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THERMALLY PROTECTED BALLAST APPARATUS

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Fig. 1.

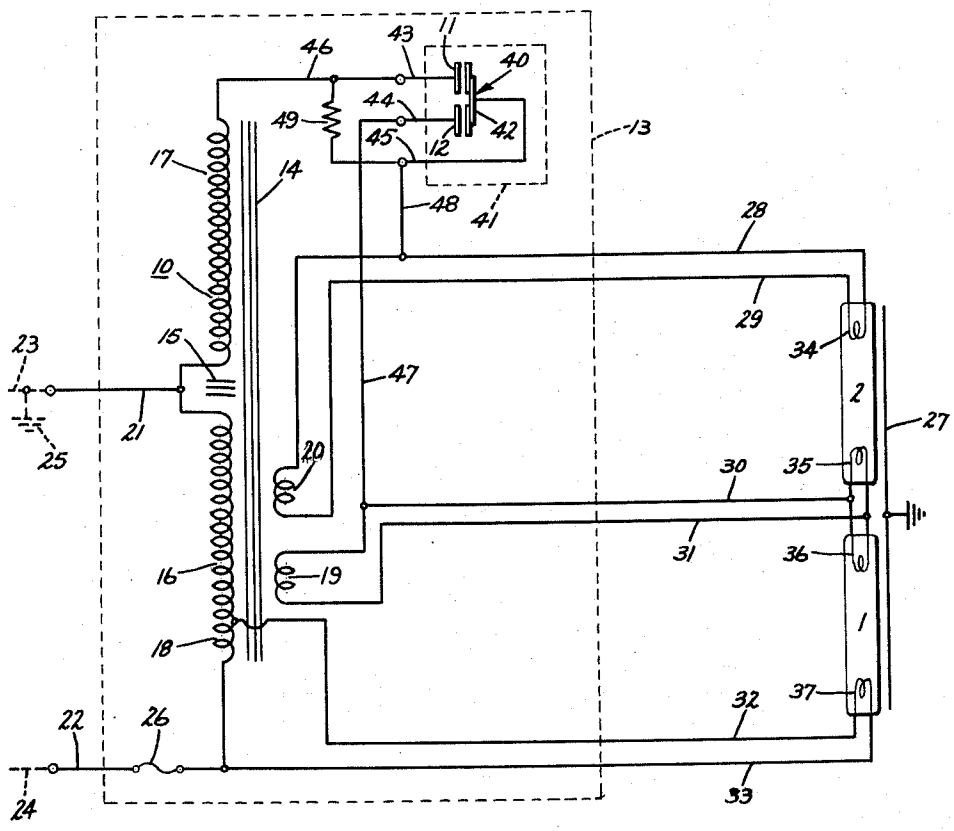
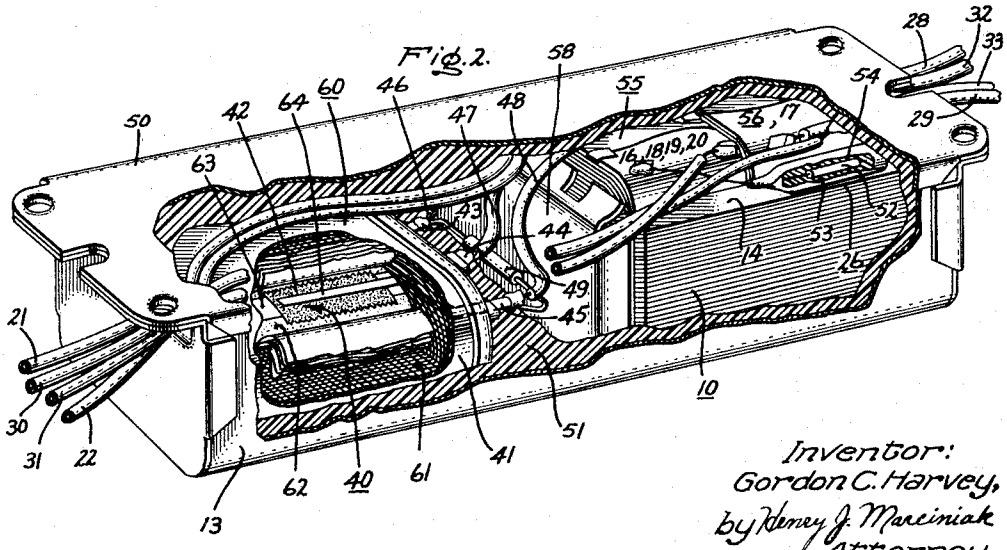


Fig. 2.



