Nov. 21, 1967 N. C. BATSCH 3,354,282

THERMAL FUSE WITH CAPILLARY ACTION

Filed May 25, 1966

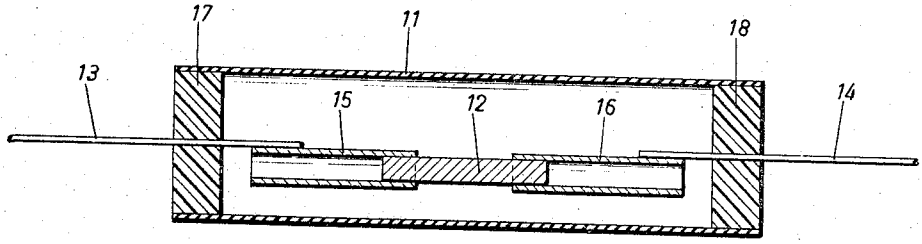


FIG. 1

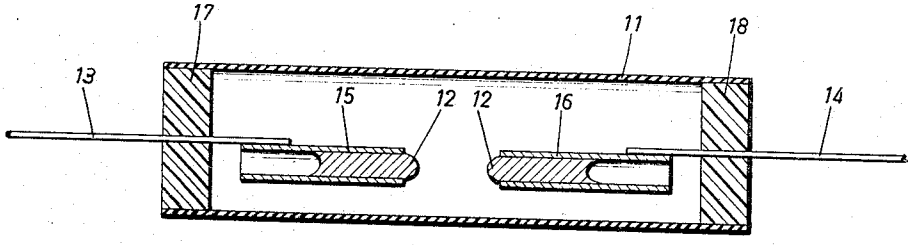


FIG. 2

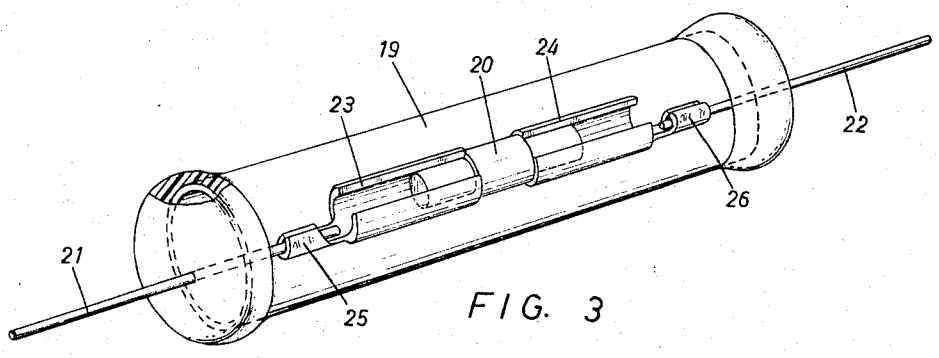


FIG. 3

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THERMAL FUSE WITH CAPILLARY ACTION

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4 Claims. (Cl. 200—142)

My invention relates to thermal fuses and more particularly to thermal fuses adapted to interrupt current flow in an electrical circuit in response to the action of heat in the vicinity of the fuse.

Thermal fuses may be used to prevent damage that may be caused by an overheated electrical apparatus or to protect an electrical apparatus against damage resulting from overheating. An example of an electrical apparatus in which a thermal fuse may be advantageously used is a fluorescent lamp ballast. A ballast usually includes a high reactance transformer and an oil filled capacitor and is generally encapsulated with a potting compound such as an asphalt and sand mixture. An electrical failure of the ballast is often accompanied by overheating of the unit. Overheating may cause the potting compound to become fluid and splatter out of the metal ballast case and may result in the decomposition of electrical insulation and the evolution of smoke and fumes.

In order to prevent a ballast from causing damage to the fixture in which it is installed and to property in the vicinity of the fixture, it is desirable to have a thermal fuse incorporated in the ballast which would interrupt the power supplied to the ballast before the temperature of the unit reaches a point at which the potting compound may become fluid and/or decomposed. A thermal fuse would normally be placed at a location where it could readily detect any temperature rise caused by an electrical failure. Therefore, it may be embedded in the potting compound so that the thermal fuse would deactivate the ballast when a predetermined temperature is reached.

A thermal fuse, as understood here, is a fusible link incorporated in an electrical circuit which upon melting opens the circuit and thus interrupts the supply current flow. In order to assure that the circuit will open, the molten fusible link must separate positively and completely. Part of the difficulty of obtaining consistently successful separations has been associated with the difficulty of breaking corrosion films which develop on the surface of the fusible link over a period of time. Many proposals for breaking this film have been made to provide more positive action which for instance, include the use of mechanical spring action, of gravity, and of chemically active fluxes. However, a spring employed to displace the connection made by the thermal fuse once the melting temperature has been reached, works safely only when the difference between the normal operating temperature of the protected apparatus and the melting temperature of the fusible link is high. Another problem is whether such a fuse with a sustained spring load will stay intact over very prolonged periods, such as for example 10 to 20 years. The use of gravity, on the other hand, requires a fuse envelope of rather substantial size. A chemically active flux is invariably corrosive to all the metal parts (conductor, fuse link, etc.) of the device at a service temperature so close to the opening temperature, and is not safe.

It is, therefore, the object of this invention to provide an improved thermal fuse of a relatively small size in which the molten fusible link will separate reliably and completely under any practical service conditions, in any position and after long useful life.

In accordance with one form of the invention, I have provided a thermal fuse for interrupting the current flow in an electric lead in response to an abnormal temperature rise that comprises a fusible link having a predetermined melting temperature range and forming a current conducting path that is enclosed by a tubular sleeve. A means for providing capillary action on the molten fuse link is attached to each end of the fusible link so that when the fusible link melts upon increase of the environmental temperature beyond its melting point, the molten material is withdrawn into the capillary means thus ensuring that the current flow in the electrical lead is entirely interrupted.

