This invention relates to starters, such as are used for fluorescent lamps. More particularly, the invention relates to that type of starter having an automatic switch and having means for preventing the starter from operating after the fluorescent lamp has failed and cannot maintain its arc.

One fluorescent lamp starter in common use has a thermal-responsive switch in series with a resistor and also has a second resistor in parallel with the first resistor and the switch, which serves to keep the switch warm so that it remains open after the initial supply of current has heated the switch enough to make it open. A capacitor is included in the circuit to suppress radio interference from the lamp.

It is an object of this invention to provide an improved fluorescent lamp starter in which a single unit having plate-like resistors takes the place of not only the separate resistors, but also the capacitor, used in known starters of a usual type. Another object is to make the manufacture of starters more economical by reducing the number of parts that have to be assembled.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views:

FIGURE 1 is a diagrammatic view showing a fluorescent starter of the prior art;

FIGURE 2 is a diagrammatic, sectional view of a fluorescent lamp starter made in accordance with this invention;

FIGURE 2a is a wiring diagram for the apparatus shown in FIGURE 2;

FIGURE 3 is a fragmentary sectional view showing the resistor on one side of a separator of the resistor unit shown in FIGURE 2;

FIGURE 4 is a view similar to FIGURE 3 but showing the other side of the separator;

FIGURE 5 is a greatly enlarged, fragmentary view taken on the section line 5—5 of FIGURE 4.

FIGURE 6 is a side elevation showing a modified form of the invention;

FIGURES 7 and 8 are top and bottom plan views, respectively, of the construction shown in FIGURE 6;

FIGURE 9 is a wiring diagram for the modified construction shown in FIGURES 6-8.

FIGURE 1 shows a starter 10 consisting of a glow tube 12, a thermally-operated switch, usually made with a bi-metal strip 14, a resistance element 16 connected in series with the glow tube 12 and the bi-metal switch 14. The starter 10 also includes a second resistance element 18 and a capacitor 20 connected across one part of the circuit and preferably across the resistance element 18. The starter 10 has conductors 21 and 22 connected to the opposite ends of a fluorescent lamp 24. The other side of the lamp is connected with a power line 26 with the usual ballast 28.

When the current from the power line 26 is supplied to the lamp 24, current flows through the starter including the switch 14 which is normally closed. As the resistance elements 16 and 18 become heated, the bi-metal of the switch 14 is caused to warp and move in a direction to open the switch. This breaks the circuit through the glow tube 12 and through the resistance element 18.

The opening of switch 14 does not open the circuit of the resistance element 18 which is connected in parallel with the other parts of the starter. During operation of the lamp, enough current flows through the resistance element 18 to keep the bi-metal switch 14 heated so that it will remain open as long as the current is supplied to the lamp 24.

FIGURE 2 shows the improved construction of this invention for starters of the character shown diagrammatically in FIGURE 1. The starter of FIGURE 2 includes a glow tube 32 and a switch 34 consisting of a bi-metal strip 36 secured at one end to an insulating block 38 attached to a panel 40. The other end of the bi-metal strip 36 carries a movable contact 42 which bears against a fixed contact 44 on the panel 40. When the bi-metal strip 36 is heated, it warps in a direction to move the contact 42 away from the fixed contact 44 and thus opens the switch 34.

The contact 44 is connected with the glow tube 32 by a conductor 46. The other side of the glow tube 32 has a conductor 48 which leads to another conductor 50 at one end of the panel 40.

The conductor 50 also connects with a resistor assembly 52. This resistor assembly 52 includes a separator 54 having resistors 56 and 58 on opposite sides of the separator.

In the construction illustrated in FIGURE 2, the resistor 56 is connected at one side by a conductor 60 to the conductor 50 at one end of the panel 40. The other side of the resistor 56 is connected by a conductor 62 to the resistor 58. At the other side of the resistor 58 there is another conductor 66 by which the resistor 58 connects with the bi-metal strip 36.

The circuit shown in FIGURE 2 also includes a conductor 70 leading from the conductor 62 to an end conductor 72 on the opposite side of the panel 40 from the conductor 50. These panel conductors 50 and 70 connect with terminals 74 and 76 extending from and supported by an end plate 78. Conductors 81 and 82 lead from the terminals 74 and 76 to a fluorescent lamp 24 and this lamp is connected with the power line 26 through the ballast 28.

When power is supplied to the lamp 24, current flows from the conductor 81 through the terminal 74 and through the conductors 50 and 60 to the resistor 56. On the other side of the resistor 56, the current flows through the conductors 70 and 72 to the terminal 76 which is connected by the conductor 82 with the other side of the power line. Current also flows from the conductor 90 through the conductor 48 to the glow tube 32 and then through the conductor 46, switch contacts 44 and 42, and through the bi-metal strip 36 and conductor 66 to the resistor 58 which is connected by the conductors 70 and 72 with the terminal 76.