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THERMALLY PROTECTED BALLAST APPARATUS

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This invention relates to ballast apparatus for starting and operating gaseous discharge lamps. More particularly, it relates to ballast apparatus employing a high reactance transformer and capacitor which are substantially encased in an encapsulating material. This application is a continuation-in-part of my copending application Serial No. 113,462, filed May 29, 1961 for Thermally Protected Ballast Apparatus now abandoned.

It is a common practice to encase or pot the components of a ballast apparatus with an encapsulating material having suitable sound dampening characteristics and good dielectric properties. For example, asphaltic compounds have been widely used as a constituent of such encapsulating materials since asphaltic compounds are relatively inexpensive and possess suitable sound dampening and electrical characteristics. Various resinous materials, such as polyesters and epoxy resins, may also be used as constituents of encapsulating materials for ballast apparatus.

As used herein, the term "encapsulating material" generally denotes a suitable material which may be used to encase components of a ballast apparatus either with or without an enclosure or case depending upon the structural characteristics of the material and the application requirements. Where asphaltic materials are used as an encapsulating material, the ballast components and the electrical connections are disposed in a ballast case, and the case is then filled with an encapsulating material which is usually heated so that the material can be readily poured. In some applications the encapsulating material itself may serve as the ballast case.

Failure of components, such as a ballast capacitor or a ballast transformer winding, is generally accompanied by the emission of excessive heat. This heat, is, of course, transferred to the encapsulating material and causes overheating of the material. Depending on the properties of the particular material used, upon overheating the encapsulating material may tend to smoke, burn, expand, or liquefy. These conditions may occur singly or in combination. For example, when an encapsulating material containing an asphaltic compound overheats, the asphaltic constituents tend to liquefy and expand. Since asphaltic encapsulating materials are usually encased, the overheated material tends to drip or erupt out of the ballast case. Encapsulating material containing resinous constituents may burn, smoke and drip. These conditions are objectionable in a ballast apparatus since the apparatus is usually placed in an overhead lamp fixture or at other locations where damage to property or injury to personnel may result when the apparatus overheats.

Heretofore the various attempts made to solve the problem have not been entirely satisfactory. For example, individually fused ballasts have not provided a complete solution to the problem. When a short circuit develops in the winding of a ballast transformer, the heat generated is frequently sufficient to cause the encapsulating material to overheat before the overload fuse is activated. Further, when a ballast capacitor fails, as for example, by a thermal runaway resulting from a dielectric breakdown, a rupture of the capacitor and an overheating of the material encapsulating the capacitor may occur before the overload fuse is activated. It will be apparent, therefore, that current overload protection for individual ballast apparatus does not provide complete protection against overheating of the encapsulating material. Thus, there is a

need in the ballast industry for a ballast apparatus that will provide complete protection against overheating and the hazards resulting therefrom.

Accordingly, it is an object of the invention to provide an improved ballast apparatus wherein the encapsulating material substantially encasing the components thereof is effectively prevented from overheating when a component failure or other electrical fault occurs in the apparatus.

Another object of the invention is to provide an improved ballast apparatus that fails safe before the temperature of the encapsulating material reaches a point where it will burn, melt or smoke.

It is a more specific object of the invention to provide an improved ballast apparatus wherein an encapsulating material containing asphaltic compound is prevented from overheating to a point where the encapsulating material will drip or erupt from the case.

In one form of the invention, I have provided a ballast apparatus for operating one or more gaseous discharge lamps, this apparatus including a reactive ballast means and a capacitor. The apparatus is provided with a first temperature responsive fuse or circuit interrupting means located in the encapsulating material, and this fuse is connected in circuit with the ballast transformer or reactor so that the current supply thereto is interrupted when the environmental temperature reaches a predetermined range.

Additionally, and in accordance with my invention, a second current interrupting means such as a thermally responsive fuse, is disposed in association with the capacitor. This second fuse is responsive to the environmental temperature of the capacitor and causes the ballast apparatus to fail safe before overheating of the capacitor and the adjacent encapsulating material takes place. The first temperature responsive fuse and the second temperature responsive fuse thereby cooperate to effectively prevent overheating of the encapsulating material upon failure of the ballast apparatus.

