United States Patent

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Dallas, Tex.

[54] **FLUORESCENT LAMP BALLAST PROTECTOR MEANS AND METHOD**
7 Claims, 7 Drawing Figs.

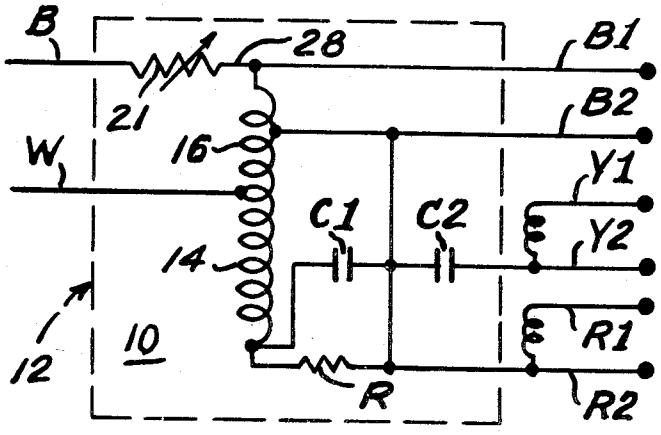
[52] **U.S. Cl.** **317/15,** 317/41
[51] **Int. Cl.** **H02h 7/04**
[50] **Field of Search** ..... 317/14 H, 15, 41

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ABSTRACT: A fluorescent lamp ballast protector which senses and limits the amount of heat generated within a ballast, thereby keeping temperature in the ballast within a preselected temperature limit to avoid deleterious effects on insulation comprises a heat-responsive layer of material having negligible resistance at temperatures below a threshold and a resistance which increases by several orders of magnitude per degree at temperatures above the threshold. The layer is preferably placed in optimum heat-transfer relation with the windings and electrically connected in series relation between a power source and the ballast. The sensor/protector can be mounted on a separate heat-conductive member to enhance heat transfer.



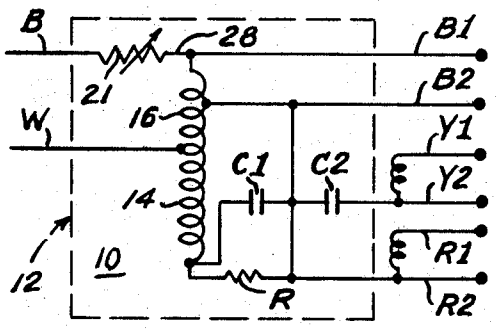


Fig. 1.

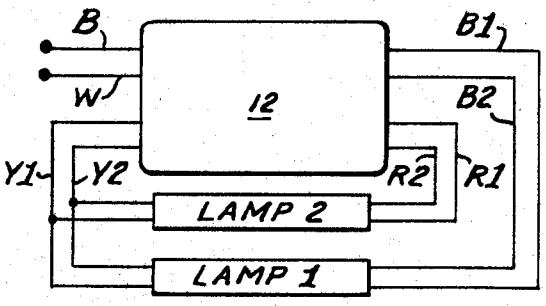


Fig. 1A.

Fig. 2.

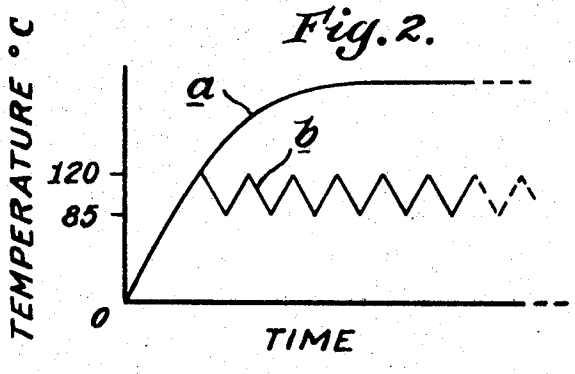


Fig. 3.

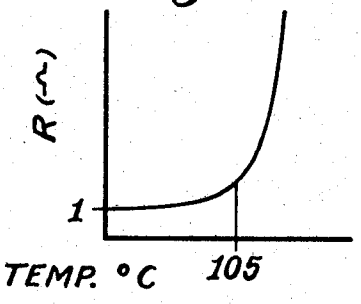


Fig. 4.

