected to one of the terminal leads 64 of the glow discharge tube.

The lower end of the bimetal switch 22 passes in a loop 22' about resistor R. That resistor (Fig. 8) has an electrically resisting core element 28 desirably of carbon or metal composition, one terminal wire 65 of which is soldered as at 66 to the panel 56 and connected to terminal post 51 to which is connected the other terminal lead 69 of the glow discharge tube 17. The opposite terminal wire 68 of the carbon resistor extends upward along panel 56 to a clip 70 riveted at 71 and soldered to the upper end of the panel and connected to a wire contact member 29 near contact 24 and normally spaced from the wire end 23 of the bimetal switch 22.

Coiled about the composition resistor 28 is a wire resistor 26 desirably of "Nichrome" wire. One terminal of this resistor 26 extends through the aperture 72 in the panel 56 to the terminal post 52 in the base 50 and the opposite end 73 of said wire resistor 26 extends through the rivet 60 and is soldered to the clip 59.

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The wire resistor 26 is preferably combined in a unitary structure with the composition resistor by embedding said wire in a coating of suitable resin or porcelain cement 74. The loop 22' of the bimetal switch is spaced from the composite resistor R by a gap in the order of .01 inch.

It will be understood that the set of the bimetal switch 22 is determined so as to effect the desired safety operation, whether the lamp is being used in a cold or in a hot environment. To this end the spring tension is such as to maintain the contact against contact 24 even at the highest temperature encountered in use of the operative lamp.

Preliminary to the operation of the safety switch, the resistor 26 will preheat the composition resistor 28 encompassed thereby so that the composition resistor 28 will reach the correct temperature for most effective operation in aiding the deflection of bimetal switch 22 from contact 24 to contact 29.

The spacing of the contacts 29 and 24 is the minimum consistent with no arcing and in practice is preferably equal to the diameter of contact wire 23 plus about .010 inch. By reason of the preheating of resistor 28 and the heat storing ability of the resistor assembly of Fig. 8, the resistor temperature remains considerably higher than that of the bimetal leaf 22 and therefore the movement of contact 23 on leaf 22 from 24 to 29 occurs quickly.

The heat generated by the resistor 26, 28 (Fig. 8) is of the order required to maintain the closure of the safety circuit even at the lowest voltage or temperature encountered.

In practice the composition resistor 28 which is normally out of circuit, may be of resistance of the order of 20,000 ohms, while the wire resistor 26 which is in circuit during the starting operation of a normal lamp may be of resistance of the order of 10 ohms.

As is clear from the foregoing, the resistor 28 or 39 of Figs. 1 and 2 respectively, and which is normally disconnected, is switched into circuit by the deflection of the safety switch under the action of resistors 26 or 34 respectively, in abnormal operation and serves to hold said switch against return from such deflected position.

While in Figs. 1 and 2, the two resistors are connected in series to prevent continued flashing of a defective lamp, it will be understood that the single holdout resistor 28 or 39 respectively, would alone be effective for the purpose, even though the actuating resistor 26 or 34 respectively, be cut out of circuit the instant it has performed its function of switching the hold-out resistor into circuit.

In Fig. 9 is shown an arrangement for thus switching a hold-out resistor into circuit and concomitantly switching the actuating resistor out of circuit. The actuating resistor 76 connected to one terminal of the starter switch 77 is connected directly to the hold-out resistor 78 which is normally out of circuit, since its other terminal is connected to the normally open contact 79 in the path of deflection of safety switch 80. The electrode 84 of the lamp is connected in the main 83, and opposite electrode 85 in the main 81 at the supply side of resistors 76 and 78. Preferably the two resistors 76 and 78 are closely juxtaposed, substantially as in Fig. 8.

In the normal starting operation, the current passes from main 81 through electrode 85 to resistor 76 and thence through the starter switch 77, contact 82, and safety switch 80 by way of

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electrode 84 to the other main 83. Upon excessive heating of resistor 76 as a result of the abortive attempts to start a defective lamp, the safety switch 80 disengages contact 82, and closes on contact 79, where it is held by the heat evolved in resistor 78, which is now connected in series with safety switch 80 and with electrodes 84 and 85 across the mains 81 and 83, the companion resistor 76 being now out of circuit.

In Fig. 10 is shown an arrangement generally similar to that of Fig. 9 except that the actuating resistor 76' intervenes between the electrode 85' and the connector 86 extending from the junction between the actuating resistor 76' and the hold-out resistor 78'. Accordingly in the normal starting operation, resistor 78' is out of circuit, but upon deflection of safety switch 80' under the influence of the heat generated by actuating resistor 76' in attempting to start a defective lamp, the circuit passes from main 83' through electrode 84' and safety switch 80' through resistor 78' and 76' in series to electrode 85' and the other main 81'.

