March 9, 1965 G. W. STAKE 3,173,059

BALLAST WITH THERMAL CUT-OUT

Filed May 28, 1962

FIG. 1

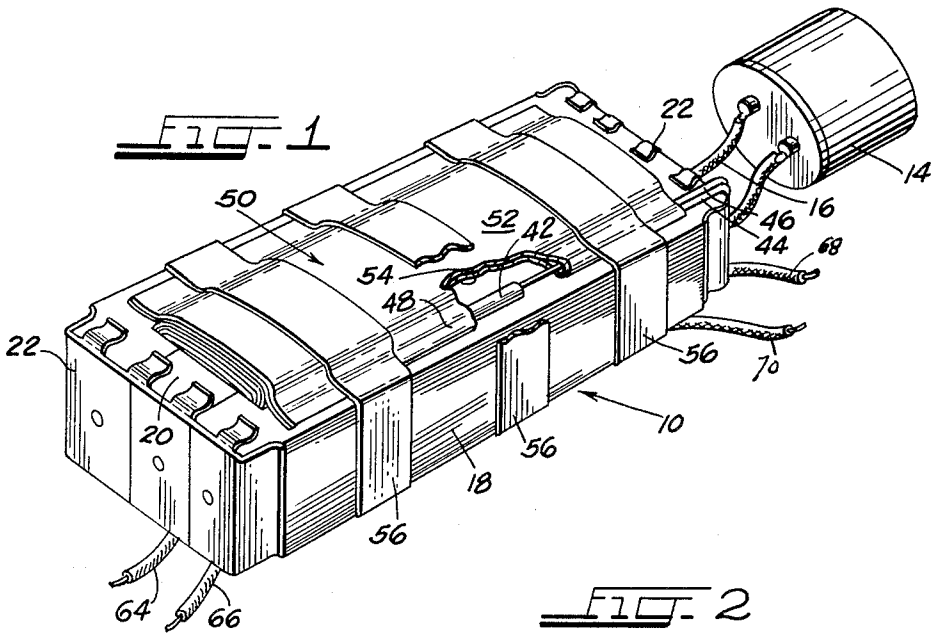


FIG. 2

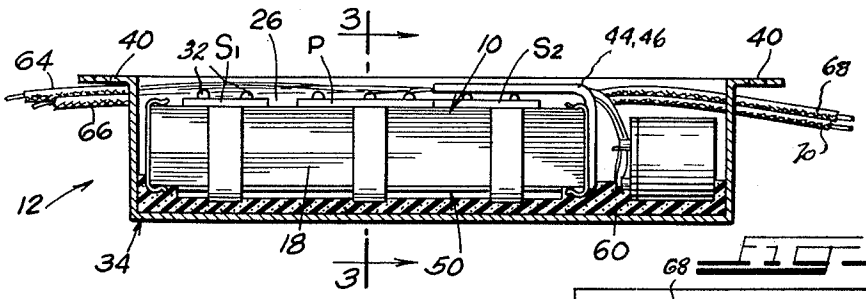


FIG. 3

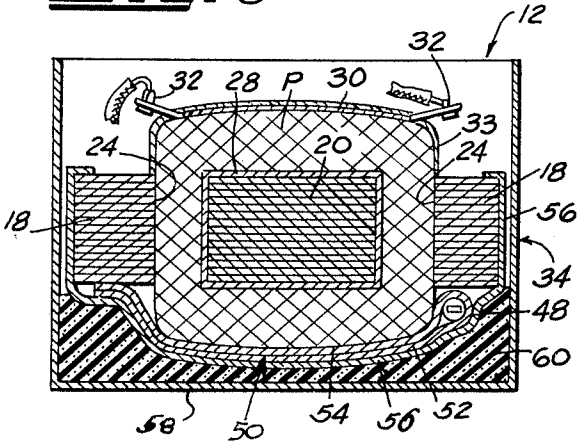
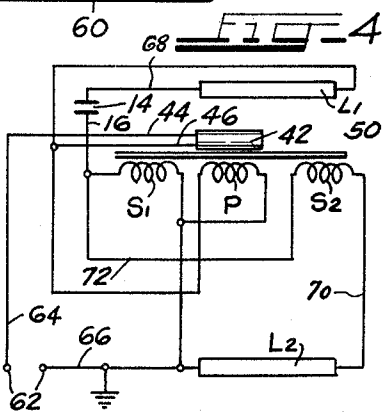


FIG. 4



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United States Patent Office 3,173,059 Patented Mar. 9, 1965

3,173,059

BALLAST WITH THERMAL CUT-OUT

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Filed May 28, 1962, Ser. No. 198,147
8 Claims. (Cl. 317—15)

This invention relates generally to ballasts for gaseous discharge devices such as fluorescent lamps used for lighting, and more particularly is concerned with a novel construction of a ballast with a thermal cut-out designed to open the primary energizing circuit of such a ballast when the temperature in the ballast exceeds a predetermined value.

