Feb. 28, 1961 L. H. WHITMAN 2,973,418

FUSE-RESISTOR

Filed Oct. 7, 1958

FIG. 1

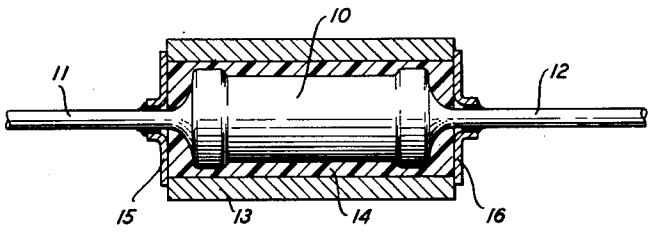


FIG. 2

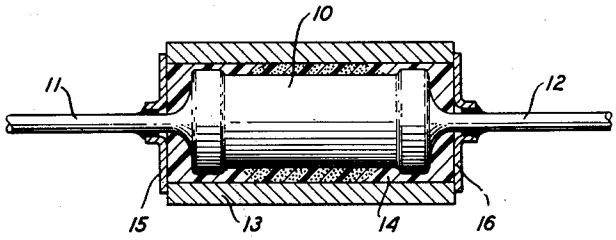


FIG. 3B

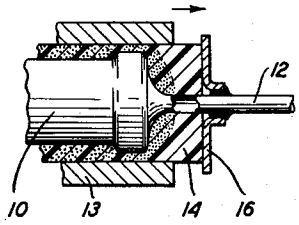
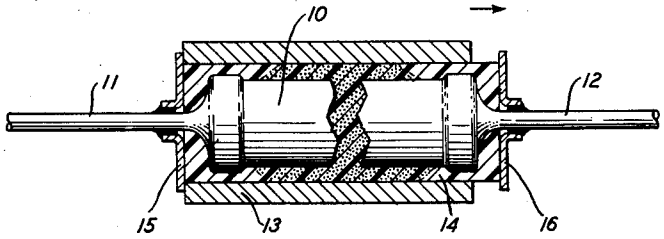


FIG. 3A



INVENTOR
L. H. WHITMAN
BY Edwin B. Cave
ATTORNEY

United States Patent Office 2,973,418
Patented Feb. 28, 1961

2,973,418

FUSE-RESISTOR

Lawrence H. Whitman, West Newbury, Mass., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

Filed Oct. 7, 1958, Ser. No. 765,831

8 Claims. (Cl. 200—123)

This invention relates to fuse-resistors and has particular reference to a circuit component which functions both as a resistor and a fuse.

One of the prime uses of fuse-resistors is in the power line of electron tube-operated equipment. In such an application the fuse-resistor, as a resistor, limits the heavy initial surge of current that occurs when such equipment is first energized and, as a fuse, protects the equipment against an extended overload. Two desirable circuit components are thus combined into one. The fuse, the fuse mounting and the associated wiring are eliminated, and a saving of space, of material and on cost of installation is thereby effected.

An object of this invention is to provide a new and novel fuse-resistor.

More specifically, an object of this invention is to provide a circuit component which, under normal electrical load, will function as a resistor only but which, when subjected to an electrical overload, will sustain an overload for a predetermined length of time and then open the circuit to thereby operate as a fuse.

Another object is to provide a combination resistor and fuse which is easily and inexpensively manufactured.

These and other objects of the present invention are realized in one illustrative embodiment thereof wherein a fuse-resistor comprises a rigid, thermally insulating tube encasing a commercially manufactured resistor having longitudinal lead wires. The resistor is suspended within the tube by a heat expandable, thermoplastic, electrical insulating material which surrounds substantially the entire surface of the resistor and is coextensive with the tube. Discs cover the respective ends of the tube and are attached to the respective lead wires of the resistor but not to the tube.

When placed in a circuit, the fuse-resistor functions under normal conditions solely as a resistor. However, when an overload in the circuit occurs, the heat generated by the resistor causes the central portion of the insulating material to soften and expand moving the end portions of the material out against the discs. The resulting longitudinal tension on the resistor either pulls the resistor apart or snaps one of the lead wires, thereby opening the circuit.

Accordingly, a feature of the invention resides in the utilization of a commercially manufactured resistance element having terminals extending therefrom.

Another feature resides in suspending the resistance element within a rigid container by means of a heat expandable, thermoplastic, dielectric material.