The circuit of Fig. 1, as above described, lends itself readily to incorporation of the entire control equipment including the starter, the thermal switch arm and the associated resistors in a single unit, as shown in Figs. 3 to 7, which has but two terminals connected to the electrodes of the lamp. Likewise the entire control equipment of the circuit of Fig. 9, and that of Fig. 10 as well, can be incorporated in a single unit with but two terminals connected to the electrodes of the lamp. The control equipment of the unit of Fig. 2 can be similarly incorporated, except that it requires more terminals.

As many changes could be made in the above construction, and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. A safety starting and operating circuit for a gaseous electric discharge device equipped with spaced electrodes, said circuit comprising a starting connection including a pair of starting contacts, a pair of safety contacts and a heating element in series, with one of said starting contacts being connected directly to one of said safety contacts, whereby when said starting connection is in series with said electrodes and a source of current, current will pass through said starting connection and said electrodes, actuating means in series with said starting contacts controlled by current flow through said starting connection, separating said starting contacts and maintaining the latter separated only while the arc of the electric discharge device is maintained, thermally responsive, electrically conductive, displaceable means actuating at least one of said safety contacts and responsive to the prolonged starting current through said heating element in the attempted operation of a defective electric discharge device for separation of said safety contacts, and current operated heat evolving means positioned adjacent said displaceable means, directly connected at one end to the other of said starting contacts, having its free end normally disconnected from said safety contacts, and in the path of movement of said displaceable means, whereby upon separation of said safety contacts, and en-

gagement of said displaceable means with said free end, said current operated heat evolving means will be connected in series with said two electrodes, said heating element and such source of current to maintain said safety contacts separated.

2. The combination set forth in claim 1 in which the end of said current operated heat evolving means connected to the other of said starting contacts is also directly connected to one of such electrodes.

3. The combination set forth in claim 1 in which the end of said current operated heat evolving means connected to the other of said starting contacts is also directly connected to said heating element.

4. A safety starting and operating circuit for a gaseous electric discharge device equipped with spaced electrodes, said circuit comprising a starting connection including a pair of normally engaged starting contacts, a pair of safety contacts, a resistor and a heat responsive electrically conductive safety switch arm in series, said resistor being in thermal association with said switch arm, with one of said starting contacts being connected directly to one of said safety contacts and said switch arm carrying the other of said safety contacts, whereby when said starting connection is in series with said electrodes and a source of current, current will pass through said starting connection and said electrodes, actuating means in series with said starting contacts controlled by current flow through said starting connection, separating said starting contacts and maintaining the latter separated only while the arc of the electric discharge device is maintained, said resistor evolving sufficient heat in the attempted operation of a defective electric discharge device for displacement of said safety switch arm and separation of said safety contacts, and a second resistor in thermal association with said switch arm, normally out of circuit, directly connected at one end to the other of said starting contacts and having its free end normally disconnected from said switch arm and in the path of movement of the latter, whereby upon displacement of said switch arm and engagement with said free end, said two resistors and said switch arm will be connected in series with said two electrodes and such source of current, said two resistors conjointly generating sufficient heat to maintain the switch arm in deflected position against said free end as long as the circuit is closed.

5. A safety starting and operating circuit for a gaseous electric discharge device equipped with spaced electrodes, said circuit comprising a starting connection including a pair of safety contacts, a heating element and a glow switch starter having a pair of starting contacts, all in series, with one of said starting contacts being connected directly to one of said safety contacts, whereby when said starting connection is in series with said electrodes and a source of current, current will pass through said starting connection and said electrodes, said pair of starting contacts in said glow switch starter separating and remaining separated only while the arc of the lamp is maintained, a heat responsive electrically conductive safety switch arm actuating at least one of said safety contacts and responsive to the prolonged starting current through said heating element in the attempted operation of a defective lamp for separation of said safety contacts, and a second heating element positioned adjacent said switch arm, directly connected at

one end to the other of said starting contacts, and having its free end normally disconnected from said safety contacts, and in the path of movement of said switch arm, whereby upon separation of said safety contacts and engagement of said switch arm with said free end, said two heating elements will be connected in series with said two electrodes, said two heating elements conjointly generating sufficient heat to maintain said switch arm in deflected position against said free end as long as the circuit is closed.

6. A safety starting and operating circuit for a gaseous electric discharge device equipped with spaced electrodes, said circuit comprising a starting connection including a pair of normally open starting contacts, a pair of normally closed safety contacts, a resistor and a heat responsive electrically conductive safety switch arm carrying one of said safety contacts, all in series with one of said starting contacts being connected directly to the other of said safety contacts, whereby when said starting connection is in series with said electrodes and a source of current, current will pass through said starting connection and said electrodes, actuating means in series with said starting contacts controlling the latter and controlled by current flow through said starting connection, said actuating means being normally inoperative while the arc of the electric discharge device is maintained, whereby said starting contacts will be retained in open position to break the circuit from such source of current to said resistor, said resistor evolving sufficient heat in the attempted operation of a defective electric discharge device for displacement of said safety switch arm to separate said safety contacts, and a second resistor in thermal association with said switch arm directly connected at one end to the other of said starting contacts and having its free end normally disconnected from said switch arm and in the path of movement of the latter, whereby upon displacement of said switch arm and engagement with said free end, said two resistors and said switch arm will be connected in series with said two electrodes and such source of current, said two resistors conjointly generating sufficient heat to maintain the switch arm in deflected position against said free end as long as the circuit is closed.

