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FUSE LINK

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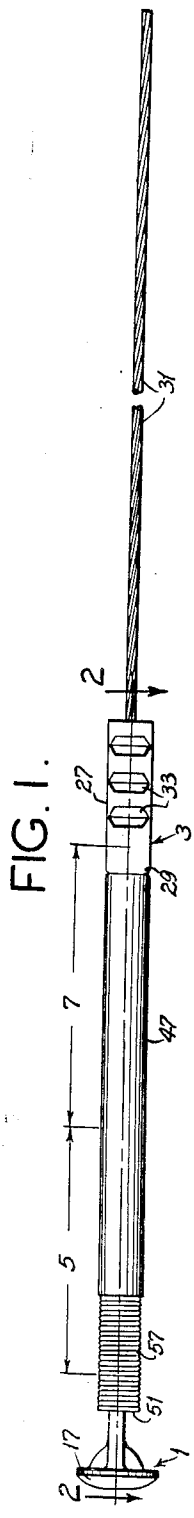


FIG. 1.

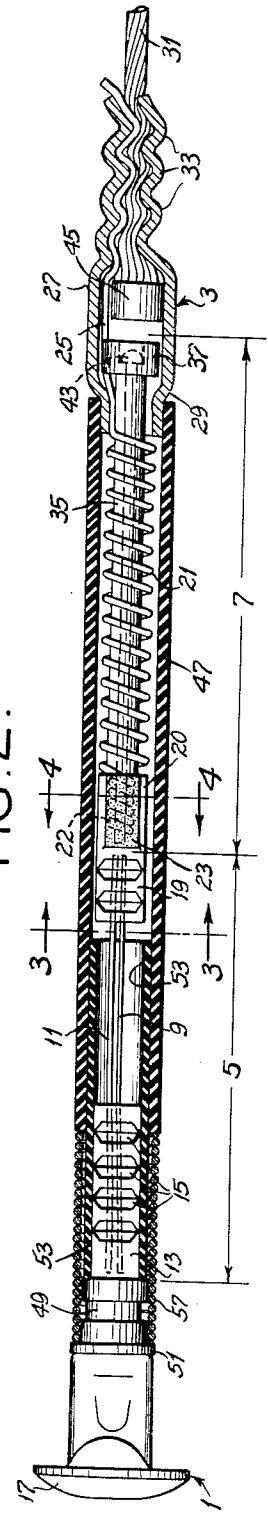


FIG. 2.

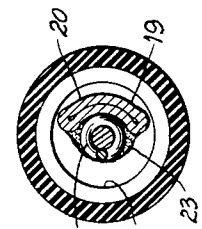


FIG. 3.

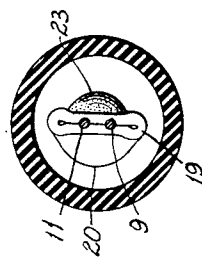


FIG. 4.

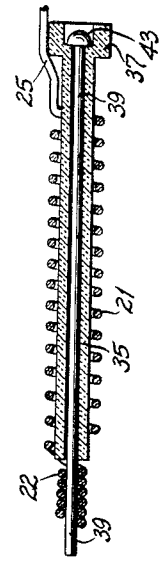


FIG. 5.

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UNITED STATES PATENT OFFICE

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FUSE LINK

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18 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.

This invention is an improvement upon the fuse links disclosed in the copending and coassigned application of Glen Appleman entitled Fuse Links, Serial No. 231,335, filed June 13, 1951, issued as Patent No. 2,614,192, October 14, 1952, its principal object being the provision of an improved construction for a 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 the circuit 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.

In general, the features of the fuse link of this invention by means of which the above-described action is obtained are as follows. The link includes spaced separable fuse terminals, which are adapted to be separated under tension imposed on the link as, for example, by spring action. A fast-acting fuse unit and a slow-acting fuse unit are connected in series both mechanically and electrically between the terminals so that if either unit fuses the circuit in which the fuse link is connected is opened. The fast-acting unit opens upon the occurrence of a heavy overload, but does not open upon the occurrence of a light overload. The slow-acting unit opens upon the occurrence of a sustained light overload, but not upon the occurrence of a

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light overload if the latter occurs only for a safe, short time interval. The fast-acting unit is connected at one end to one fuse terminal. The slow-acting unit comprises a heat-conductive strain element having a connection at one end to the other end of the fast-acting element and having a connection at its other end to the other fuse terminal. One of these connections comprises an electrically conductive heat accumulator element and fusible material connecting the strain element thereto. The other connection is an insulating connection to preclude the strain element from carrying current. An electrical resistance heater element is positioned adjacent to and electrically insulated from the strain element, and is electrically connected between the said one end of the fast-acting unit and the said other fuse terminal by connections one of which comprises said fusible material. Other features 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 one of various possible embodiments of the invention is 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; and,

Fig. 5 is a detail section of a subassembly of an insulating tube, heater coil and heat-conductive wire.