The advantages of a thermally activated, automatic reclosing protective device of the type used in the invention herein are well-known. Such a device which is thermally operated, and which will hereinafter be called a cut-out device, is connected in series with the primary winding of the fluorescent lamp ballast and will open whenever the ballast reaches abnormal temperature due to excessive current or internal heat. When the current or heat decreases to normal operating temperatures, the cut-out resets automatically and the ballast resumes normal operation. Obviously, as soon as the fluorescent lamps are extinguished, maintenance personnel are aware of some abnormality and may take the necessary steps to correct the same.

Various reasons may be assigned to an increase in temperature in the ballast, such as short circuits, break-down of insulation within the ballast, faults in the ballast external circuit, and especially in certain instances, destruction or part destruction of lamp filaments causing rectification with consequent high current flowing on one or more windings of the ballast.

The invention has been described in connection with a structure embodying the construction of U.S. Patent No. 2,558,293 but is applicable to similar or other ballast circuits or systems.

The invention herein comprises a structure in which a single thermal cut-out disposed at a central location within the ballast is made to respond to heat conditions occurring in portions of the ballast remote from that location. It is, therefore, the primary object of the invention to achieve the advantage of central location but response to temperatures at remote locations through suitable structure described.

The invention is accomplished by locating the thermal cut-out in close proximity, and preferably within, a member which may be considered a heat sink or heat conducting member, the member in turn being applied in close proximity to those portions of the ballast which normally give rise to the generation of heat.

Several other objects of the invention are concerned with advantages which flow from the structure as generally referred to above. These are the transfer of heat from the locations of high temperature to the locations of low temperature whereby to promote the uniformity and better cooling of the ballast, and the decrease of noise by shielding of stray flux.

Many objects and other advantages may occur to those skilled in this art as the description of the invention proceeds in connection with which a preferred embodiment has been illustrated and set forth in detail in accordance with the patent laws.

In the drawing:

FIG. 1 is a perspective view of the principal components of a ballast shown outside of its canister in unpotted condition, the same embodying the invention, a portion being broken away.

FIG. 2 is a sectional view through a ballast using the components of FIG. 1, the canister being partially potted in this view.

FIG. 3 is a sectional view taken generally along the line 3—3 of FIG. 2 and in the direction indicated.

FIG. 4 is a schematic electrical diagram of the ballast of the invention connected in circuit with a pair of fluorescent lamps.

As stated above, the invention is characterized by providing a centrally located thermal cut-out device connected in series with the primary winding of a ballast and associated with a heat sink or heat conducting member so that heat generated in the various parts of the ballast will immediately be transmitted to the thermal cut-out and cause the cut-out to operate if the temperature rises above that for which the thermal cut-out is pre-set to open. The heat sink as described hereinafter consists of a member of metal sheeting, such as aluminum or copper, preferably foil of relatively high flexibility partially or fully folded upon itself with the thermal cut-out disposed in the fold. This member is applied to the face of the transformer of a ballast whereby the flexibility may cause the member to conform to the contours and configuration of the windings of the ballast, is taped in place, and serves to conduct heat from the various parts of the transformer to the thermal cut-out.

Referring now generally to the drawing, the reference character 10 designates generally the transformer of a ballast which is given the reference character 12 in FIGS. 2 and 3. The transformer is in electrical connection with the condenser 14 by means of at least one suitable electrical wire such as shown at 16.

In construction, the transformer 10 consists of stacks of laminations including outer framing parts 18 and a center winding leg 20 held together by suitable metal clamps 22 engaging the ends thereof. Windows are formed between the center winding leg 20 and the framing parts 18 as shown at 24, and the usual windings are disposed within these windows.

In the transformer 10, there are three windings of suitable construction such as a primary P, a first secondary S_1 and a second secondary S_2. In the particular example shown, these windings are arranged coaxially along the length of the center winding leg 20 and a suitable separation between the primary winding P and the first secondary winding S_1 exists as shown at 26 by virtue of a shunt (not shown) between these latter two windings. The windings together with the condenser 14 are connected in the circut which is shown in FIG. 4.