7. A safety starter for a gaseous electric discharge device equipped with spaced electrodes, said starter comprising a starter unit including a pair of starting contacts, means for actuating said contacts repeatedly to open and close the latter, an associated bimetal safety switch arm, a support therefor at one end thereof, a pair of resistances at the support end of said switch arm in heat transfer relation thereto, a pair of neighboring contacts, one of said neighboring contacts being connected to one of said starting contacts and normally engaged by the free end of said switch arm, the other of said neighboring contacts being normally spaced from the free end of said switch arm in the path of movement thereof and connected to one end of one of said resistances, the free end of said last named resistance being connected directly to the other of said starting contacts, a pair of terminals, one of said terminals being connected to one end of the other of said resistances, the other end of said last named resistance being connected in series with said safety switch arm, said pair of starting contacts, and said other terminal.

8. A safety starter for a gaseous electric discharge device equipped with spaced electrodes,

said starter comprising a starter unit including a pair of starting contacts, means for actuating said contacts respectively to open and close the latter and to leave them open upon initiation of a discharge between said electrodes, an associated bimetal safety switch arm, a support therefor at one end thereof, a pair of resistances at the support end of said switch arm in heat transfer relation thereto, one of said resistances being connected at one end to said bimetal switch arm, a pair of neighboring contacts, one of said neighboring contacts being connected to one of said starting contacts and normally engaged by the free end of said switch arm, the other of said neighboring contacts being normally spaced from said switch arm and connected to one end of the other of said resistances, the free end of said last named resistance being connected directly to the other of said starting contacts and a pair of terminals connected respectively to said last named starting contact and the free end of said first named resistance.

9. A safety starting device for a gaseous electric discharge lamp equipped with spaced electrodes, said device comprising a self contained unit including a starter element having a pair of starting contacts, means for actuating said contacts repeatedly to open and close the latter and to leave them open upon initiation of a discharge between said electrodes, a safety element comprising a bimetal switch leaf, said switch leaf having a loop at one end affixed to said panel, and a contact carried by the other end thereof, a heater unit encompassed by said loop of said bimetal switch leaf, said heater unit comprising a pair of heater elements in heat transfer relation to said switch leaf, one of said heater elements being connected at one end to said switch leaf near the looped end thereof, a terminal post connected to the other end of said heater element, a pair of fixed contacts mounted on the panel adjacent the contact carrying end of said switch leaf, one of said fixed contacts being connected to one of said starting contacts and normally engaged by the contact carried by said switch leaf, the other of said contacts being normally spaced from said contact carried by said switch leaf and connected to one end of the other of said resistances, the free end of said last named resistance being connected directly to the other of said starting contacts and to a second terminal post.

10. The combination set forth in claim 9 in which said first resistor encompasses said second resistor.

11. In a safety starter unit, the combination of a support base, a panel rising therefrom, a starter element at one side of the panel and including a pair of starting contacts, means for actuating said contacts repeatedly to open and close the latter, and safety means at the other side of the panel, said safety means comprising a bimetal switch arm having a looped portion at one end affixed to said panel, a contact at the free end of said bimetal switch arm, a pair of

neighboring contacts including a contact normally engaged by said switch contact and connected to one of said starting contacts, and a second contact normally spaced from said switch contact, a resistor unit disposed in the bight of said loop and in heat transfer relation to said switch arm, said resistor unit including a composition resistance connected at one end to said second contact, and a wire resistor connected at one end to said bimetal switch arm, and a pair of terminal posts through said support base and connected respectively to the other end of said wire resistor, and to the other end of said composition resistor and to the other of said starting contacts.

12. A safety starter unit for a gaseous electrical discharge device, comprising a support base having a pair of terminal posts, an insulating panel rising therefrom, a glow switch starting unit mounted on one face of said panel and including a pair of normally open starting contacts having one of said starting contacts connected to one of said posts, safety means mounted on the other face of said panel, said means in said glow switch starting unit for actuating said contacts repeatedly to open and close the latter, safety means comprising a bimetal switch having a loop at its base and affixed to said panel, a resistor unit disposed in the bight of said loop and comprising a composition resistance, a lead from said resistance extending along said panel, and a contact extending transversely at the top of said panel and connected to said lead, the opposite end of said composition resistor being connected to said last named terminal post, said resistor unit also including a wire resistor, one end of said wire resistor being connected to said bimetal switch, the other end of said wire resistor being connected to the other terminal post, said panel having a contact near but spaced from said transverse contact and normally engaged by the outer end of said bimetal switch, said latter contact being connected to the other starting contact of the starter unit.

MAYNARD A. BABB.
ARNOLD E. HAYES.

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