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

Referring to the drawing, a specific embodiment of the fuse link of this invention is shown to have spaced separable 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 elec-

trical 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. As stated, 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.

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 their outer ends (their left ends as illustrated in Fig. 2) to the terminal 1. The latter comprises a tube 13 of electrically conductive material such as copper. Wires 9 and 11, at their outer ends, extend into the tube 13, which is crimped, as indicated at 15, to be flattened upon the wires thereby mechanically and electrically connecting them to the terminal. Fixed on the outer end of the tube 13 is a terminal head 17 of electrically conductive material. The inner ends of the wires 9 and 11 are mechanically and electrically connected to an intermediate terminal element 19 of electrically conductive material such as copper. The element 19 also functions as a heat accumulator, as will be made clear. It consists of a short length of tubing. The inner ends of the wires 9 and 11 extend into one end of the tubing, which is flattened (see Fig. 3) to grip the wires. The other end of the tubing is flattened and also bent to be of trough shape in transverse section, as indicated at 20 in Figs. 3 and 4.

The slow-acting unit 7 includes an electrical resistance heater element 21 formed as a coil of Nichrome or similar wire. The inner end of the coil is formed into a smaller coil 22 and is mechanically and electrically connected to the element 19 by a fusible connection indicated at 23. This connection is made by securing the small coil 22 within the trough 20 of the element 19 by means of a fusible material such as a low melting point solder, having a low melting temperature relative to the temperature required to fuse the fast-acting unit 5. The other and outer end 25 of the heater is electrically connected to the terminal 3. The latter comprises a tube 27 of electrically conductive material such as copper. One end of this tube (its inner end) is necked down to provide a shoulder 29. A flexible conductor or lead 31, such as a braided copper wire, extends into the outer end of the tube 27, which is crimped as indicated at 33 to grip the lead 31. The end 25 of the heater element extends through the tube alongside the lead 31 and is gripped between the crimped portion 33 of the tube and the lead.

The heater coil 21 surrounds a tube 35 of ceramic insulating material. This has both electrical insulating and heat insulating properties. The tube 35 extends from adjacent the terminal 19 into the necked-down inner end of the terminal tube 27. The outer end portion of the ceramic tube 35 within the tube 27 is enlarged as indicated at 37 for interlocking with the shoulder 29. The arrangement is such that outward pull on the terminal 3 is transmitted to the ceramic tube. A heat conductive member 39 comprising a wire of heat conductive material such as copper extends through the ceramic

tube. The inner end of this wire extends through the small coil 22 at the end of the heater coil 21 and is connected to the element 19 and to the coil 22 by the fusible material 23. The outer end of the wire 39 has a head 43 in engagement with the outer end of the ceramic tube 35 within its enlarged end portion 37. The arrangement is such that outward pull on the ceramic tube is transmitted to the wire 39, which serves as a strain element relieving the heater coil 21 of tension. A spacer 45 of ceramic insulating material may be provided within the terminal tube 27 between the ends of the ceramic tube 35 and the flexible lead 31.

The fast-acting unit 5 and the slow-acting unit 7 are enclosed in a fuse tube 47 made of fiber or any other suitable material. This tube, which is somewhat shorter than the combined lengths of units 5 and 7, seats at one end against the shoulder 29 of the lower terminal tube 27. On the terminal tube 13 is a collar 49 having a flange 51. A tube 53 of insulating paper or any other suitable material is fitted on tube 13 with its outer end against the collar, and projects beyond the tube 13, being slidably telescoped within the end of the fuse tube 47. A coil compression spring 57 surrounds the slidable tube 53, being compressed between the upper end of the fuse tube 47 and the flange 51 on the collar to bias the terminal 1 outward.

The above-described arrangement is such that the terminal 1, the fast-acting unit 5, the intermediate terminal 19, the heater 21, and the terminal 3 are electrically connected in series. The fuse wire 9 and the strain wire 11 are electrically in parallel. Neither the spring 57 nor the heat-conductive wire 39 are in the electric circuit. The connection of wire 39 to the terminal 3 is insulated by the tube 35 to preclude the wire from carrying current. 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 the spring 57 quickly effects separation of the terminals 1 and 19 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 by the spring 57. 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 23, which electrically and mechanically connects the heater 21 to the element 19, is heated to its melting temperature. When the solder melts, the spring 57 quickly effects separation of the element 19 and the end of the heater 21 to break the cir-

cuit. The solder is heated principally by direct heat exchange with the element 19. The element 19 receives heat principally by heat conduction through the heat-conducting wire 39 and acts as a heat accumulator, storing up heat generated by the resistance heater 21. The wire 39 receives heat from the entire length of the coil 21 and conducts it to the element 19. The tube 47 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 21, the rate of heat transfer from the heater to the heat accumulator element 19 (principally via wire 39), the heat accumulating characteristics of the element 19, and the melting point of the solder 23. 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 13.7 times the rating, and after 10 seconds of an overload less than 2.8 times the rating, the slow-acting unit will, of course, remain intact for periods longer than five minutes.