A further feature resides in closing the ends of the container with cover members and attaching the cover members to the respective terminals of the resistance element, but not to the container.

A complete understanding of the invention and of these and other features and advantages thereof may be gained from consideration of the following detailed description taken in conjunction with the accompanying drawing wherein one embodiment of the invention is

illustrated. It is to be expressly understood, however, that the drawing is for the purposes of illustration and description and is not to be construed as defining the limits of the invention.

In the drawing:

Fig. 1 is a longitudinal view partly in section of the fuse-resistor of this invention;

Fig. 2 is a similar view which shows the initial effects of an overload on the fuse-resistor;

Fig. 3A is a fragment of a similar view which depicts one result of an overload sustained for a length of time necessary for the fuse-resistor to open a circuit; and

Fig. 3B is a similar view which depicts an alternative result of an overload sustained for a length of time necessary for the fuse-resistor to open a circuit.

Referring to Fig. 1, there is shown a resistor **10** having lead wires **11** and **12** extending longitudinally from its respective ends. The resistor **10** may be any commercially manufactured resistor, i.e., fixed composition, wire-wound, film type, or otherwise, which has longitudinal lead wires. The type of resistor utilized, its resistance value and its watt size will be determined by the particular electrical circuit in which the resistor is to be employed.

The resistor **10** is encased within a rigid, thermally insulating open-ended container **13**. A typical example of such a container is a ceramic or glass tube. Suspending the resistor within the container is a material **14** which may be any heat expandable, thermoplastic, dielectric substance and, more particularly, any organic resin such as an epoxy resin. The material **14** fills the space around the resistor **10** and inside the container **13** and adheres to both the resistor and the container. The container **13** and the material **14** thereby encase the body of the resistor, the material being substantially coextensive with the container.

Covering the ends of the container **13** and having the lead wires **11** and **12** extending therethrough are discs **15** and **16**, respectively. The discs are not affixed to the container **13** but are securely attached to the lead wires by any well-known means such as soldering.

Normal electrical loads and overloads of short duration are carried by the resistor without appreciably affecting the surrounding material **14**. If, however, a sustained overload should occur, the resistor will overheat. Although heat is generated along the entire surface of the resistor, some heat dissipation occurs at its ends through the lead wires. Thus, as shown in Fig. 2, the greatest concentration of heat develops at the center of the resistor. The portion of material **14** enclosing the center of the resistor softens and expands, moving the still solid end portions of the material **14** axially outward against the discs **15** and **16**. A longitudinal stress is thereby placed upon the resistor. If the tensile strength of the core of the resistor **10** is less than the tensile strength of the lead wires, the resistor will fracture in the manner shown in Fig. 3A. If the converse is true, one of the lead wires will break as illustrated in Fig. 3B.

Thus, an electrical load above normal is sustained by the resistor **10** over a predetermined length of time before any undue tension is placed upon the resistor. Then, within a subsequent predetermined time the material **14** expands sufficiently to render the resistor inoperative. The failure of the resistor within definable limits thereby prevents damage to the other circuit components.

The term thermoplastic material as used in the above description and in the appended claims refers to a substance which is relatively nonfluid at room temperatures and which is nonrigid or fluid at the temperatures associated with a substained electrical overload of a resistance element.

Although but one embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and the scope of the accompanying claims.

What is claimed is:

1. A fuse-resistor comprising a resistor, axial lead wires extending from the respective ends of said resistor for connecting said resistor to an electric circuit, a glass tube encasing said resistor, an epoxy resin surrounding substantially the entire surface of said resistor and suspending said resistor within said glass tube, said epoxy resin being substantially coextensive with said glass tube and adhering to both said resistor and said glass tube, discs placed in contact with and covering the respective ends of said cylinder, said lead wires extending through and securely attached to said discs whereby an above normal load for a predetermined length of time creates a concentration of heat around the center portion of said resistor which causes said epoxy resin surrounding said center portion to soften and expand, moving said epoxy resin surrounding the end portions of said resistor axially outward against said discs, thereby producing a longitudinal tension on said resistor and said lead wires which causes the failure of either said resistor or one of said lead wires and breaks the circuit.

