Oct. 14, 1952 G. APPLEMAN 2,614,192

FUSE LINK

Filed June 13, 1951

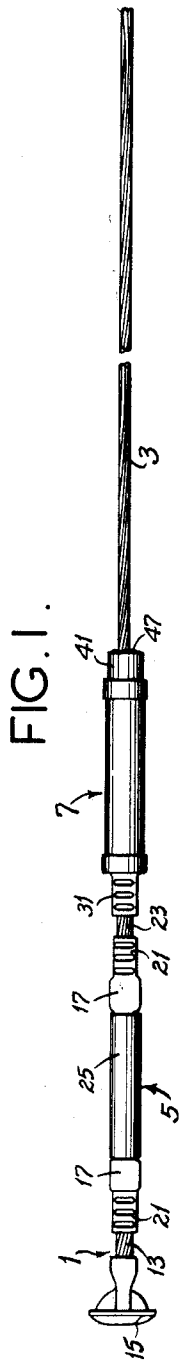

FIG. 1.

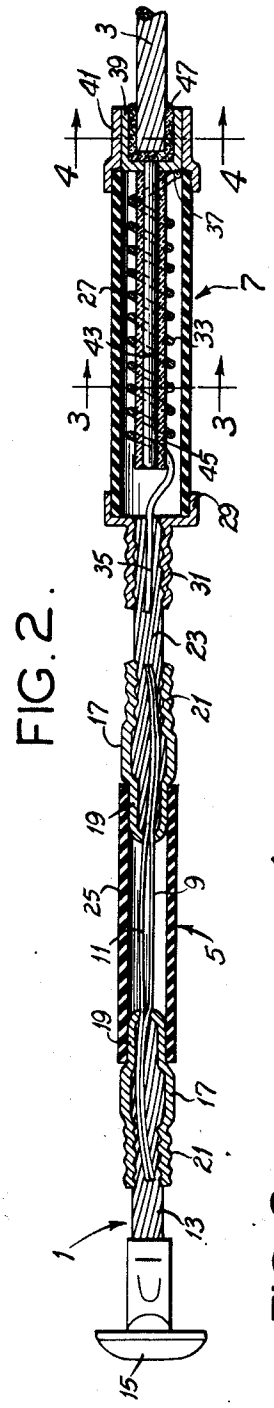

FIG. 2.

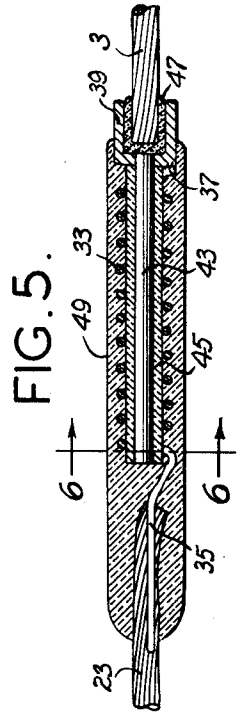

FIG. 5.

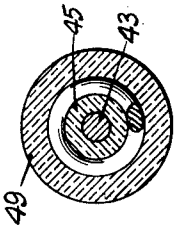

FIG. 6.

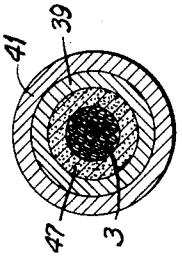

FIG. 4.

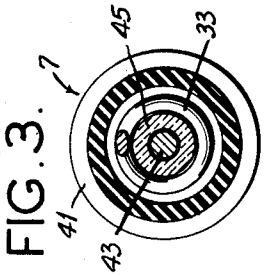

FIG. 3.

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Patented Oct. 14, 1952 2,614,192

UNITED STATES PATENT OFFICE

2,614,192

FUSE LINK

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Application June 13, 1951, Serial No. 231,335

4 Claims. (Cl. 200—123)

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This invention relates to fuse links and more particularly to dual-unit fuse links for use in electric power distribution systems.