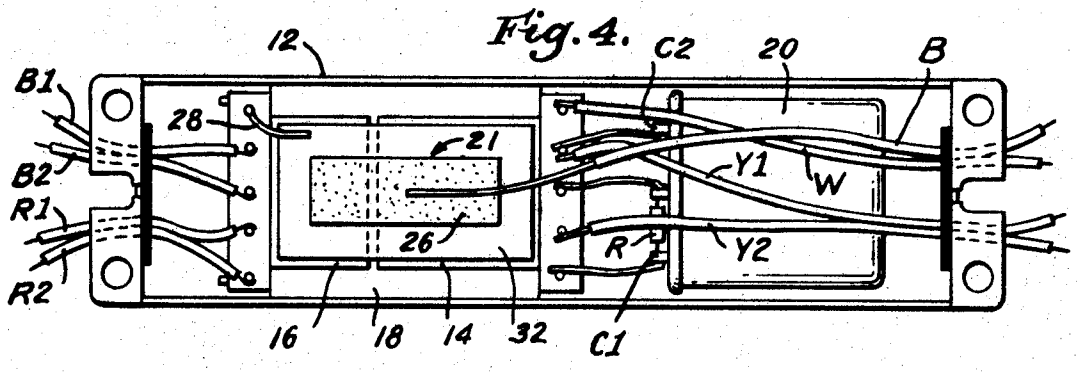


Fig. 6.

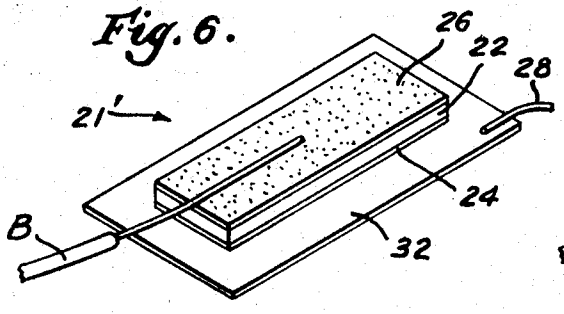
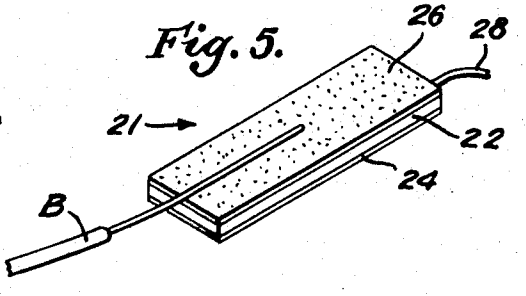


Fig. 5.



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FLUORESCENT LAMP BALLAST PROTECTOR MEANS AND METHOD

BACKGROUND OF INVENTION

A fluorescent lamp is an electric discharge device having a negative coefficient of resistance. Therefore, means are required to limit the current passing through the lamp during operation to prevent a runaway condition. Further, starting of a fluorescent lamp is facilitated by providing high voltage and operation is enhanced by providing proper voltage and current levels. These functions are served by devices called ballasts which, essentially, include a transformer having an iron core and a condenser located in a housing completely filled in with a potting compound commonly referred to as pitch.

During normal operation, the coil temperatures of a ballast run from 90° C. to 100° C. Class A insulation having a temperature limit of 105° C. is the standard insulation currently used in ballasts. This results in a normal ballast life expectancy of approximately 12 years. However, under some conditions, temperatures may exceed 105° C. by substantial amounts. If the ballasts are allowed to run at elevated temperatures, the life of the insulation deteriorates rapidly. With one lamp out, some ballasts run as high as 125° C. Such a ballast will have an average life of only 3 years. Lamp rectification, another cause of overheating, may result in coil temperatures of 180° C. or more, causing the pitch to melt and drop and causing rapid deterioration of the insulation. A fixture which is not properly dissipating heat or where an error has been made in the installation, can result in temperatures up to 150° C. with concomitant ballast failure. Essentially, ballast failure is caused by deterioration of the insulation. This results in internal shorts or hot spots, causing temperatures as high as 200° C., or more resulting in dripping of pitch, ignition of adjacent combustible material, or even violent failure.

In recent years there has been a trend to design the ballast with a cross-sectional area smaller to make them compatible with new designs for shallow fixtures made for ceiling mountings and the like. However, this increases the operating temperatures in the ballast and therefore shortens the life of the ballast.

Most ballast failures result in little more deleterious effects than lamp extinction. That is, normally the ballast is deenergized when a component fails with no excessive current or leakage. However, failures of insulating material or components can occur that result in excessive heating with or without excessive input current.

It will be obvious, in view of the purposes of the ballast mentioned above and the possibility of ballast failures that ballasts must be protected to prevent the starting of fires, damage to surrounding area, etc. In fact, the National Electrical Code published by the National Fire Protection Association states in Article 410–71(*e*) "Fluorescent fixtures for indoor installation shall incorporate ballast protection."