2. A fuse-resistor comprising a resistor, lead wires extending axially from the respective ends of said resistor for connecting said resistor to an electric circuit, a ceramic tube encasing said resistor, a heat expandable, thermoplastic, dielectric cement surrounding substantially the entire surface of said resistor and suspending said resistor within said ceramic tube, said cement being substantially coextensive with said ceramic tube and adhering to both said resistor and said ceramic tube, discs placed in contact with and covering the respective ends of said ceramic tube, said lead wires extending through and securely attached to said discs, whereby an above normal load creates a concentration of heat around the center portion of said resistor which causes said cement surrounding said center portion to soften and expand, moving said cement surrounding the end portions of said resistor axially outward against said discs, thereby producing a longitudinal tension on said resistor and said lead wires which causes the failure of either said resistor or one of said lead wires and opens the circuit within a predetermined length of time.

3. A fuse-resistor comprising a resistor having axial lead wires extending therefrom for connecting said resistor to an electrical circuit, a rigid, thermally insulating tube encasing said resistor, a heat expandable, thermoplastic, dielectric cement surrounding substantially the entire surface of said resistor and suspending said resistor within said tube, said cement being substantially coextensive with said tube and adhering to both said resistor and said tube, disks placed in contact with and covering the respective ends of said tube, said lead wires extending through and securely attached to said disks, whereby an above normal load for a predetermined length of time causes said material surrounding the center portion of said resistor to soften and expand, moving said cement surrounding the end portions of said resistor axially outward against said disks, thereby producing a longitudinal tension on said resistor that pulls said resistor apart and opens the circuit.

4. A fuse-resistor comprising a resistor having longitudinal leads extending therefrom for connecting said resistor to an electrical circuit, a rigid, thermally insulating tube encasing said resistor, a heat expandable, thermoplastic, dielectric material surrounding said resistor and suspending said resistor within said tube, said material being substantially coextensive with said tube, disks

covering the respective ends of said tube, said leads extending through and securely attached to said disks, whereby an above normal load for a predetermined length of time causes said material surrounding said resistor to soften and expand, moving said material axially outward against said disks, thereby creating a longitudinal tension on said resistor that pulls said resistor apart and opens the circuit.

5. A fuse-resistor comprising a resistor having terminal wires extending axially therefrom, a rigid, thermally insulating tubular member encasing said resistor, a heat expandable thermoplastic dielectric material surrounding said resistor and filling the free space within said tubular member, cover members closing the respective ends of said tubular member and attached to said terminal wires but not to said tubular member, whereby prolonged electrical overloading of said resistor causes said material surrounding said resistor to soften and expand, moving said material axially outward against said cover members, thereby creating a longitudinal tension on said resistor that parts said resistor and opens the circuit.

6. A fuse-resistor comprising a resistance element having longitudinal terminal leads extending therefrom, a rigid, tubular member encasing said resistance element, a heat expandable, thermoplastic, dielectric material surrounding said resistance element and filling the free space within said tubular member, cover members closing the respective ends of said tubular member and attached to said terminal leads but not to said tubular member, whereby prolonged electrical overloading of said resistance element causes said material surrounding said resistance element to soften and expand, moving said material axially outward against said cover members, thereby creating a longitudinal tension on said resistor that pulls said resistance element apart and opens the circuit.

7. In a fuse-resistor, a resistance element having longitudinal terminals extending therefrom, a rigid, open ended container enclosing said resistance element, a heat expandable, thermoplastic, dielectric material disposed about said resistance element and filling the free space within said container, cover members closing said open ends of said container and attached to said terminals but not to said container, whereby prolonged electrical overloading of said resistance element causes said material surrounding said resistor to soften and expand, moving said material axially outward against said cover members, thereby creating a longitudinal tension on said resistor that parts said resistance element and opens the circuit.

8. In a fuse-resistor, a resistance element having longitudinal terminal means extending therefrom, a rigid, open ended container enclosing said resistance element, a heat expandable, thermoplastic, dielectric material disposed about said resistance element and filling the free space within said container, cover means closing said container and attached to said terminal means but not to said container, whereby prolonged electrical overloading of said resistance element causes said material surrounding said resistance element to soften and expand, moving said material axially outward against said cover members, thereby creating a longitudinal tension on said resistor that pulls said resistance element apart and opens the circuit.

References Cited in the file of this patent

UNITED STATES PATENTS

1,984,498	Spurgeon et al.	Dec. 18, 1934
2,302,820	Van Liempt	Nov. 24, 1942
2,744,981	Spears	May 8, 1956
2,830,156	Burgess	Apr. 8, 1958

FOREIGN PATENTS

378,556	Great Britain	Aug. 18, 1932