The resistors 56 and 58, and their separator 54, are enclosed in a shell of electrical insulation 86 which actually contacts with the resistors 56 and 58 but which is shown separated from them in FIGURE 2 for clearer illustration. The insulation material 86 touches the bi-metal strip 36 so that heat generated by passage of current through the resistors 56 and 58 passes through the electrical insulating material 86 by conduction and causes the bi-metal strip 36 to be heated until it moves the contact 42 away from the fixed contact 44 and thus breaks the circuit through the glow tube 32. The circuit through the resistor 56 is not disturbed, however, since it is in parallel with the glow tube circuit and the continued flow of electricity through the resistor 56 maintains suffi-
cient heat to keep the bi-metal strip warped so that its contact does not touch the fixed contact. FIGURES 3, 4, 5 and 6 show the construction of the resistor assembly 52 which is shown diagrammatically in FIGURE 2. The separator 54 is preferably made of ceramic material and is relatively thin. This separator 54 is best shown in FIGURE 5. The separator 54 has its opposite sides coated with printed conductors. This print is on the surface of the separator 54 as illustrated in FIGURES 3 and 4, the areas of conductive material which are printed on the opposite faces of the separator 54 being designated by the reference characters 91, 92, 93 and 94.

The conductor 66 is connected to the printed portion 92 by solder 98. The conductor 62 is connected with the printed portion 91 by solder 98. On the other side of the separator 54, the conductor 70 is soldered to the printed portion 93 and the conductor 60 is soldered to the printed portion 94. The resistor 58 is printed on one side of the separator 54, as shown in FIGURE 5, so as to have its different edge portions overlap and connect with the printed portions 91 and 92 of the conductors. The resistor 56 is printed on the other side of the separator 58 and overlaps the printed portions 93 and 94 of the conductors.

The insulating material 86 which surrounds and covers the assembly 52 is shown in FIGURES 3–5. This insulating material 86 is a coating over the resistors 56 and 58, and over the exposed areas of the separator 54 and the printed portions 91, 92, 93 and 94 of the conductors. The material 86 is preferably molded on the resistors, separator, and printed portions of the conductors; and there is no spacing such as shown in FIGURE 2. The separation in that figure is merely for clearer illustration of the circuits.

FIGURES 6–8 show a modified form of the invention which may be connected in accordance with the wiring diagram of FIGURE 9. In this modified construction, a separator 106, which separates the resistors from one another, also serves as the supporting frame for the entire starter unit. The separator 106 is made of a high "K" dielectric ceramic composition, of which barium titanates are probably the best known. A "K" of 6,000 is typical. Other compositions that can be used include the separators of this invention are strontium titanate, lead titanate, magnesia, and certain of the alkaline earth oxides and mixtures of these materials.

On one side of the separator 106, there is a resistor 108 and on the other side there is a resistor 110. These resistors 108 and 110 may be applied to the separator 106 in the same manner as the resistors 56 and 58 are applied to the separator 54 in the construction illustrated in FIGURES 2–5. Underlying areas of highly conductive material, such as silver, are printed on the separator 106. The highly conductive printed areas are indicated by the reference characters 111, 112, 113 and 114.

In constructions having the resistors on opposite sides of a separator which serves as the frame on which the starter is assembled, the resistors on opposite sides of the separator can be connected by a jumper or clip 116 which passes around an edge of the separator 106; and in the preferred construction shown in FIGURES 6–8, a rivet 122 extends through the separator 106 and holds the clip 116 against the edge of the separator. The clip 116 establishes a circuit between the highly conductive printed area 113 and a bi-metal strip 126 which is preferably a continuation of the clip 116.

A contact 128 extends through the separator 106 and is in contact under the end of the bi-metal strip 126 remote from the rivet 122. With changes in temperature, the strip 126 moves toward and from the contact 128. This contact 128 is in the circuit with the highly conductive printed area 112.

The glow tube 32 is connected with the resistor 108 by conductors 130 and 131, and through the printed area 112. The resistor 111; and is connected with the resistor 110 by other conductors 132 and 133. The conductors 130 and 132 are stiff enough to support the glow tube 32 from a panel 134 that carries terminals 136, 137 and 138. The conductors 130 and 131 are connected to the terminal 136; and the conductors 132 and 133 are connected with the terminal 137. A conductor 140 connects the contact 128 with the terminal 138. The conductors 131 and 132 are preferably stiff enough to support the separator 106 from the panel 134. This panel closes one end of a housing 144 in which the starter is contained.