Individual fuses have been used in an attempt to minimize the effect of the excessive current input as well as excessive temperature conditions. Bimetallic switches which open the line or deenergize the circuit upon the occurrence of a specific temperature and automatically reset at a different and lower specific temperature have also been used to protect against ballast failures. These thermal cutouts are placed in ballasts near the core and coil to sense any excessive temperatures. FIG. 2 shows curve *a* of an unprotected ballast in a failure mode while curve *b* is for a ballast protected with a bimetallic switch type protector which causes cycling between a high of 120° C. and a reset temperature of 85° C. The switch turns the ballast off and allows the ballast to cool down until it is safe for it to continue operation and will allow the ballast to operate until a fault condition pushes the temperature up to the unsafe limit again. Upon correction of the fault, the ballast which has not been abused by excessive temperatures can then be used to normal full life.

Both the fuse and the bimetallic switch have certain inherent disadvantages, however. The fuse protector has the disadvantage that when it breaks the circuit the entire ballast must be replaced even though in many instances the fault may not have been in the ballast. Further, fuses have the characteristic of aging with a concomitant change in calibration—that is, the opening temperature rises with aging. A disadvantage of any bimetallic switch is that it may aggravate a minor failure by continually returning the ballast to the line time after time. It is even conceivable that in some circumstances a minor failure could develop into a spectacular one. Although atypical, some fixture explosions have occurred where gases generated from a failed ballast have ignited on reenergizing the fixture after a normal off period.

An object of the invention is the provision of ballast protector means which will protect the ballast against deleterious effects of heat and current. Yet another object is the provision of a protector which is manually resettable. Another object of the invention is the provision of resettable means for protecting a ballast which minimizes the danger of causing ignition of volatile materials. Another object of the invention is the provision of protector means which are reliable yet which do not add to the expense of the unit by any significant amount, and which can readily be insertable in the ballast casing.

The above and other important objects of the invention will become apparent from the following description and the accompanying drawings illustrating several embodiments of the invention.

It should be understood, however, that this is given only by way of illustration and not of limitation, and that various changes in the detailed construction of the invention may be made without departing from the scope thereof.

FIG. 1 is a circuit diagram of a typical ballast protected by a sensor/protector made in accordance with this invention;

FIG. 1A is a schematic diagram showing the wiring connections between a typical ballast and two lamps;

FIG. 2 is a characteristic curve of ballast temperature in a failure mode, protected by a bimetallic switch and one which is unprotected;

FIG. 3 is a Resistivity v. Temperature curve of a sensor/protector made in accordance with the invention;

FIG. 4 is a plan view showing the main component parts of the ballast and the location of the sensor/protector of the instant invention;

FIG. 5 is a pictorial view of a protector used in the invention; and

FIG. 6 is a modification of FIG. 5.

Referring now to the drawings in detail, the ballast unit is generally indicated by the numeral **10**. A casing **12**, generally parallelepiped in shape, contains therein a primary coil **14** and a secondary coil **16** of a transformer having a core **18**. Also mounted within the casing is a condenser **20**. A plate **32** of good thermally conductive material such as copper is placed on the windings **14**, **16** but electrically insulated therefrom by conventional means. As may be seen in FIG. 3, sensor/protector **21** has a resistance of the order of 1 ohm at room temperature, but its resistance rises by several orders of magnitude within a temperature range of a few degrees above a threshold or anomaly temperature. Layers **24** and **26** of a conventional solder are attached to layer **22** by ultrasonic vibration or other conventional means, after which plate **32** is attached as by soldering to layer **24** and leads **28** and **30** are attached to plate **32** and layer **26** respectively by standard soldering techniques. The material of layer **22**, as stated above, possesses a resistance characteristic having a positive temperature coefficient (PTC) and a sharply defined transition temperature above which its resistance increases sharply. Examples of such materials are barium-titanate doped with lanthanum $Ba_{0.997}La_{0.0033}$ and carbon black-filled polyethylene. These materials have heretofore been employed in PTC thermistors and also in self-regulating heaters since, when such materials are supplied with a constant voltage, the power consumed falls off rapidly as soon as the transition temperature is reached. In the present invention, layer **22** is employed as a switching element to essentially cut off or reduce the current applied to the ballast upon overheating.

As seen in FIG. 5, it may be desirable to omit heat collector plate 32 in some cases. Then leads 28, 30 are soldered directly to layers 24, 26 respectively.

