March 24, 1942. J. M. WALLACE 2,277,619

CIRCUIT INTERRUPTER

Filed Dec. 28, 1939

Fig. 1.

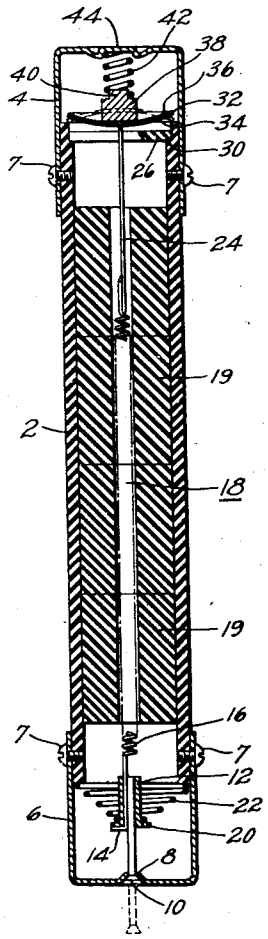


Fig. 2.

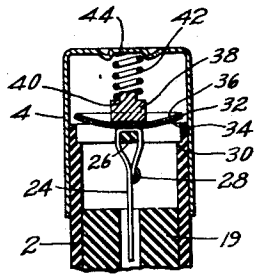


Fig. 3.

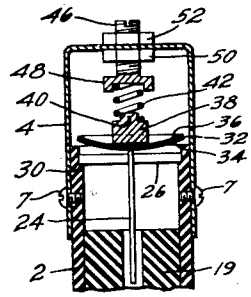


Fig. 5.

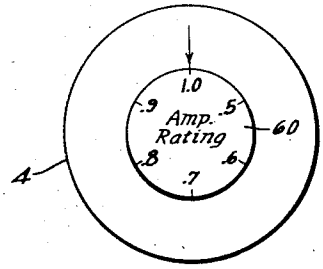


Fig. 4.

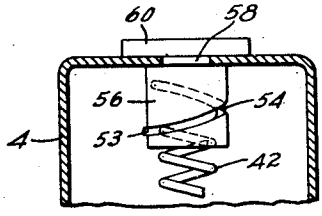
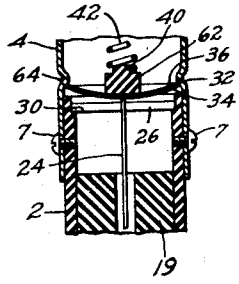


Fig. 6.



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CIRCUIT INTERRUPTER

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17 Claims. (Cl. 200—113)

My invention relates generally to circuit interrupting devices, and more specifically to protective interrupting devices which are adapted to automatically interrupt an electric circuit upon the passage therethrough of overload currents of predetermined values.

In the protection of electrical circuits and apparatus served thereby, it is desirable to protect not only against relatively heavy overloads such as short circuits, but also against relatively light overloads which may become harmful due to their continued duration.

Protection against these two types of overloads may be obtained by means of a fuse wire which embodies a fusible connection of a low melting point alloy as is disclosed in my copending application, Serial No. 294,073, filed September 9, 1939, and assigned to the assignee of this application. In this type of protective device, the circuit is interrupted on light continuing overloads in or through a mass of soft or molten metal, the characteristics of which may vary considerably, especially for varying masses of the metal. The amount of metal is difficult to control, especially for fuses of low current ratings where small amounts are used.

Accordingly, it is an object of my invention to provide a novel type of circuit interrupting means capable of interrupting a circuit substantially instantaneously upon the passage therethrough of relatively heavy overloads, and which will also operate to open its circuit in response to relatively light, but continuing overloads, with a time lag.

Another object of my invention is to provide a novel fuse embodying a fusible element to substantially instantaneously interrupt a circuit upon the occurrence of relatively heavy overloads and short circuits, and which includes novel means for interrupting the circuit upon the occurrence of relatively light, but continuing overloads.

It is a further object of my invention to provide a fuse incorporating a time lag protective means, the characteristics of which are readily manually adjustable to suit the particular circuit requirements.

It is a further object of my invention to provide a fuse incorporating a time lag protective means which is automatically resettable.

Still another object of my invention is to provide a fuse embodying time lag protective means which is operable to open the circuit with a snap-action.

Another object of my invention is to provide a fuse which also embodies time lag protective means, with an indicator or signal device to provide a readily visible indication of a circuit interrupting operation.