The principal object of the invention is the provision of an improved fuse link particularly for use in electric power distribution systems adapted reliably to protect transformers or other apparatus from heavy overloads while remaining inactive on light overloads unless such light overloads are prolonged beyond a safe time limit. The fuse link acts in such a way as quickly to open a circuit in which it is connected upon the occurrence of a heavy overload, i. e., an overload which in a short time would damage a transformer or other apparatus protected by the fuse link. However, it does not open upon the occurrence of a light overload, i. e., an overload which the transformer or other apparatus protected by the fuse link can safely carry for some time, unless such light overload continues long enough to endanger the transformer or other apparatus. If a light overload should be sustained for a period long enough to endanger the protected transformer or other apparatus, the fuse link will then open the circuit. Thus, the fuse link of this invention maintains closed the circuit in which it is connected until the occurrence of either a heavy overload or a sustained light overload. It will not open the circuit upon the occurrence of a short-duration light overload, and thus enables short-duration light overloads, such as occur in starting a motor, for example, to be drawn without disrupting service.

Other objects will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of which will be indicated in the following claims.

In the accompanying drawing, in which several of various possible embodiments of the invention are illustrated,

Fig. 1 is a view in side elevation of a fuse link embodying the invention;

Fig. 2 is an enlarged longitudinal section of the link taken on line 2—2 of Fig. 1;

Fig. 3 is an enlarged transverse section taken on line 3—3 of Fig. 2;

Fig. 4 is an enlarged transverse section taken on line 4—4 of Fig. 2;

Fig. 5 is a view of an alternative embodiment of the slow-acting unit of the fuse link; and,

Fig. 6 is an enlarged transverse section taken on line 6—6 of Fig. 5.

Similar reference characters indicate corresponding parts throughout the several views of the drawing.

Referring to the drawing, Figs. 1–4 illustrate a first embodiment of the invention comprising spaced separable fuse terminals 1 and 3. The terminals are mechanically and electrically connected by a fast-acting fuse unit 5 and a slow-acting fuse unit 7. These units are connected in series both mechanically and electrically between the terminals to carry current and to take mechanical stress resulting from tensioning of the link as long as both units are intact. When either unit fuses, both the mechanical and electrical connections are broken. In referring to the terminals 1 and 3 as separable, it is meant that when either of units 5 or 7 fuses, the terminals may move apart. The fast-acting unit 5 is adapted to open upon the occurrence of a heavy overload, but to remain intact upon the occurrence of light overloads. The slow-acting unit 7 is adapted to open upon the occurrence of a sustained light overload, but to remain intact upon the occurrence of any light overload of such short duration as not to endanger a transformer or other apparatus under protection.

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The fast-acting fuse unit 5 consists of a fuse element comprising a fuse wire 9 and a strain wire 11. These wires are connected at one end (their left end as illustrated) to the terminal 1. The latter comprises a short length of a flexible electrically conductive cable or lead 13 having an electrically conductive terminal head 15 at its upper end. The wires 9 and 11, at their left ends, are electrically and mechanically connected to the end of the lead 13 as, for example, by a connection such as is particularly described in U. S. Patent 2,067,577. In general, this connection comprises a ferrule 17 receiving the end of the lead 13, the latter being cut on a bias to form a scarfed end rather than a right-angled end. The ferrule has an end portion 19 of reduced diameter. The end of the lead 13 is received in the larger end of the ferrule, and the wires 9 and 11 extend into the ferrule through its smaller end, being laid alongside the end of the lead 13, and the ferrule is crimped upon the lead 13 and the wires 9 and 11 as indicated at 21 thereby mechanically and electrically to connect the wires 9 and 11 to the lead 13. The wires 9 and 11, at their right ends, are connected to an intermediate electrically conductive flexible lead 23 by a ferrule 17 which is of the same construction as the one which connects the left ends of the wires to the lead 13. The wires 9 and 11 are enclosed in a fiber tube 25 which fits on the reduced ends 19 of the ferrules.