FIG. 1 shows a schematic wiring diagram for the ballast of FIG. 4 while FIG. 1A shows how the ballast is connected to the lamps. Since the operation of a ballast per se is well known in the art, only a brief description will be given. The PTC sensor/protector 21 is placed in series with the ballast in one of the main lead lines, B and W, and preferably in line B, as shown in the FIGURE. Both capacitors C1 and C2, C1 being the larger, are contained in housing 20. Upon initial energization of the ballast, due to the step-up transformer, 250 volts are impressed between leads B1, B2 and leads Y1, Y2, causing lamp 1 to fire. The voltage then collapses across lamp 1 with the voltage then impressed across lamp 2 causing it to fire. Thereafter equal voltage is impressed across each lamp.

Essentially, the protector 21 acts as a temperature sensor sensing the temperature and current of the coil so that upon the occurrence of any fault condition in the ballast, the concomitant increase in current or temperature is carried over to the protector 21. The temperature of the protector 21 increases by heat transfer from the ballast and I^2R heating from the current until a point is reached when there is a feedback effect in element 21. That is, once the I^2R heat generated in element 21 exceeds the heat dissipated, self-heating will cause the resistance to rapidly increase beyond the threshold point from approximately 1 ohm to several thousand ohms until the current is effectively turned off except for a negligible amount which keeps element 21 in the high resistance stage as long as the fault remains. Thus, element 21 acts like a switch which deenergizes the ballast. However, this is done without cycling and the concomitant disadvantage associated with the bimetallic switch is pointed out supra, since some current will continue to flow through the ballast keeping the layer 22 in the high resistance state as long as a fault is in existence, while at the same time keeping the temperature within safe limits. In other words, a balance is reached between heat generated in the sensor and heat dissipated. Thus, the arcing which may result from the energization of a circuit while a fault exists as with a bimetallic protector is obviated, while at the same time the invention provides means to permit the operation of a ballast while a minor fault exists without the danger of exacerbating the condition of the ballast due to temperatures which would deleteriously affect the insulation of the various component parts, yet avoids the indefinite cycling associated with a bimetallic switch when a fault occurs.

Further, since the lamps are extinguished upon the existence of a fault, the problem is readily discerned and can be quickly corrected without the need for replacing the whole ballast if it is still usable. Use of sensor/protector 21 requires that for resetting, the light switch be turned off and the unit allowed to cool. Then if the problem is of a minor nature, e.g., if it is due to poor ventilation or a particularly hot day, the lamps will restart upon closing of the light switch.

An example illustrative of my invention is as follows:

A sensor/protector was made in accordance with the FIG. 6 embodiment having a room temperature resistance of 1.2 ohms. When connected as shown in FIGS. 1, 2 and 4, a voltage drop of approximately 1.12 volts occurred across sensor/protector 21. The temperature of the ballast was then increased to simulate overheating thereof. Switching occurred at 115° C. at which point the voltage drop across element 21 increased to 44 volts while the current dropped to 200 ma., thereby effectively protecting the ballast unit.

Thus, the disadvantages of the nonresettable protector in which the entire ballast unit must be replaced once the fuse has been burnt out and the danger of changes in calibration of the fuse due to aging, as well as the possible harmful affects of cycling the ballast on and off, have been avoided by the instant invention. Further, since the sensor/protector has no moving parts, it has an extremely long life compared to bimetal types which are subject to calibration shifts upon excessive cycling. Due to its construction, the sensor/protector is of extremely low cost while facilitating ease of installation.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results obtained.

As various changes could be made in the above constructions without departing from the scope of the invention, 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.

I claim:

1. The method of protecting fluorescent lamp ballasts from deleterious excessive temperatures due to a fault condition in a component of the ballast comprising:

taking a layer of material having a resistance of approximately 1 ohm and having a threshold temperature above which the resistance rises several orders of magnitude,

placing the layer in heat-transfer relation to the windings of the ballast,

electrically connecting the layer between a power source and the ballast, whereby the temperature within the ballast will be limited to a desired maximum value by a decrease in current in the windings.

2. The method of claim 1 where the layer has a threshold temperature of approximately 105° Centigrade.

3. The method of claim 1 where the layer is lanthanum doped barium titanate.

4. The method of claim 1 where the layer is carbon black-filled polyethylene.

5. In a fluorescent lamp ballast comprising transformer primary and secondary windings and a condenser, the combination with said ballast of a sensor/protector comprising a layer of PTC material having a relatively constant resistance of negligible quantity at temperatures below a selected threshold and a resistance which increases by several orders of magnitude with temperature above the threshold, the layer supported in heat-transfer relation with the ballast windings and electrically connected in series relation between a power source and the ballast.

6. The structure according to claim 5 in which conductive layers are attached to spaced portions of the PTC layer.

7. The structure according to claim 5 in which the sensor/protector is attached to a thermally conductive plate and the plate bridges the windings.

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