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 conjunction with the accompanying drawings in which:

FIGURE 1 is a schematic sectionalized elevation view of the thermal fuse;

FIGURE 2 is a sectionalized elevation view of a ruptured thermal fuse; and

FIGURE 3 is a perspective view of a preferred form of the fuse.

Referring to FIGURE 1, there is illustrated, a thermal fuse which comprises a tubular sleeve **11** made of any suitable rigid insulating material such as cardboard, plastic, or glass. The sleeve **11** encloses a fusible link **12** providing a conductive path between a pair of lead terminals **13** and **14**. Capillary means in the form of tubes **15** and **16** are attached to the end portions of fusible link **12** and with their free ends connected to lead terminals **13** and **14**. The open ends of sleeve **11** are closed by suitable seals **17** and **18** which may be of resinous or equivalent material and additionally provide a support for terminal leads **13** and **14**. The space within sleeve **11** may be filled with a solid wax or an inert gas which would completely encase fusible link **12**. Such filler may be desirable in order to prevent corrosion of the fusible link and/or arcing when the fusible link melts.

The condition of the thermal fuse immediately after rupture is illustrated in FIGURE 2. Upon increase of the environmental temperature beyond its melting point, fusible link **12** has become liquid and, through the surface tension forces arising from the capillary size of tubes **15** and **16**, has been retracted into these tubes. This separates the fusible link and provides a complete interruption of the current flow in the electrical lead. Other means may be used to provide for capillary action on the molten metals so as to ensure that the contacts open which will become apparent from the following description.

A preferred form of the thermal fuse, shown in FIGURE 3, comprises a tubular glass sleeve **19** enclosing a fusible link **20** which provides a conductive path between a pair of terminal leads **21** and **22**. The terminal leads are secured to the fusible link **20** in a suitable manner. To provide for capillary effect, two longitudinally slit tubes **23** and **24** are provided, which may be slipped over terminal leads **21** and **22** and then pressed onto the end portions of fusible link **20**. The free ends of the longitudinally slit tubes **23** and **24** are secured to terminal leads **21** and **22**, for instance, by crimping as shown at **25** and **26**. The longitudinally slit tubes provide the same effect as the capillary tubes used in FIGURES 1 and 3, i.e., they retract the molten fusible link and thereby completely interrupt a current flow in the electrical lead. Also trough-shaped elements could successfully be used as the capillary means. As is well known, the capillary force on the fusible link which

causes the retraction of the liquified fuse material comprises the surface tension forces of the molten fuse material provided the molten fuse material completely wets the capillary means. The shape of the capillary means employed must be such that for the chosen quantity of low melting fuse metal, surface tension forces are large compared to the effects of gravity upon the melting metal.

The thermal fuse disclosed operates independently of position and is conveniently positioned in the electrical apparatus or component to be protected at a location where it can sense any overheating. Overheating of the apparatus will cause the temperature of the fuse to rise above its service temperature. When the fusible link is heated to its predetermined melting temperature, it melts and the molten metal is retracted into the capillary means, thereby interrupting the current conduction path and opening the circuit. When the apparatus cools sufficiently, the molten link hardens in the retracted position and the circuit remains open. Thus, this novel thermal fuse permanently removes a malfunctioning electrical apparatus from electrical power normally supplied to it. Once the thermal fuse has functioned, it cannot be reset to an operating position.

If the thermal fuse is used in a fluorescent lamp ballast as proposed, it may be embedded in the potting compound with the other components, As is well known in the art, ballast components which in the simplest form consist of a reactance, may be a high reactance transformer including a magnetic core, a primary winding and a secondary winding mounted on the core. It is also well known to add a power factor capacitor if necessary. The thermal fuse may be connected in series circuit relationship with one of the transformer windings and will function as previously described. However, to provide complete protection for the ballast, a thermal fuse should be placed in at least one of the lead wires connected with the source of electrical energy. The fuse of the invention may also be connected in series circuit relationship with the above-mentioned capacitor.

It will be appreciated therefore that the specific embodiments of the invention which I have described herein may be changed or varied without departing from the

principle of the invention. It is to be understood, therefore, that I intend by the appended claims to cover all such changes and modifications that fall within the true spirit and scope of the invention.

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

1. A thermal fuse for interrupting the current flow in response to its environmental temperature comprising a sleeve, a pair of lead terminals extending from said sleeve for connection in an external circuit, a fusible link disposed within said sleeve and joining said lead terminals, said fusible link having a predetermined melting temperature range and forming a current conducting path between said lead terminals, and hollow capillary means at each end of said fusible link and forming an electrical connection between said link and said terminals overlapping at least a portion whereby upon increase of the environmental temperature beyond the melting point of the link the melted link is withdrawn into the capillary means to permanently sever the link thereby ensuring that the current flow between said lead terminals is completely interrupted.

2. A thermal fuse as defined in claim 1 wherein the open ends of said sleeve are closed with a resinous seal.

3. A thermal fuse as defined in claim 1 wherein said hollow capillary means comprises a longitudinally slit tube secured at one end to the end portion of said fusible link and at its opposite end to one of said lead terminals.

4. A thermal fuse as defined in claim 1 wherein said hollow capillary means comprises a trough-shaped element one end of which partially encloses one end portion of said fusible link while its opposite end is secured to one of said terminal leads.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,354,282 November 21, 1967

Norbert C. Batsch

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 17, strike out "overlapping at least a portion" and insert the same after "means" in line 14, same column 4.

Signed and sealed this 31st day of December 1968.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents