Feb. 22, 1944. E. H. TAYLOR 2,342,310

FUSIBLE PROTECTIVE DEVICE

Filed Feb. 13, 1940

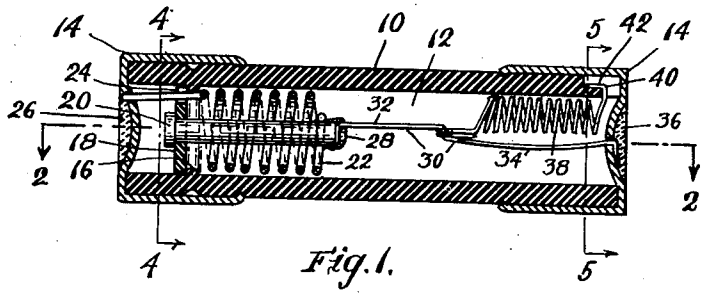

Fig. 1.

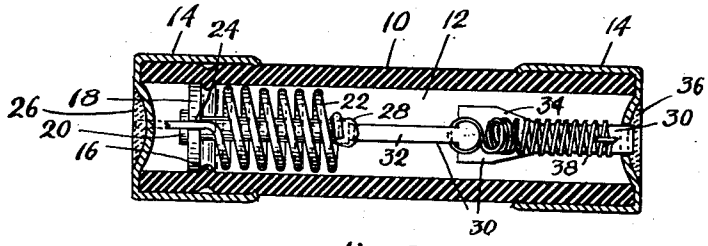

Fig. 2.

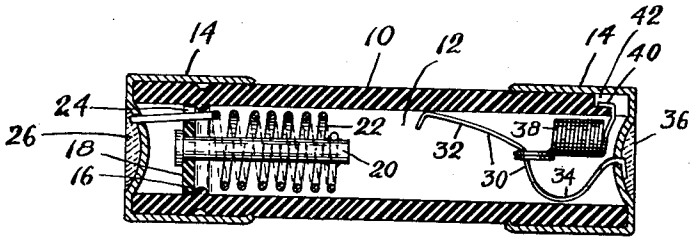

Fig. 3.

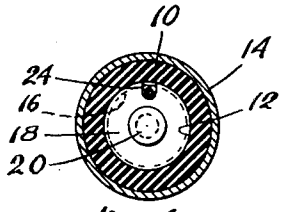

Fig. 4.

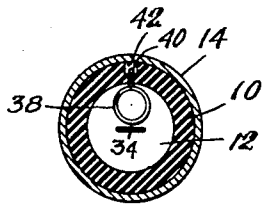

Fig. 5.

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Patented Feb. 22, 1944

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UNITED STATES PATENT OFFICE

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FUSIBLE PROTECTIVE DEVICE

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Application February 13, 1940, Serial No. 318,698

18 Claims. (Cl. 200—123)

The present invention relates to thermal cut-outs or fusible protective devices characterized by the use of means for melting or fusing a low temperature metal to effect the release of a movable circuit interrupting conducting element.

One object of the present invention is to provide a reliable device of the type set forth above, whereby long continued moderate overload currents will be effective to fuse the low melting temperature material and permit the release of a movable circuit interrupting conductor to interrupt the circuit after the overload current has been continued for a predetermined period of time. To this end, the illustrated device is provided with a heater element, a mass of heat absorbent material, a conducting element and specifically a fusible link having a fusing portion connected to the heat absorbent mass by the heat softenable material, a mass of heat softenable or fusible material, and means to maintain the fusible portion of the conducting element under tension and to move the conducting element away from the heat absorbent mass upon fusing of the fusible connecting mass to interrupt the circuit.

A further object of the invention is a device of the type described wherein a part only of the fusible link is normally under tension, the untensioned part being flexible and arranged to flex freely upon the melting of the low melting temperature material, or the fusing of the tensioned fusing part of the link, to permit the tensioning spring to act freely and promptly to separate the disjoined conducting parts of the device for the purposes of enhancing circuit interruption.

Another object of the invention is to provide a simple reliable thermal cut-out or fusible protective device wherein the means for tensioning the fusible portion of the movable circuit interrupting conductor is so arranged that it does not affect the circuit interrupting characteristics thereof.

Another object of the present invention is to improve generally the construction and operation of thermal cut-outs or fusible protective devices.