These and other objects of my invention will become more apparent upon consideration of the following detailed description of preferred embodiments thereof, taken in connection with the attached drawing, in which:

Figure 1 is a longitudinal sectional view of a fuse embodying the features of my invention;

Fig. 2 is a longitudinal sectional view of the upper end of the fuse shown in Fig. 1 and taken at right angles to the section of Fig. 1;

Fig. 3 is a fragmentary longitudinal sectional view of the upper end of a fuse similar to Fig. 1 but showing a means for adjusting the spring loading on the bimetal element;

Fig. 4 is a fragmentary longitudinal sectional view of the upper end of a fuse showing another means for adjusting the spring loading on the bimetal element;

Fig. 5 is an end view of the fuse shown in Fig. 4; and

Fig. 6 is a fragmentary longitudinal sectional view of a further modified form of fuse.

In general, my novel interrupting device includes a fusible link connected between a pair of fuse terminals with one of the connections including circuit opening means controlled by a bimetal element which may be heated by a separate heating element or may be self-heated. A spring is utilized to maintain the bimetal element in engagement with the fuse link and, in certain forms of my invention, I have provided means whereby the loading of this spring may be manually altered to thereby vary the rating of the fuse.

In the embodiment of my invention shown in Figs. 1 and 2, I have shown an elongated fuse tube 2 which may be of any suitable insulating material, such for example as fiber, porcelain, glass, or the like. The fuse tube 2 is provided with end caps 4 and 6 suitably secured over the ends of the tube as by the screws 7. The end cap 6 is provided with a central inwardly punched opening 8 for receiving an indicating rivet member 10, the head of which is shaped to be normally seated against the inclined sides of the cap opening 8. An anchoring sleeve 12 is provided over the inner end of the indicating rivet 10 and includes an outwardly extending lower flange 20, which serves as an abutment for one end of a coil compression spring 22 with the other end of the spring 22 being seated on the adjacent end of the fuse tube 2. The anchoring collar

12 also serves to anchor one end of a fuse link 18 which includes a coil tension spring 16 having its lower end passing through the anchoring sleeve 12 and bent over as at 14 to overlie the flange 20 on the collar. The anchoring sleeve 12 may be secured to the indicating rivet 10 in any desired manner, such for example as by crimping or soldering.

The fuse tube 2 preferably has a lining provided with a small bore to receive the fuse link 18, which lining is preferably of an insulating material capable of evolving an arc-extinguishing gas when in proximity to an electric arc, such for example as fiber, boric acid, a synthetic resin or the like, and is here illustrated as being composed of blocks 19 of such material centrally bored to receive the fuse link 18. The spring 16 of the fuse link 18 has its upper end secured to a fusible filament 24 as by soldering or the like, and the fusible filament 24 is, in turn, anchored to an insulating bar 26 seated on a shoulder 30 provided by the reduced upper end of the fuse tube 2. The fusible filament 24 may be anchored to the insulating bar 26 as by being looped around the bar and then secured to itself as by soldering or the like, as shown.

Seated on the upper open end of the fuse tube 2 is a bimetal element 32. This bimetal element may be of any desired shape, such as of rectangular strip form or spiral strip form and preferably so constructed as to be movable with a snap action. However, it is herein illustrated as being of concave disc shape so that the central portion thereof will engage the portion of the fusible filament 24 which is wrapped around the insulating bar 26. The bimetal element 32 is composed of two metallic laminations 34 and 36 intimately bonded together, for example as by welding or the like, and which laminations are composed of materials having different coefficients of expansion. The lamination 36 is composed of a material such as brass having a greater coefficient of expansion than the lamination 34 which may be of a material such as iron, so that when the bimetal element is heated, due to the unequal expansion of the laminations, a force is built up to a value sufficient to suddenly reverse its curvature and attain a position corresponding to the dotted line position shown in Fig. 1. Seated on top of the bimetal element 32, I have provided a heating element 38 which may be of any suitable resistance material, such for example as carborundum or graphite. The heating element 38 is provided with an integral reduced projection 40 for telescoping into the lower end of a coil compression spring 42 which has its other end seated in a recess 44 stamped in the upper fuse cap 4.

It can thus be seen that with the spring 42 normally held compressed, the circuit through the fuse will extend, for example, from the terminal cap 4 through the coil spring 42, heater 38, bimetal 32, fusible filament 24, coil tension spring 16, which is normally held in tension, indicating rivet member 10, to the lower fuse cap 6.

The manner of operation of this embodiment of my invention is as follows: On the occurrence of relatively light continuing overload currents, the current flowing through the heater 38 causes the bimetal element 32 to become heated. When the temperature becomes high enough, the bimetal disc reverses its curvature and the circuit is opened between the disc and the fusible filament 24. In a high voltage circuit, this gap will be bridged by an arc. The arc will burn the fusible filament wire in two, allowing the coil springs 16 and 22 to draw the fusible filament outwardly through the bore in the insulating blocks 19 to thus draw out the arc formed into contact with the gas evolving insulating material 19 to extinguish the arc. Due to the large mass of the heater 38 and the bimetallic element 32, the thermal capacity of these parts will be high and so the fuse will not operate on magnetizing surges. It will, however, operate on currents which are far too small to cause fusion of the fusible wire 24.