The subject matter which I regard as my invention is set forth in the appended claims. The invention itself, however, together with further objects and advantages thereof may be better understood by referring to the following description taken in connection with the accompanying drawing in which:

FIG. 1 is a schematic circuit diagram of a ballast apparatus embodying my invention, showing the temperature responsive fuses connected in electrical circuit therein.

FIG. 2 is a perspective view of the ballast apparatus in accordance with the invention, with portions thereof cutaway.

In FIGS. 1 and 2 I have illustrated a preferred embodiment of my invention showing a ballast apparatus for operating and starting a pair of gaseous discharge lamps **1**, **2** which may be rapid start type of fluorescent lamps. The ballast apparatus includes a high reactance transformer **10**, a series capacitor **11**, a starting capacitor **12** and a ballast case **13** which is shown schematically by a dashed rectangle. The high reactance transformer **10** is of the shell type and has a magnetic core **14**, a magnetic shunt **15**, a primary winding **16**, a high reactance secondary winding **17** and cathode heating windings **18**, **19**, **20** inductively coupled with the primary winding **16**. A pair of input terminal leads **21**, **22** is provided in order to connect the primary winding **16** across a suitable alternating current supply, such as a 120 volt, 60 cycle supply shown schematically by dashed lines **23**, **24**. As indicated by the grounded connection **25** of line **23**, input terminal lead **21** is provided for connection to the grounded line **23** of the power supply and the other input terminal lead **22** is adapted for connection to the ungrounded line **24** of the power supply.

Although in the embodiment of the invention shown in

FIG. 1 a transformer 10 is employed to step up the supply voltage to provide the required operating voltage level for a pair of serially connected lamps 1, 2, it will be appreciated that in applications where the supply voltage is sufficient to operate fluorescent lamps, a high reactance step-up transformer, such as transformer 10, may not be required. For example, depending on the supply voltage available and the type of lamp to be operated, the step-up transformer might be replaced by a ballast reactor or by a reactor combined with a cathode heating transformer. Therefore, as used herein, the term ballast means is intended to cover ballast reactors and cathode heating transformers as well as ballast transformers.

One of the temperature responsive fuses 26 in accordance with the invention is shown connected in circuit with the input terminal lead 22 so that when the temperature responsive fuse 26 is activated, the power supply to the high reactance transformer 10 is cut off. Although as shown in FIG. 1, the temperature responsive fuse 26 is connected in circuit with input lead 22 provided for connection to the ungrounded side of the power supply, it will be appreciated that the fuse 26 may be connected in circuit with the input lead 21 provided for connection to the grounded supply line 23 or in the circuit of the primary winding 16. Upon activation, fuse 26 will cause an open circuit in the primary circuit of the high reactance transformer 10 and thereby cause the ballast apparatus to fail safe.

Electrical leads 28, 29, 30, 31, 32, 33 are brought out externally of the ballast case 13 for connecting the ballast apparatus in circuit with the serially connected lamps 1, 2. The output leads 28, 32 apply the output of the high reactance transformer 10 across the lamps 1, 2. Since hot cathode type of lamps 1, 2 are employed in the illustrated embodiment of the invention, it is necessary to supply the lamp cathodes 34, 35, 36, 37 with heating current. Cathode windings 19, 20 are closely coupled with the primary winding 16 of high reactance transformer 10. Cathode heating winding 18 is an extension of the primary winding 16 and is connected in circuit with cathode 37 of lamp 1 by leads 32, 33. The electrical leads 30, 31 connect cathode heating winding 19 in circuit with cathodes 35, 36 of lamps 1, 2. Cathode heating winding 20 is connected in circuit with the cathode 34 of lamp 2 by electrical leads 28, 29.

Lamps 1, 2 are disposed in capacitive relationship with a conductive plate 27, which is usually the lamp fixture, so that starting of lamps 1, 2 can be facilitated. The second temperature responsive fuse 40 in accordance with the invention is located in electrical circuit with the capacitors 11 and 12, and in the illustrated embodiment of the invention it is contained in a capacitor case 41 which houses the capacitor 11 and the starting capacitor 12. In FIG. 1, the capacitor case 41 is represented schematically by the small dashed rectangle. A fusible foil element 42 forms a current conductive path between the common capacitor plates of capacitors 11, 12. It will be seen that the capacitors 11, 12 are connected in circuit with the high reactance transformer 10 and lamps 1, 2 by means of the circuit connections to the three terminals 43, 44, 45. Thus, electrical lead 46 joined to terminal 43 connects capacitor 11 in series circuit relationship with the high reactance secondary winding 17. Leads 48 and 28 connect capacitor 11 in circuit with the lamps 1, 2. The starting capacitor 12 is connected across lamp 2 by leads 47, 48 which are joined in electrical contact with terminals 44, 45 respectively. A bleeder resistor 49 is connected across the capacitor terminals 43, 45 to discharge the capacitors 11, 12 when the circuit is deenergized.