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 may 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 separable fuse terminals, a fast-acting fuse unit and a slow-acting fuse unit connected in series both mechanically and electrically between the terminals, said fast-acting unit being connected at one end to one fuse terminal, said slow-acting unit comprising a heat-conductive strain element having a connection at one end to the other end of the fast-acting unit and having a connection at its other end to the other fuse terminal, one of said connections comprising an electrically conductive heat accumulator element and fusible material connecting the strain element thereto, the other connection being an insulating connection to preclude the strain element from carrying current, and an electrical resistance heater element adjacent to and electrically insulated from the strain element and electrically connected between said other end of the fast-acting unit and said other fuse terminal by connections one of which comprises said fusible material.

2. A fuse link as set forth in claim 1 wherein the heater element comprises a coil surrounding the strain element and electrically and thermally insulated therefrom.

3. A fuse link comprising a fuse tube, fuse terminals at the ends of the tube and free of the tube, a fast-acting fuse unit and a slow-acting fuse unit in the tube connected in series both mechanically and electrically between the fuse terminals, said fast-acting unit being connected at one end to one of the fuse terminals, said slow-acting unit comprising a heat-conductive strain element having a connection at one end to the other end of the fast-acting unit and having a connection at its other end to the other fuse terminal, one of said connections comprising an electrically conductive heat accumulator element and fusible material connecting the strain element thereto, the other connection being an insulating connection to preclude the strain element from carrying current, and an electrical resistance heater element adjacent to and electrically insulated from the strain element and electrically connected between said other end of the fast-acting unit and said other fuse terminal by connections one of which comprises said fusible material.

4. A fuse link as set forth in claim 3 wherein the heater element comprises a coil surrounding the strain element and electrically and thermally insulated therefrom.

5. A fuse link comprising a fuse tube, fuse terminals at the ends of the tube and free of the tube, a fast-acting fuse unit and a slow-acting unit in the tube connected in series both mechanically and electrically between the fuse terminals, said fast-acting unit being connected at one end to one of the fuse terminals, said slow-acting unit comprising a heat-conductive strain element having a connection at one end to the other end of the fast-acting unit and having a connection at its other end to the other fuse terminal, one of said connections comprising an electrically conductive heat accumulator element and fusible material connecting the strain element thereto, the other connection being an insulating connection to preclude the strain element from carrying current, and an electrical resistance heater element adjacent to and electrically insulated from the strain element and electrically connected be-

tween said other end of the fast-acting unit and said other fuse terminal by connections one of which comprises said fusible material, and a spring reacting from the fuse tube and acting upon one of the terminals to bias said terminals in terminal-separating direction.

6. A fuse link as set forth in claim 5 wherein the heater element comprises a coil surrounding the strain element and electrically and thermally insulated therefrom.

7. A fuse link comprising spaced separable fuse terminals, a fast-acting and a slow-acting fuse unit connected in series both mechanically and electrically between the terminals, said fast-acting unit being connected at one end to one fuse terminal and at its other end to an electrically conductive heat accumulator element, said slow-acting element comprising a heat-conductive strain element connected at one end by fusible material to the heat accumulator element and at its other end to the other fuse terminal, and being insulated from said other fuse terminal, and an electrical resistance heater element adjacent the strain element connected at one end to said heat accumulator element by said fusible material and at its other end to said other fuse terminal.

8. A fuse link comprising a fuse tube, fuse terminals at the ends of the tube and free of the tube, a fast-acting fuse unit and a slow-acting fuse unit in the tube connected in series both mechanically and electrically between the terminals, said fast-acting unit being connected at one end to one fuse terminal and at its other end to an electrically conductive heat accumulator element, said slow-acting element comprising a heat-conductive strain element connected at one end by fusible material to the heat accumulator element and at its other end to the other fuse terminal, and being insulated from said other fuse terminal, and an electrical resistance heater element adjacent the strain element connected at one end to said heat accumulator element by said fusible material and at its other end to said other fuse terminal.

9. A fuse link comprising a fuse tube, fuse terminals at the ends of the tube and free of the tube, a fast-acting fuse unit and a slow-acting fuse unit in the tube connected in series both mechanically and electrically between the terminals, said fast-acting unit being connected at one end to one fuse terminal and at its other end to an electrically conductive heat accumulator element, said slow-acting element comprising a heat-conductive strain element connected at one end by fusible material to the heat accumulator element and at its other end to the other fuse terminal, and being insulated from said other fuse terminal, an electrical resistance heater element adjacent the strain element connected at one end to said heat accumulator element by said fusible material and at its other end to said other fuse terminal, and a spring reacting from the fuse tube and acting upon one of the terminals to bias said terminals in terminal-separating direction.