The slow-acting fuse unit 7 is mechanically and electrically connected between the intermediate lead 23 and the terminal 3, the latter comprising a length of electrically conductive flexible cable. The unit 7 comprises a tube 27, such as a fiber tube, which has properties of heat resistance, electrical insulation, and strength in

tension. Suitably fixed on one end of the tube is a cap 29 having a ferrule 31 receiving the right end of the lead 23. At 33 is shown an electrical resistance heater element consisting of a coil of Nichrome or similar wire. One end 35 of the coil extends into the ferrule 31 alongside the lead 23, and the ferrule is crimped as shown for an electrical connection of lead 23 and coil 33 and a mechanical connection of lead 23 to the tube 27. The other end 37 of the coil is electrically connected by a non-melting connection to an electrically conductive socket member 39 made of copper or an equivalent material which is fixed in a ferrule 41 secured to the right end of the tube 27, the socket member opening outward. The socket member 39 serves as a heat accumulator element, and has an elongate slender member 43 of heat-conductive material extending for a substantial portion of the length of the tube. As shown, this extension member 43 consists of a pin or wire of copper or an equivalent heat-conductive material. The coil 33 is wound around a sleeve 45 of heat and electrical insulating material, such as a ceramic sleeve, surrounding the extension. One end of the terminal lead 3 is held in the socket of the heat accumulator element 39 by a fusible connection, more particularly by a mass of low melting point solder indicated at 47 or other relatively low melting point material having a low melting temperature relative to the temperature required to fuse the fast-acting unit 5. Apart from the fusible connection, the terminal lead 3 is free to pull out of the socket.

The above-described fuse link is adapted to be mounted in a fuse switch of the type such as is shown in U. S. Patent 2,086,028, in which the link is held under spring tension. Tension is transmitted from terminal 1 through the strain wire 11, lead 23, the tube 27 (which serves as a strain element) and the fusible connection 47 to the lead 3. The heater 33 is not tensioned. A current path is established between the terminals 1 and 3 including fuse wire 9, lead 23, heater element 33 and member 39. Heat-conductive extension 43 does not carry current, being isolated from flow of current between the terminals. Upon flow of current through the fuse link, the fuse wire 9 is self-heated due to its resistance characteristics. If the current should reach a value such as to heat the fuse wire to its melting temperature, it quickly melts. This is quickly followed by melting of the strain wire 11, whereupon terminal 1 is quickly pulled away from the ferrule 17 on lead 23 to extinguish any arc which may be drawn upon the fusing of the fast-acting fuse unit 5. It will be understood that the fuse wire 9 is somewhat longer than the strain wire 11 so that the latter takes all the tension to which the fast-acting unit is subjected. This relieves the fuse wire 9 of strain so that its stress-free time-current characteristic is retained in use. A fuse wire having a time-current characteristic for affording protection against heavy overloads such as would damage apparatus to be protected if allowed to continue even for only a short time is selected in accordance with principles which are well known in the art. It will be understood that the time-current characteristic of the fast-acting unit 5 may be varied by using different fuse wires of different time-current characteristics, and that the time-current characteristic is dependent upon the requirements of whatever apparatus is to be protected.

The slow-acting unit 7 is adapted to break the circuit whenever the solder 47, which electrically and mechanically connects the terminal lead 3 in socket 39, is heated to its melting temperature. When the solder melts, the terminal lead 3 is quickly pulled out of the socket to break the circuit. The solder is heated principally by direct heat exchange with the socket 39, which in turn receives heat principally by heat conduction through the heat-conducting extension 43 and acts as a heat accumulator, storing up heat generated by the resistance heater 33. The extension 43 receives heat from the entire length of the coil 33 and conducts it to the socket 39. The tube 27 confines the heat. The time-current characteristic of the slow-acting unit 7 is dependent upon such factors as the heat generation characteristics of the heater 33, the rate of heat transfer from the heater to the heat accumulator socket element 39 (principally via wire 43), the heat accumulating characteristics of the element 39, and the melting point of the solder 47. The time-current characteristic of the slow-acting unit may be varied by varying one or more of these factors. The slow-acting unit is designed, in accordance with these considerations, to have a time-current characteristic such as to open upon the occurrence of a light overload sustained for a period long enough to endanger a transformer or other apparatus under protection. In designing the fast- and slow-acting units of a fuse link for protecting a transformer having a specified full load continuous rating, for example, the fast-acting unit might be designed with a time-current characteristic such that it opens in four seconds upon the occurrence of an overload twenty-five times the specified full load continuous rating, and in less time upon the occurrence of higher overloads. The slow-acting unit might be designed with a time-current characteristic such that it will open after five minutes of a sustained light overload 2.8 times the specified full load rating, after one minute of an overload 4.75 times the rating, after 30 seconds of an overload 6.7 times the rating, and after 10 seconds of an overload 13.7 times the rating. For overloads less than 2.8 times the rating, the slow-acting unit will, of course, remain intact for a period longer than five minutes.