When the environmental temperature of the temperature responsive fuse 40 reaches the melting point of foil element 42, it normally breaks away and deenergizes the capacitors 11, 12 and the lamp circuit before the temperature reaches a point where thermal runaway may occur and where the encapsulating material surrounding the capacitor case 41 may overheat. On the other hand, fuse 40 may cause a short circuiting of the capacitor when it melts or breaks away and this too causes a safe failure of the ballast as will be explained below. A thermally protected capacitor which is particularly suitable for use in the ballast apparatus of this invention is described and claimed in the copending application filed in the name of Frederick W. Grahame and Carl E. Paul S.N. 113,459, May 29, 1961 and in the co-pending application filed in the name of Rayno S.N. 233,310 filed Oct. 26, 1962, both of said applications being assigned to the same assignee as this invention.

The fusible foil element 42 is comprised of a low melting temperature alloy such as a tin alloy containing lead, tin, silver, or antimony, which has a melting temperature ranging from 150 degrees centigrade to 250 degrees centigrade. Although a three terminal type of capacitor is shown in the illustrative embodiment of the invention, it will be appreciated that in a ballast apparatus utilizing a two-terminal capacitor the capacitors may be thermally fused and employed in accordance with the invention. Also, where the capacitors are housed in separate capacitor cases, two capacitors individually fused may be employed in accordance with the invention.

It will be apparent from the foregoing description that the temperature responsive fuse 40 cooperates with the temperature responsive fuse 26 connected in the primary circuit of the high reactance transformer 10 to detect an abnormal temperature rise in the ballast apparatus and to deenergize components of the circuit so that the ballast apparatus fails safe before the encapsulating material reaches a temperature where it may smoke, drip or erupt from the ballast case 13. As for example, when the capacitor 11 fails by a short circuit, when fuse 40 melts or breaks away, lamps 1, 2 operate at a lower power factor thereby increasing the current requirements. The increased current flow in the primary winding 16 and the secondary winding 17 will result in a temperature rise which will cause the temperature responsive fuse 26 to be activated. Thus, both fuses 40 and 26 cooperate to provide complete protection for the ballast apparatus.

In FIG. 2, the physical arrangement of the components of the ballast apparatus schematically illustrated in FIG. 1 is shown. The temperature responsive fuse 26 is located adjacent to the magnetic core 14 of the high reactance transformer 10. Since the temperature responsive fuse 26 is located along the core steel of the magnetic core 14, it can readily sense a temperature rise in the ballast apparatus because of the good thermal conductivity of the magnetic core 14, and will deenergize the ballast apparatus if the temperature rises to an undesirably high level.

It will be seen that the ballast apparatus is completely enclosed in a ballast case 13 which includes a cover plate 50. The high reactance transformer 10 and the capacitor case 41 containing the capacitor 11 and the starting capacitor 12 are substantially encased in an encapsulating material 51.

Asphaltic compounds are preferably used as constituents of encapsulating materials for ballast apparatus since they are moisture resistant, have good dielectric and sound dampening characteristics and are relatively inexpensive. Although I have described the invention specifically in connection with potting or encapsulating materials containing asphaltic compounds, it will be appreciated that the invention can be utilized in ballasts employing other synthetic and organic encapsulating materials. The asphalt and sand mixture used in the exemplification of the invention had a softening temperature of approximately 120 degrees centigrade. As will hereinafter be more fully described, the temperature responsive fuse 26 which is embedded in the potting material should preferably be activated at about the softening temperature of the potting material used since the temperature of the potting

material near the source of electrical fault generating heat may be at a higher temperature.