With the above and other objects and features in view, the invention will now be described with reference to the accompanying drawing which illustrates a preferred embodiment of the invention and in which:

Fig. 1 is a view partly in section taken along the longitudinal axis of the device;

Fig. 2 is a view in section taken along the line 2—2 of Fig. 1;

Fig. 3 is a view in section similar to Fig. 1 but illustrating the device in operated position;

Fig. 4 is a view in cross section taken along the line 4—4 of Fig. 1; and

Fig. 5 is a view in section taken along the line 5—5 of Fig. 1.

The fusible protective device embodying the present invention, and chosen for the purposes of illustration, is of the cartridge fuse type and includes a cylindrical body 10 open at both ends and having an internal chamber 12. The fuse body 10 is formed of vulcanized fibre or other suitable insulating material. The ends of the body 10 are closed by ferrules or terminal members 14 which are arranged to be crimped at their inner ends to prevent undesired removal of the ferrules from the plug body 10. These ferrules preferably are formed of brass or other suitable electric conducting material.

The left hand end of the fuse body 10, as illustrated in Fig. 1, is provided with an inwardly extending annular shoulder 16 against which a washer 18, formed of fibre or other suitable insulating material, is arranged to seat. The washer 18 is of substantially the same diameter as the internal bore of the fuse body 10 and is provided with a central opening through which is frictionally inserted a headed plug or rod 20 formed of copper or other suitable heat absorbing material. The plug 20 is of such size that it will absorb a substantial amount of heat to provide sufficient time lag for the device, as will later become apparent. The plug 20 is surrounded by an open helical coil of resistance wire 22 which, in the illustrated embodiment of the invention, is spaced from the plug 20 and has a diameter which is only slightly less than the diameter of the chamber 12. The left hand end of the helix 22 extends outwardly through a slot or opening 24 formed in the washer 18 and is arranged to pass through an opening formed in the left hand end terminal or ferrule 14 to which it is secured by means of a mass of high melting temperature solder 26. The other or right hand end of the helix 22 is soldered or otherwise suitably secured to the right hand end portion of the plug or heat absorbent member 20. The wire from which the coil 22 is formed is sufficiently rigid to be self-supporting and, consequently, will not sag or otherwise be brought into contact with the copper heat absorbing plug 20, thus short-circuiting one or more of the convolutions of the helix.

The right hand end of the heat absorbing copper plug 20 has affixed thereto by means of a relatively small mass of low melting temperature solder 28 one end of the fuse link 30. The fuse link 30 at its left hand end is provided with a relatively narrow fusing portion 32 and a wider right hand portion 34. The resistance of the fuse link 30 is relatively low and, consequently, this link has a minimum heating effect. The right hand end of the fuse link 30 is threaded through a slot formed in the right hand end cap or terminal 14 and this end is fixed in position by a mass of high melting temperature solder 36.

The fusing portion 32 of the fuse link 30 is maintained under tension by a tensioned spring 38 and one of the convolutions of the spring surrounds the fusing portion 32 adjacent to the junction of the fusing portion 32 with the relatively wider portion 34 and bears against the end of the wider portion. The free end of the spring 38 is provided with a hook 40 which is arranged to be received in a recess 42 formed in the right hand end of the fuse body 10. The spring, of course, is under suitable tension when the parts are in the positions shown in Figs. 1 and 2.

It is evident from the above detailed description of the construction of the illustrated cartridge fuse that the heating element 22 is not placed under any tension by the spring 38 since the tension of the spring is transmitted through the fusible portion 32 and through the body of the plug 20 to the washer 18 which is thus securely seated against the shoulder 16 formed in the interior of the left hand end of the fuse body 10. Furthermore, the parts are so connected and located relatively to each other that substantially the entire mass of the heat absorbing plug 20 must be heated by the heating coil 22 to a temperature sufficiently high to fuse or melt the low melting temperature mass 28 which connects the right hand end of the plug 20 to the left hand end of the fuse link 30. Thus, the action of the circuit interrupting elements of the device is delayed until after the overload current passing through the heating coil 22 has generated sufficient heat to raise the temperature of the entire mass of the plug 20 to the fusing or melting temperature of the mass 28.