10. A fuse link comprising a fuse tube, fuse terminals at the ends of the fuse tube and free of the fuse tube, the terminal at one end of the fuse tube having a terminal head and being carried by a tube slidably telescoped in the fuse tube, a fuse wire and strain wire in the fuse tube connected at one end to said one terminal and at their other end to an electrically conductive heat accumulator element, an electrical resistance

heater coil in the fuse tube connected at one end to the heat accumulator element by fusible material and at its other end to the other fuse terminal, the latter having a flexible lead secured thereto, said coil surrounding a tube of insulating material, a heat-conductive wire extending through said insulating tube and connected at one end to said accumulator element by said fusible material and having a head at its other end in engagement with a portion of the insulating tube so as to relieve the coil of tension, and a compression spring reacting from said one end of the fuse tube and acting upon said one terminal to tension the strain wire and the heat-conductive wire.

11. In combination, a fast-acting fuse unit and a slow-acting fuse unit connected in series, said fast-acting unit being connected at one end to an electrically conductive heat accumulator element, said slow-acting unit comprising an electrical heater element and a heat conductive member connected at one end to said accumulator element by a fusible connection, the heat conductive member being positioned to receive heat from the heater element and conduct it to the accumulator element.

12. In combination, a fast-acting fuse unit and a slow-acting fuse unit connected in series, said fast-acting unit being connected at one end to an electrically conductive heat accumulator element, said slow-acting unit comprising a tube of insulating material, an electrical heater coil surrounding the tube, and a heat conductive member extending through the tube, one end of the coil and one end of the heat conductive member being connected to the accumulator element by a fusible connection.

13. In combination, a fast-acting fuse unit and a slow-acting fuse unit connected in series, said fast-acting unit being connected at one end to an electrically conductive heat accumulator element, said slow-acting unit comprising a tube of insulating material, an electrical heater coil surrounding the tube, and a heat conductive member extending through the tube, one end of the coil and one end of the heat conductive member being soldered to the accumulator element by solder having a low melting temperature relative to the temperature required to fuse the fast-acting unit.

14. In combination, a fast-acting fuse unit and a slow-acting fuse unit connected in series, said fast-acting unit being connected at one end to an electrically conductive heat accumulator element, said slow-acting unit comprising a tube of insulating material, an electrical heater coil surrounding the tube, and a heat conductive member extending through the tube, one end of the coil and one end of the heat conductive member being soldered to the accumulator element by solder having a low melting temperature relative to the temperature required to fuse the fast-acting unit, said accumulator element comprising a metal terminal.

15. In combination, a fast-acting fuse unit and a slow-acting fuse unit connected in series, said fast-acting unit being connected at one end to an electrically conductive heat accumulator element, said slow-acting unit comprising a tube of insulating material, an electrical heater coil surrounding the tube, and a heat conductive member extending through the tube, one end of the coil and one end of the heat conductive member being soldered to the accumulator element by solder having a low melting temperature relative

to the temperature required to fuse the fast-acting unit, said accumulator element comprising a metal tube flattened upon said one end of the fast-acting unit, said metal tube being bent to trough shape, said ends of the coil and heat 5 conductive member being soldered to the metal tube within the trough.

16. In combination, a fast-acting fuse unit and a slow-acting fuse unit connected in series, said fast-acting unit being connected at one 10 end to an electrically conductive heat accumulator element, said slow-acting unit comprising a tube of insulating material, an electrical heater coil surrounding the tube, and a heat conductive member extending through the tube, one 15 end of the coil and one end of the heat conductive member being soldered to the accumulator element by solder having a low melting temperature relative to the temperature required to fuse the fast-acting unit, said heat conductive member comprising a metal wire having a head at 20 its other end in engagement with a portion of the tube so that the wire relieves the coil of tension.

17. In combination, a heat accumulator element comprising a flattened metal tube, a fuse wire extending into one end of the flattened tube, and an electric resistance heater element having one end disposed against the flattened tube and soldered thereto.

18. In combination, a heat accumulator element comprising a flattened metal tube having a trough shape in transverse section, a fuse wire extending into one end of the flattened tube, and an electric resistance heater element having one end disposed against the tube within the trough and soldered thereto.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,691,705	Cook--	Nov. 13, 1928
2,174,477	Pittman et al. -----	Sept. 26, 1939
2,281,029	Earle -----	Apr. 28, 1942
2,281,795	Pittman et al. -----	May 5, 1942
2,485,076	Timerman -----	Oct. 18, 1949