In the exemplification of the invention, the temperature responsive fuse **26** employed a fusible link **52** having a melting temperature of approximately 121 degrees centigrade and a wax fuse body **53** having a melting temperature of approximately 119 degrees centigrade. Temperature responsive fuses suitable for use as fuse **26** in the practice of this invention are described and claimed in copending application Serial No. 59,867 filed on October 3, 1960 and assigned to the same assignee as the present invention. The wax fuse body **53** is wrapped with a paper wrapper **54** in order to prevent diffusion of the asphaltic potting material **51** into the wax body **53** of the fuse **26** and to maintain the structural configuration of the wax body **53**.

Continuing with the description of the ballast apparatus as shown in FIG. 2, the high reactance ballast transformer **10** includes coil assemblies **55**, **56** mounted on the central winding leg of a shell type of magnetic core **14** which is comprised of a stack of laminations held together in assembled relation by a clamping element **58** at each end thereof. Coil assembly **55** includes the primary winding **16**, and cathode heating windings **18**, **19**, **20** which are closely coupled therewith, and coil assembly **56** includes the secondary winding **17**.

At the right end of the ballast case **13**, it will be seen that four leads **28**, **29**, **32**, **33** extend externally therefrom for connection in circuit with the cathodes **34**, **37** of lamps **1**, **2**. At the left end of the ballast apparatus, another group of four leads **21**, **22**, **30**, **31** extend externally of the ballast case **13**. The input terminal leads **21**, **22** are provided for connection across the alternating current supply lines and are conventionally identified as the white and black leads, respectively. The other two leads **30**, **31** are provided for connection with the cathodes **35**, **36** of lamps **1**, **2**.

In the manufacture of the ballast apparatus, after the internal connections are made to the components of the ballast apparatus, the ballast case **13** is filled with the encapsulating material **51**. Usually, the encapsulating material **51** is heated to a liquid state and is injected into the ballast case **13** as a hot liquid. When the hot liquid encapsulating material **51** cools, it solidifies, and the capacitor case **41**, the transformer **10**, the temperature responsive fuse **26** and the internal leads are substantially covered and encapsulated in the encapsulating or a potting material **51**.

The three terminals **43**, **44**, **45** are disposed near the high reactance transformer **10** so that connections may be conventionally made thereto prior to encapsulation. The common terminal **45** is connected to lead **48** and the two other terminals **43**, **44** are connected to leads **46**, **47**. A bleeder resistor **49** is connected across terminals **43**, **45**. As is best seen in the cutaway view of capacitor assembly **60**, shown in FIG. 2, the capacitor assembly **60** is constructed of a roll **61** comprised of metallic foil layers **62** such as aluminum which are interleaved with paper layers **63** to form a foil armature separated substantially only by paper layers **63**. It will be noted that the fusible foil element **42** bridges a break in the metallic foil layer **62**. A tap strap **64** is brought out from the fusible element **42** which provides a current conductive path in layer **62**. The common terminal **45** is joined with metallic foil layer **62** by means of the tap strap **64**. The fusible foil element **42**, used in the exemplification of the invention, had a melting temperature of approximately 205 degrees centigrade.

When the environmental temperature of the fusible foil element **42** reaches a point where the foil element **42** melts, it will be seen that the tap strap **64** breaks away and thereby causes the circuit to be interrupted. The interruption in the circuit may be a short or open circuit type of failure. The term "interruption" as used herein denoted either an "open circuit" or "short circuit" activation of the fuse.

Capacitor case **41** is filled with a dielectric material which generally is a liquid dielectric. When a liquid dielectric becomes contaminated, an incipient capacitor failure by thermal runaway may occur. Such a condition may occur at the end of the normal life period of the capacitor.

In the event that the capacitor fails by thermal runaway, the heat generated may be sufficient to cause the asphaltic encapsulating material **51** to heat up and activate temperature responsive fuse **26** which becomes activated at an approximate temperature of 120 degrees centigrade. In particular, both temperature responsive fuses **26** and **40** may cooperate to prevent the asphaltic encapsulating material **51** from overheating to a point where it will drip and erupt from the ballast case **13**.