A typical winding construction is best illustrated in FIG. 3 in which the winding P is formed on a rectangular paper tube 28 that is slipped over the center winding leg 20 and has the turns of the winding upon the said tube. A terminal strip or board 30 having various metal terminals 32 fastened thereto is usually held in place upon the coil by means of a piece of adhesive tape such as shown at 33. The ends of the winding and the various connecting leads are soldered to various of the terminals.

The normal disposition of the transformer 10 within the well-known metal canister 34 is as shown in FIGS. 2 and 3. The canister 34 is in the form of a metal box and the transformer 10 with its condenser 14, and perhaps other minor components not shown, such as discharge resistors, radio interference condensers and the like, are disposed as shown with the terminal strips or boards 30 facing upward. This may be considered the inner face of the ballast since, after the canister 34 is completely filled with potting compound and a cover placed over the flanged ears 40, this will be that face which is engaged against a metal fixture to which the ballast 12 is secured. The portion of the transformer 10 which is at the bottom of the canister as viewed in FIGS. 2 and

3 may be considered the outer face of the transformer 10, and this is best shown in FIG. 1 facing upward best to illustrate the invention.

It will be understood, therefore, that reference to outer face of the transformer 10 will intend to signify that portion which is farthest from the surface to which the ballast is secured.

As seen in FIG. 1, there is a thermal cut-out device illustrated at 42 which connects by a pair of electrical leads 44 and 46 to the primary winding P of the transformer 10. Obviously, since the normal terminals of the primary winding are on the opposite face of the transformer 10, these leads 44 and 46 pass along the length of the transformer from the central location of the thermal cut-out 42 down the end to the other side. This, of course, is a mere detail of construction and any suitable manner of connecting leads or conductors to the thermal cut-out 42 may be utilized.

The thermal cut-out 42 is shown disposed in the fold 48 of a foil member designated generally 50 having two leaves 52 and 54. The leaf 52 is the outer leaf and the leaf 54 is the inner leaf. Since the member is of aluminum or copper foil, it is quite flexible, almost like paper, and is formed of such size as to cover all of the exposed windings on the outer face of the transformer 10. (Conventional windings, of course, have paper wrappings.) Through the use of several strips of commercial self-adhesive tape, such as shown at 56 (thickness exaggerated in drawing), the foil member is tightly secured to the transformer 10. In attaching the member 50, it will be molded in place so as to cause the same to conform to the contours and configuration of the exposed windings and thereby be in close and intimate engagement therewith.

As mentioned above, the member 50 serves as a heat sink or blanket whose tendency it will be to conduct heat from any high temperature location to the thermal cut-out 42. Notwithsanding the disposition of the thermal cut-out 42 alongside the primary winding P, if the temperature of the winding S_1 should rise as it might in case there is rectification in the ballast circuit, heat from that winding will immediately be conducted to the thermal cut-out 42 causing the same to open the primary winding P. This same thing is true of heat which is generated in the secondary winding S_2 at the opposite end of the transformer core.

Certain additional advantages flow from the provision of the member 50 with the thermal cut-out 42. Normally the winding S_1 carries little or no current and is quite cool whereas all of the current from the source is carried by the primary winding P and winding S_2. The heat sink 50 tends to distribute the heat and thereby the ballast transformer 10 tends to run cooler over all. Another advantage which has been mentioned above is the fact that since the member 50 covers a complete face of the transformer 10, the possibilities of stray flux finding its way to the canister 34, especially to the wall 58, is materially reduced. This materially decreases the sources of noise. Grounding the heat sink to the steel core is preferred.

In assembling ballast 12 of the construction of the invention, after the components have been arranged as shown in FIG. 1, the outer face is disposed in the canister 34 which previously has been supplied with a layer of hot potting compound as shown at 60. This compound is fluid but nevertheless fairly viscous, and the ballast components are pressed into it, thereby forcing the member 50 to be pressed tightly against the face of the transformer 10. Following this, potting compound is run in from the top, the usual insulating paper placed over the terminal strips and boards and the cover secured in place.

In the construction of the ballast, normally the transformed will be impregnated with varnish or other insulating compound and baked. It might be noted that the thermal cut-out 42 and the heat sink 50 are secured after impregnation to prevent the impregnating compound

from being drawn into the interior of the thermal cut-out 42. If an hermetically sealed thermal cut-out 42 is used, this precaution need not be taken.