FIGURE 9 shows a wiring diagram for the starter illustrated in FIGURES 6–8, and the operation of this wiring diagram will be evident from the description of the starter shown in FIGURES 2–5. The principle of operation is identical and the changes in the wiring are merely those necessitated by the different location of the structural elements of the starter.

The preferred construction has been illustrated and described, but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. A fluorescent lamp starter including first and second resistor elements of plate form, said resistors being physically located parallel to one another in a contiguous relationship so as to create a capacitance between them, a thermal responsive switch connected in a series circuit with said first resistor, said second resistor being connected in parallel with said series circuit, and said first and second resistors being located in close physical relationship with said thermal switch so as to supply heat to the switch, said parallel combination of plate resistors and thermal switch being mounted on a single support for connection in parallel with a fluorescent lamp.

2. A fluorescent lamp starter including a panel, a separator plate supported from the panel, resistors on opposite sides of the separator plate and adjacent to the surfaces of the separator plate, a bi-metal strip connected at one end with the separator plate and in an electric circuit with one of the resistors, a contact for connection with a power circuit, the other end of the bi-metal strip being movable toward and from said contact with changes in temperature of the bi-metal strip.

3. The fluorescent lamp starter described in claim 2, and in which the separator plate is a high dielectric composition.

4. The fluorescent lamp starter described in claim 3, and in which the separator plate has a "K" value of at least approximately 6,000.

5. A fluorescent lamp starter including two resistor elements of plate form and located close together to serve as a capacitor, said resistors being connected in parallel with the resistance elements of a fluorescent lamp to provide capacitance for reducing radio interference, an automatic, thermally-responsive switch in series with one of the resistor elements, the other resistor element being connected in parallel with the switch, and both of the resistor elements being in position to supply heat to said switch, and in which the automatic, thermally-responsive switch includes contacts and a bi-metal strip to which one of the contacts is connected, and the resistor elements are in position to supply heat to the bi-metal to operate the switch, the bi-metal strip being located so that heating of the strip moves it in a direction to open the contacts of the switch, and said other resistor maintaining the switch open by supplying heat to the bi-metal strip, and a separator located between the resistor elements and by which the resistor elements are carried, said separator being made of electrical insulating material, there being a coating of electrical insulating material over the resistor elements and the separator, the coating touching the bi-metal strip and the heat from said other resistor.
to the bi-metal being transmitted by conduction through the coating.

6. The fluorescent lamp starter described in claim 5 and in which the resistor elements and the separator with the coating over them comprise a single unit, and there are conductors extending from the resistor elements and through the insulation, a panel by which the unit is carried, the unit being connected and supported from the panel by the conductors.

7. The fluorescent lamp starter described in claim 6 and in which there is a glow tube in series with the switch, and the glow tube is supported from the panel by electrical conductors, and the conductors connect the tube in series with the switch.

8. The fluorescent lamp starter described in claim 7 and in which the panel is supported from an end plate and there are terminals on the end plate on the side of the end plate remote from the panel, and the conductors from the resistor and tube circuit are connected with the terminals.

9. The fluorescent lamp starter described in claim 8 and in which there is a housing into which the starter fits, a shoulder near one end of the housing, the end plate fitting into one end of the housing, and means for holding the end plate in fixed relation with the housing.

10. A fluorescent lamp starter including two resistor elements of plate form and located close together to serve as a capacitor, conductors for connecting the resistance elements across a fluorescent lamp to provide capacitance for reducing radio interference, an automatic, thermally-responsive switch in series with one of the resistor elements, the other resistor element being connected in parallel with the switch, and both of the resistor elements being in position to supply heat to said switch, and in which there is a separator between the resistors, and the resistors are coatings applied to opposite surfaces of the separator.

11. The fluorescent lamp starter described in claim 10 and in which the conductors include portions that are printed on the opposite surfaces of the separator, and the resistors have portions of their areas overlapping and adhered to part of the areas of the printed portions of the conductors.

12. A fluorescent lamp starter including two resistor elements of plate form and located close together to serve as a capacitor, conductors for connecting the resistance elements across a fluorescent lamp to provide capacitance for reducing radio interference, an automatic, thermally-responsive switch in series with one of the resistor elements, the other resistor element being connected in parallel with the switch, and both of the resistor elements being in position to supply heat to said switch, and in which there is a separator between the resistors, and the thermally responsive switch includes contacts and a bi-metal strip, the strip and contacts being supported from the separator whereby the separator, resistors, and thermally responsive switch constitute a unitary assembly.

13. The fluorescent lamp starter described in claim 12, and in which there is a glow tube in series with the resistor that is in series with the thermally responsive switch, the glow tube also being supported from the separator and comprising part of the unitary assembly.

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