An incipient thermal runaway generally results in high temperatures in the center of the capacitor roll and temperature responsive fuse **40** becomes activated. The fusible foil element **42** melts and causes the capacitors **11**, **12** to become deenergized terminating the heating. On the other hand, as pointed out above, if fuse **40** shorts the capacitor **11** upon melting, the resultant increase in the primary and secondary currents causes heating of the ballast transformer and thereby causes activation of the fuse **26**. Thus, both fuses cooperate to provide protection. If the thermal runaway were allowed to proceed without being checked, the heat generated would cause the liquid dielectric to decompose and expand. The gaseous decomposition products and the expansion of the liquid dielectric may cause the capacitor bushings or the capacitor case **41** to rupture and cause hot liquid dielectric and asphaltic material to escape from the ballast case **13**. It will be apparent that the low temperature responsive fuse **26** adjacent to the transformer core **14** will not in all instances sense this temperature rise soon enough to deenergize the ballast apparatus since the thermal runaway condition usually originates near the center of the capacitor roll **61**. Both fuses are needed for complete protection.

Although I have shown the capacitor fuse **40** located within the capacitor case **41**, it will be recognized that the fuse or other current interrupting device may be otherwise associated with the capacitor or capacitors. The important point is that the current interrupting device shall inactivate the capacitor before it can cause damage.

It will be understood that the predetermined temperature at which the thermal fuses are activated will depend on the melting point of the fusible material employed. Many such materials do not have precise melting points and if used in a thermal fuse, would cause the fuse to become activated over a range of temperatures. The term "predetermined temperature," as used herein, applies to thermal fuses employing materials that have precise melting points and also those which have melting points that occur over a predictable range of temperatures. Thus, the predetermined temperature denotes the temperature or temperatures at which a thermal fuse is activated.

In the absence of conditions which will cause overheating of the encapsulating material **51** or the capacitor roll **61** and thereby activation of the fuse **26** or the fuse **40**, the ballast apparatus functions in a normal manner to start and operate the lamps **1**, **2**. During starting, a substantially open circuit condition exists across the lamps **1**, **2** since they present a substantially infinite impedance to the flow of current before ignition. Under open circuit conditions all of the output voltage of the high reactance transformer is applied across lamp **1** since the starting capacitor **12** in effect shunts out lamp **2**. After lamp **1** is started, current flows through the starting capacitor **12** and the voltage developed across the starting capacitor **12** is applied across lamp **2** and is sufficient in magnitude to start lamp **2**. The capacitor **11** provides sufficient capacitive reactance as compared with the induc-

tive reactance of the transformer 10 to cause a leading current to flow therethrough.

Although in the illustrative exemplification, the invention is embodied in a ballast apparatus for operating two rapid start lamps, it will be appreciated that the dual temperature responsive fuse arrangement is not limited to a particular ballast circuit configuration. Thus, the low temperature responsive fuse 26 and the higher temperature responsive capacitor fuse 40 may be used in accordance with the present invention in ballast applications where a capacitor and the ballast means are substantially encased with an encapsulating or potting material and where it is desirable to effectively prevent the encapsulating material from overheating. Both temperature responsive fuses cooperate to provide complete thermal protection for a ballast apparatus and cause the ballast apparatus to fail safe when conditions occur that may cause the encapsulating material to overheat.

It will be apparent that the specific ballast apparatus which I have described herein may be changed substantially without departing from the principle of the invention. While this invention has been explained by describing a preferred embodiment thereof, it will be apparent that many modifications may be made without departing from the spirit of the invention, and therefore it is intended to cover all such equivalent variations within the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A ballast apparatus for operating at least one gaseous discharge lamp from an alternating current supply comprising a ballast transformer having a magnetic core, a primary winding and a secondary winding inductively coupled with the primary winding on said magnetic core, a pair of input terminal leads for connection to said alternating current supply, said primary winding being connected across input terminal leads, means including electrical leads for connecting the output of said transformer across said gaseous discharge lamp, a temperature responsive fuse connected in circuit with one of said windings and providing a current conduction path thereto, said temperature responsive fuse causing said conduction path to be interrupted when said fuse is heated to a first predetermined temperature to cause the apparatus to permanently fail, at least one capacitor connected in circuit with one of said windings, a current interrupting means connected within said capacitor, said current interrupting means when activated causing said capacitor to permanently fail safe, a ballast case substantially enclosing said apparatus, and as asphaltic potting material substantially filling said ballast case and surrounding said capacitor, said transformer and said temperature responsive fuse, said temperature responsive fuse and current interrupting means preventing said asphaltic potting material from overheating and escaping from said ballast case.

2. The ballast apparatus set forth in claim 1 wherein said capacitor is connected in series circuit relationship with said secondary winding and provides sufficient capacitive reactance to cause a leading current to flow in said secondary winding.