Upon the occurrence of relatively heavy overloads, such as short circuits, for example, the fusible filament 24 will substantially instantaneously be fused to interrupt the circuit in the same manner as before, before the heater 38 has a chance to heat the bimetal 32 sufficiently to cause it to reverse its curvature. Obviously when the fuse operates to interrupt the circuit under any of the two preceding conditions, when the fusible filament 24 is broken, the coil compression spring 22 is released and acts not only to aid spring 18 to draw out the arc into engagement with the gas evolving insulating material 19, but also acts to project the indicating rivet member 10 outwardly of the end cap 6 to a dotted line position such as is shown in Fig. 1. This will obviously give a clear visible indication that the fuse is blown and needs replacement.

On the occurrence of relatively light overloads in a low voltage circuit, the gap introduced between the bimetal element 32 and the fusible filament 24 when the bimetal element quickly reverses its curvature may be long enough to prevent an arc from being sustained in the gap. In this event, the fusible filament 24 is not destroyed and no indication is given by the indicating rivet 10 that the fuse is blown. However, this is not necessary since after the bimetal element 32 has cooled off it will reassume its normal position shown in Fig. 1 to reestablish the circuit through the fuse and thereby automatically re-establish the circuit.

The rating of the fuse will depend upon the loading of spring 42 which asserts a force on the bimetal element 32 in opposition to its movement to open the circuit between the bimetal element and the fusible filament 24. Thus, the rating of the fuse may be determined by the strength of the particular spring 42 which is employed.

In Fig. 3 I have shown a fuse wherein a single loading spring 42 may be employed to obtain a fuse of various ratings. To accomplish this result, I have provided a threaded stud 46 extending through a central aperture in the upper end fuse cap 4, and which is provided with an integral lower inverted cup-shape portion 48 in which the upper end of the loading spring 42 may be seated. The stud 46 is threadedly engaged with a nut 50 secured to the end cap 4 and may be locked in an adjusted position by a cooperating lock nut 52.

It is believed obvious that by turning the stud 46 the loading on the bimetal element 32 may be changed, thus changing the force necessary to reverse the curvature of the bimetal element 32 which, in turn, changes the amount of heat necessary to reverse the curvature of the bimetal element 32, thus directly affecting the rating of the fuse.

If it is desired to provide a readily manually operable means for changing the rating of my

novel fuse, I have shown in Fig. 4 a construction wherein the loading spring 42 has its upper end extending through a helical slot in a load control tube 56 which has a reduced upper end portion 58 rotatably received in a central aperture through the upper end cap 4, and an enlarged outer disc or dial portion 60 which is accessible for manual operation at the outer side of the fuse tube cap 4. As shown in Fig. 5, the dial 60 may be calibrated to provide a 2:1 ratio of adjustment of the fuse rating.

The ability to easily manually vary the rating of a fuse is especially advantageous where close coordination with the capacity of the circuit or apparatus being protected is required, and also compensation for varying ambient temperatures may be readily made in this fashion.

The bimetal element 32 may be self-heated if desired, thus eliminating the separate heater 38. In Fig. 6 I have shown such a structure where the heater element 38 of the previously described embodiments is replaced by a block of insulating material 62 which serves as a seat for the loading spring 42, and for insulating the spring from the bimetal element. The outer edges of the bimetal element 32 are engaged beneath a shoulder 64 formed on the end cap 4. The circuit through the fuse in this embodiment of my invention obviously extends from the fuse cap 4 radially inwardly through the bimetal to the center thereof, thence to the fuse link 18 and terminal cap 6 in the same manner described in connection with the embodiment shown in Fig. 1.

The operation of this form of my invention is identical with that previously described in connection with that shown in Fig. 1 except that the bimetal is self-heating instead of requiring a separate heater.

It should be obvious from the foregoing, that I have provided a novel type of circuit interrupting means which will give substantially instantaneous protection against relatively heavy overloads on the order of short circuits, which will give a time lag protection on relatively light overloads, and which provides an automatically resettable protective device under certain light load and low voltage conditions. Furthermore, I have provided a fuse, the rating of which may be readily manually changed within a wide range.

Having described preferred embodiments of my invention in accordance with the patent statutes, I desire that it be understood that my invention is not limited to the particular embodiments disclosed herein, inasmuch as it will be obvious, particularly to persons skilled in the art, that many changes and modifications may be made in these particular structures, without departing from the broad spirit and scope of my invention. Therefore, I desire that my invention be interpreted as broadly as possible and that it be limited only by what is expressly set forth in the following claims.