Figs. 5 and 6 illustrate an alternative embodiment of the slow-acting fuse unit wherein, instead of using a fuse tube 27, the extension 43, sleeve 45, heater coil 33 and the end of the lead 23 are embedded in a solid body 49 of ceramic material molded around these elements as shown. In this case the molded body takes tensile stress resulting from tensioning of the link. The extension 43 fits tightly enough in the sleeve 45 and the sleeve is held tightly enough in the body 49 that the extension will not pull out of the body.

The fuse link of this invention is particularly useful for protecting transformers in electric power distribution systems, being adapted to protect such a transformer from harmful overloads that occur on its secondary or load side and also from faults that may occur on its primary side. Thus, for example, if the consumer demand should impose an overload of current value less than that which would open the fast-acting unit and for a period less than that which would open the slow-acting unit, the fuse link will not open. If, however, the overload should be prolonged to such an extent that the transformer might be damaged, the slow-acting unit will open. Also, if a fault should occur on the primary side of the transformer, imposing a heavy overload, the fast-acting unit will open quickly to protect the

transformer. It will be understood that the fuse link is also useful in other applications as, for example, for motor protection, to permit a motor to draw high starting current for the short time necessary to start it, without opening the circuit.

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

As many 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 drawing shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A fuse link comprising spaced terminals mechanically and electrically connected by a fast-acting fuse unit and a slow-acting fuse unit, said units being connected together in series mechanically and electrically between the terminals to carry current and to take mechanical stress resulting from tensioning of the link as long as both units are intact, both the mechanical and electrical connection being broken when either unit fuses, said slow-acting unit comprising an elongate slender member of heat-conductive material isolated from flow of current between the terminals, an electrically conductive heat accumulator element at one end of said member for storing heat received by conduction through said member, a body of fusible material in contact with the heat accumulator element and forming a fusible element in the connection of the terminals, a sleeve of thermal and electrical insulating material surrounding said member, and an electrical resistance heating coil surrounding said sleeve, the coil being connected to carry current flowing between the terminals.

2. A fuse link as set forth in claim 1 wherein the heating coil is enclosed to confine heat.

3. A fuse link comprising first and second terminals mechanically and electrically connected by a fast-acting fuse unit and a slow-acting fuse unit, said units being connected together in series mechanically and electrically between the terminals to carry current and to take mechanical stress resulting from tensioning of the link as long as both units are intact, both the mechanical and electrical connections being broken when either unit fuses, the fast-acting unit being connected at one end to the first terminal, the slow-acting unit comprising an elongate slender member of heat-conductive material isolated from flow of current between the terminals, an electrically conductive heat accumulator element at one end of said member for storing heat received by conduction through said member, an electrically insulating mechanical connection between the heat accumulator element and the other end of the fast-acting unit, a body of fusible material in contact with the heat accumulator element connecting the second terminal thereto, a sleeve of thermal and electrical insulating material surrounding said elongate member, and an electrical resistance heating coil surrounding said sleeve, the coil being connected at one end to the said other end of the fast-acting unit and at its other end to the heat accumulator element.

4. A fuse link as set forth in claim 3, wherein the mechanical connection between the heat accumulator element and the said other end of the fast-acting unit comprises an enclosure for the heating coil to confine heat.

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REFERENCES CITED

The following references are of record in the file of this patent:

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