The invention should be fairly well understood from the description above, but in order to illustrate the type of circuit with which the invention is particularly applicable, attention may be invited to FIG. 4 which is the basic circuit of U.S. Patent 2,558,293 shown here associated with a pair of lamps L_1 and L_2 and adapted to be connected to a source of alternating current as shown at 62. The two leads which extend to the line 62 are designated 64 and 66, and these may be taken as those conductors shown in FIGS. 1 and 2 extending from the left side of those parts illustrated. Leads extending to the lamps L_1 and L_2 respectively, are those shown at 68 and 70. In the diagram, the heat sink 50 is shown as a metal member extending in close proximity to the three windings P, S_1 and S_2. The thermal cut-out 42 is shown in engagement with the heat sink 50 adjacent the winding P, and its leads 44 and 46 connect the same in series with the primary winding P.

Operation of the circuit is well-known.

It is again desired to emphasize that the invention herein is not limited to use with a circuit of the series-sequence type shown in FIG. 4 but is suitable for use with many different ballasts. It is especially useful, however, with the series-sequence circuit because the winding S_1 of FIG. 4 is a starting winding and carries practically no current during operation of the system. The lamp L_1 is ignited by the combined voltages of the primary windings P and S_1 after which Lamp L_2 is ignited by the voltage of S_2 and the phase shift voltage of S_1. In operation, the circuit may be traced from the left terminal of the winding P through the lamp L_1, condenser 14, electrical lead 72, secondary winding S_2, lamp L_2, back to the right-hand terminal of the primary winding P. It will be seen that the principal operating circuit does not include the winding S_1. In view of such characteristics it is conventional to manufacture a transformer of this kind with the winding S_1 having a large number of turns of very small gauge wire. In the event the lamp L_2 should become faulty such that the current passing through the lamp is for a great part rectified, it will be seen that the direct current resulting will pass through the windings S_1 and S_2 to the primary. The high leakage reactance which impedes flow of alternating current through S_1 is not effective for direct current. S_1 will be required to carry all of the direct current passing through S_2. The result will be that the temperature of the winding S_1 will rise and may even burn out the winding thereby destroying the utility of the entire ballast. This is an unnecessary expense since it is not caused by any fault of the ballast. Replacing the lamp L_2 would solve this difficulty. Obviously the invention protects the ballast because as soon as the temperature in S_1 rises, heat is immediately conducted by way of the heat sink 50 to the thermal cut-out 42 which may be set for a suitable value to open the circuit.

The use of the phrase "heat sink" is not intended to be limiting. Often in semi-conductor circuitry a heat sink is a metal member of large mass whose primary purpose is to prevent susbtantial fluctuations in temperature. In this specification the primary functions are as described: heat transmission and equalization, with the added electrical advantage.

Variations are capable of being made without departing from the spirit and scope of the invention as defined in the appended claims.

What it is desired to secure by Letters Patent in the United States is:

1. In combination with a ballasting structure in which there is an elongate transformer including a plurality of windings arranged along the length of an iron core, said windings including at least a centrally located primary winding adapted to be connected to an A.C. source, a plurality of remotely situated secondary windings induc-

tively coupled to said primary winding, and said ballasting structure being disposed in a metal canister; a thermal cut-out device being connected in series with said primary winding, a flexible metal heat conducting member of sufficient area to overlay one face of said windings, said heat conducting member surrounding said cut-out device to conduct heat generated by said remotely situated secondary windings to the vicinity of said centrally located primary winding and the said associated thermal cut-out, said thermal cut-out device operating if the temperature rises above a predetermined level to prevent damage to said ballast apparatus.

2. The combination of claim 1 in which said heat conducting member comprises a dual thickness sheet of flexible metal foil.

3. The combination of claim 1 in which said heat conducting member comprises a sheet of flexible metal foil having a fold and the cut-out device disposed in the fold.

4. The combination of claim 1 in which said heat conducting member comprises a sheet of metal foil folded upon itself to form two leaves and the cut-out device being disposed between the leaves.

5. The combination of claim 1 in which heat conducting member comprises a sheet of metal foil folded upon itself to form two leaves and the cut-out device being disposed between the leaves, and at the fold.

6. The combination as claimed in claim 1 in which said heat conducting member is located between said windings and at least one side of said canister to limit the threading of said canister by stray flux from said windings.

7. The combination as claimed in claim 1 in which thermal cut-out device is located centrally of the plurality of secondary windings.

8. The combination of claim 3 in which the cut-out device is located centrally of said fold.

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MAX L. LEVY, *Primary Examiner.*

SAMUEL BERNSTEIN, *Examiner.*