I claim as my invention:

1. In a circuit interrupting device having a pair of terminals, a fuse link connected to one of said terminals, and a thermally responsive movable element connected to the other of said terminals and normally engaging said link, whereby said element is movable away from said link in response to predetermined conditions to break the circuit, and the fusible portion of said link being closer to said element than other conducting parts of the link at least when said element is moved away from said link, whereby an arc will be established between said element and the fusible portion of said link.

2. In a circuit interrupting device having a pair of terminals, a fuse link connected to one of said terminals, and including a fusible portion, and a thermally responsive movable element connected to the other of said terminals and having a part engaging the fusible portion of said fuse link, whereby said element is movable away from said fusible portion in response to predetermined thermal conditions to strike an arc to said fusible portion.

3. In a circuit interrupting device having a pair of terminals, a fuse link connected to one of said terminals, and means connecting said fuse link to the other of said terminals including a concavo-convex bimetallic disk movable to break the circuit adjacent said fuse link with a snap action in response to temperature changes.

4. In a circuit interrupting device having a pair of terminals, a fuse link having one end thereof connected to one of said terminals, and the other end thereof anchored to a support, means tensioning said fuse link, and thermally responsive means connected to said other terminal and having a movable part normally engaging said fuse link, and movable away from said link in response to predetermined thermal conditions to insert a gap in the circuit.

5. In a circuit interrupting device having a pair of terminals, a fuse link and heating means connected between said terminals, and heat responsive means for inserting a gap in the circuit through the device, with said fusible element constituting one terminal of said gap in response to predetermined heating thereof by said heating means.

6. In a circuit interrupting device having a pair of terminals, a fuse link connected to one of said terminals, and a thermally responsive movable element and electric heating means, in heating conducting relation thereto connected in serial arrangement to the other of said terminals, and said element having a part normally engaging said fuse link.

7. In a circuit interruting device, means for automatically interrupting a circuit upon the passage therethrough of currents of a predetermined value, time lag means for automatically opening said circuit in response to the passage therethrough of currents of a lesser predetermined value for a predetermined length of time, and said first mentioned means being responsive to an arc established by said time lag means to interrupt said circuit.

8. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in the tube having one end thereof anchored relative to the tube, said fuse link having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a part movable into and out of engagement with said fuse link in response to the presence or absence through the circuit of relatively light continuing overload currents, and means tensioning said fuse link.

9. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in the enclosure having one end thereof anchored relative to said enclosure and having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a bimetallic element having a part movable into and out of engagement with said fuse link in response to

the presence or absence through the circuit of relatively light continuing overload currents, and means tensioning said fuse link.

10. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in said enclosure having one end thereof anchored relative to said enclosure and having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a bimetallic element having a part movable into and out of engagement with respect to said fuse link, and electric heating means in heat conducting relation with said bimetallic element.

11. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in said enclosure having one end thereof anchored relative to said enclosure and having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a bimetallic element having a part movable into and out of engagement with respect to said fuse link, electric heating means in heat conducting relation with said bimetallic element, and resilient means for maintaining said heating means and bimetallic element in engagement.

12. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in said enclosure having one end thereof anchored relative to said enclosure and having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a bimetallic element having a part movable into and out of engagement with respect to said fuse link, electric heating means in heat conducting relation with said bimetallic element, and manually adjustable resilient means for maintaining said heating means and bimetallic element in engagement.

13. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in said enclosure having one end thereof anchored relative to said enclosure and having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a bimetallic element having a part movable into and out of engagement with said fuse link in response to the presence or absence through the circuit of relatively light continuing overload currents, and means for varying the responsiveness of said movable part.

14. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in said enclosure having one end thereof anchored relative to said enclosure and having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a bimetallic element having a part movable into and out of engagement with said fuse link in response to the presence or absence through the circuit of relatively light continuing overload currents, resilient means opposing disengaging movement of said movable part, and manually operable means for varying the loading of said resilient means.

15. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in said enclosure having one end thereof anchored relative to said enclosure, said fuse link having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a part movable into and out of engagement with said fuse link in response to the presence or absence through the circuit of relatively light continuing overload currents, means of a material capable of evolving an arc extinguishing gas when in proximity to an electric arc forming a restricted arc passage in said tube, and means biasing said other end of said fuse link for movement through said passage when said fuse blows.

16. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in said enclosure having one end thereof anchored relative to said enclosure, said fuse link having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a part movable into and out of engagement with said fuse link in response to the presence or absence through the circuit of relatively light continuing overload currents, and indicating means responsive solely to rupture of said fuse link for providing indication which is readily visible at the exterior of said fuse tube.

17. In a fuse, a fuse enclosure having a pair of spaced terminal portions, a fuse link in said enclosure having one end thereof anchored relative to said enclosure, said fuse link having the other end thereof connected to one of said terminal portions, means for connecting said link to the other of said terminal portions including a part movable into and out of engagement with the fusible portion of said link to open and close the circuit in response to the presence or absence of relatively light continuing overload currents.

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