3. A ballast apparatus for operating at least one gaseous discharge lamp from an alternating current supply comprising a ballast means, a pair of input terminal leads for connection to said alternating current supply, circuit means including electrical leads for connecting said ballast means and said input terminal leads in circuit with said gaseous discharge lamp, a first current interrupting means connected in circuit with one of said input leads, said first current interrupting means being responsive to the temperature of said ballast means and when activated causing the apparatus to permanently fail, at least one capacitor connected in circuit with said ballast means, a second current interrupting means being associated with said capacitor for interrupting the current in response to the temperature of said capacitor thereby to cause the capacitor to permanently fail, and an encapsulaing material substantially encasing said apparatus, said first and second current interrupting means preventing said encapsulating material from overheating.

4. A ballast apparatus for operating at least a pair of fluorescent lamps from an alternating current supply comprising a high reactance transformer having a magnetic core, a primary winding and a secondary winding inductively coupled with said primary winding on said magnetic core, a pair of input terminal leads for connection to said alternating power supply, said primary winding being connected across said input terminal leads, means including electrical leads for connecting the output of said high reactance transformer across said lamps, a first temperature responsive fuse connected in circuit with one of said windings and providing a current conduction path thereto, said fuse interrupting said current conduction path when said fuse reaches a first predetermined temperature to cause the apparatus to permanently fail, a capacitor assembly including a pair of capacitors connected in circuit with said high reactance transformer, a second temperature responsive fuse connected in circuit with said capacitors and providing a current conduction path thereto, said second temperature responsive fuse interrupting said current conduction path when said second temperature responsive fuse reaches a second predetermined temperature to cause said capacitor assembly to permanently fail, said second predetermined temperature being higher than said first predetermined temperature, and an encapsulating material substantially encasing said first temperature responsive fuse, said capacitor assembly and said ballast transformer.

5. The ballast apparatus set forth in claim 4 wherein one of said capacitors is a starting capacitor.

6. A ballast apparatus for operating at least one fluorescent lamp from an alternating current supply comprising a high reactance transformer having a magnetic core, a primary winding and at least one secondary winding inductively coupled therewith on the magnetic core, a pair of input terminal leads for connecting to said alternating current supply, said primary winding being connected across said input terminal leads, circuit means including electrical leads for applying the output of said high reactance transformer across said lamp, a first current interrupting means connected in circuit with one of said input terminal leads, said first current interrupting means causing an open circuit when said first current interrupting means is heated to a first predetermined temperature, a capacitor assembly comprising at least a pair of foil armatures connected to at least a pair of terminals and a capacitor case enclosing said foil armatures, said terminals being connected in circuit with said secondary winding, a second current interrupting means disposed within said capacitor case and normally causing an interruption in the circuit between one of said foil armatures and one of said terminals when the temperature therein exceeds a second predetermined temperature, a ballast case enclosing said apparatus, and a potting material filling said ballast case and substantially encapsulating said capacitor assembly, said high reactance transformer and said first current interrupting means, said first and second current interrupting means causing said ballast apparatus to fail safe before said potting material overheats to cause said potting material to escape from said ballast case.

7. The ballast apparatus set forth in claim 6 wherein said pair of terminals are connected in series circuit relationship with said secondary winding and said foil armatures provide sufficient capacitive reactance to cause a leading current to flow through said secondary winding.

8. A ballast apparatus for operating at least one fluorescent lamp from an alternating current supply comprising a high reactance transformer having a shell-type magnetic core, a primary winding and a high reactance secondary winding inductively coupled therewith on said

magnetic core, a pair of input terminal leads for connection to said alternating current supply, said primary winding being connected across said input terminal leads, a first temperature responsive fuse connected in circuit with one of said windings, said first temperature responsive fuse causing said circuit to open when heated to a first predetermined temperature, a capacitor connected in series circuit relationship with said secondary winding, circuit means including electrical leads for applying the output of said high reactance transformer across said lamp and for connecting said capacitor in circuit with said lamp, a second temperature responsive fuse disposed within said capacitor, said second temperature responsive fuse when heated to a second predetermined temperature causing an interruption of the circuit in the capacitor, a ballast case enclosing said apparatus, and an asphaltic potting material filling said ballast case and substantially encapsulating said high reactance transformer, said capacitor and said first temperature responsive fuse, and said first temperature responsive fuse and said second temperature responsive fuse being effective to cause the apparatus to permanently fail safe before said asphaltic potting compound is overheated and escapes from said ballast case.

9. A ballast apparatus for operating a pair of fluorescent lamps from an alternating current supply comprising a high reactance transformer having a magnetic core, a primary winding and at least one high reactance secondary winding inductively coupled therewith on said magnetic core, a pair of input terminal leads for connection to said alternating current supply, a capacitor connected in series circuit relationship with said secondary winding, a starting capacitor, said capacitors having a common foil armature, a capacitor case enclosing said capacitors, circuit means including electrical leads for applying the output of said high reactance ballast transformer across said lamps and for connecting said starting capacitor across one of said lamps, a first current interrupting means connected in circuit with one of said input leads, said first current interrupting means causing an open circuit in said input lead when said current interrupting means is heated to a predetermined temperature, a second current interrupting means connected in circuit with said common foil armature, said second current interrupting means causing an interruption in the circuit connection to said common foil armature when the temperature of said capacitor exceeds a predetermined point, and an encapsulating material substantially encasing said high reactance ballast transformer, said capacitors and said first current interrupting means, and said first and second current interrupting means being effective to prevent said encapsulating material from overheating by causing the apparatus to permanently fail.

10. A ballast apparatus for starting and operating a pair of fluorescent lamps from an alternating current supply comprising a high reactance ballast transformer having a shell-type magnetic core, a primary winding and a high reactance secondary winding inductively coupled therewith on said magnetic core, a pair of input terminal leads for connection to said alternating current supply, said primary winding being connected across said input terminal leads, a capacitor connected in series circuit relationship with said secondary winding, a starting capacitor, circuit means including electrical leads for connecting said starting capacitor across one of said lamps and for applying the output of said high reactance transformer across said lamps, a first temperature responsive fuse connected in circuit with said primary winding and providing a conduction path thereto, said first temperature rseponsive fuse when heated to a predetermined temperature causing said conduction path to be interrupted, a second temperature responsive fuse connected in circuit with said capacitors adjacent thereto and causing an open circuit thereto when the temperature of said second temperature responsive fuse exceeds a predetermined temperature range, a ballast case enclosing said apparatus, and an asphaltic potting material substantially filling said ballast case and substantially encapsulating said high reactance ballast transformer, said capacitors and said first temperature responsive fuse, and said temperature responsive fuses effectively preventing faults occurring in said ballast apparatus from overheating said asphaltic potting material by causing the ballast apparatus to permanently fail.

11. A ballast apparatus for operating at least one gaseous discharge lamp from an alternating current supply comprising a ballast means, a pair of input terminal leads for connection to said alternating current supply, circuit means including electrical leads for connecting said ballast means and said input terminal leads in circuit with said gaseous discharge lamp, at least one current interrupting means connected in circuit with one of said input leads, said current interrupting means being responsive to the temperature of said means and being located adjacent said ballast means, at least one capacitor connected in circuit with said ballast means, a temperature responsive fuse being associated with said capacitor, said temperature responsive fuse being disposed within said capacitor, and an encapsulating material substantially encasing said apparatus, said current interrupting means and temperature responsive fuse being arranged to prevent said encapsulating material from overheating by causing the ballast apparatus to permanently fail.

12. A ballast apparatus for operating at least a pair of fluorescent lamps from an alternating current supply comprising a high reactance transformer having a magnetic core, a primary winding and a secondary winding inductively coupled with said primary winding on said magnetic core, a pair of input terminal leads for connection to said alternating power supply, said primary winding being connected across said input terminal leads, means including electrical leads for connecting the output of said high reactance transformer across said lamps, a temperature responsive fuse connected in circuit with one of said windings and providing a current conduction path thereto, said fuse interrupting said current conduction path when said fuse reaches a first predetermined temperature to cause the ballast apparatus to permanently fail, a capacitor connected in circuit with the secondary winding of said high reactance transformer, a current interrupting means connected in circuit with said capacitor and providing a current conduction path thereto, said current interrupting means interrupting said current conduction path when said capacitor reaches a second predetermined temperature to cause the capacitor to permanently fail, said second predetermined temperature being higher than said first predetermined temperature, and an encapsulating material substantially encasing said temperature responsive fuse, said capacitor assembly and said high reactance transformer.

13. The ballast apparatus set forth in claim 12 wherein said first temperature responsive fuse is located adjacent said magnetic core and said second temperature responsive fuse is located within said capacitor.

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