In the illustrated construction, the spring 38 is so arranged and located that it does not affect the characteristics of the fuse link 30. The free or hooked end 40 of the spring 38 is insulated from the right hand end cap 14 and, consequently, does not carry any current. Furthermore, since the spring is connected to the fuse link 30 at the end of the fusing portion 32 thereof remote from the heat absorbing block 20, the fusing portion 32 is always under tension and when the portion 32 is fused by a current approximating a short-circuit current in value, the spring will be effective to move the fused ends of the portion 32 away from each other, thereby more rapidly and surely interrupting the current.

The illustrated device is designed to operate for indefinite periods of time when traversed by a current not exceeding the rated capacity of the device. When, however, the device is traversed by currents moderately in excess of its rated capacity, the heating coil 22 will gradually become heated and the heat generated thereby will be transmitted to the heat absorbing plug 20 by radiation and convection and also by conduction through the right hand end of the coil 22 which is soldered or otherwise affixed to the right hand end portion of the heat absorbing plug 20. By this means, the entire mass of the plug 20 is gradually heated, depending on the overload current, to a temperature which is substantially uniform throughout the entire mass, thus delaying the fusing of the mass of low temperature melting material 28 for a period would be sufficient to take care of temporary overloads, such as might be incident, for example, to the starting of an electric motor. When, however, the moderate overload is continued for a period which might cause injury to the device or devices which the fuse was designed to protect, the mass 28 will melt, thus permitting the spring 38 to move the left hand end of the link 30 away from the right hand end of the plug 20, thus interrupting the circuit and moving the fuse link 30 into the position shown in Fig. 3, wherein the relatively wide portion 34 of the fuse link 30 operates as a flexible pigtail and permits the desired separation of the parts just above discussed. If, on the other hand, the device is traversed by a current which approximates a short-circuit in value, the fusible mass 28 will not be heated to a point which will permit the release of the left hand end of the fuse link 30 but the high current will cause the fusible portion 32 to fuse and thus permit the spring 38 to operate to separate the adjacent fused ends of the portion 32. This action, of course, is substantially instantaneous and does not permit the heating coil 22 to become heated sufficiently to fuse the mass 28.

The unstressed portion 34 of the fusible link is flexible and is arranged to flex, as illustrated in Fig. 3, when either the low melting temperature metal melts or the most readily fusible part 32 of the link fuses, thereby permitting the spring to act without hindrance quickly to separate the disjoined current conducting parts of the device and effect circuit interruption.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a unitary fusible protective device, the combination of a heating conductor, a heat absorbent mass spaced from and surrounded by and arranged to be heated by said heating conductor and having one end connected to said heating conductor, said heat absorbent mass and said heating conductor having independent supports, a flexible fusible conductor, readily fusible means for directly connecting one end of said flexible conductor to said heat absorbent mass, and means exerting tension on at least a part of the flexible conductor for moving it to interrupt the circuit upon fusing of the readily fusible means.

2. In a unitary fusible protective device, a heating conductor, an infusible heat absorbent mass surrounded by and arranged to be heated by said conductor and supported independently of said conductor and having one end connected to one end of said heating conductor, a flexible conductor having a fusing portion of reduced cross section, readily fusible means for connecting one end of said flexible conductor to said heat absorbent mass, and means connected to said flexible conductor at said portion of reduced cross section to stress said fusing portion and to move said flexible conductor to interrupt the circuit when said readily fusible means is heated to a fusing temperature, a substantial part of said flexible conductor being free from stress.

3. In a fusible protective device, a heating conductor, a heat absorbent mass surrounded by and arranged to be heated by said heating conductor

and having one end connected to said heating conductor, means for supporting said heat absorbent mass and heating conductor independently of each other, a flexible conductor having a fusing portion, readily fusible means for connecting one end of said fusing portion to the heat absorbent mass, and means engaging the other end of the fusing portion of the flexible conductor for stressing only the fusing portion of the flexible conductor and for moving the conductor to interrupt the circuit upon fusing of the readily fusible means.

4. In a fusible protective device, a heat absorbent mass, a heating conductor surrounding said mass and air-spaced therefrom and having one end connected to one end of said heat absorbent mass, a flexible conductor having a fusing portion, readily fusible means for connecting one end of the flexible conductor to the heat absorbent mass, and means for tensioning the fusing portion only of said flexible conductor arranged to interrupt the circuit by moving said conductor upon fusing of the readily fusible means.

5. In a fusible protective device, a heating conductor, a flexible conductor having a fusing portion, readily fusible means for electrically connecting the fusing portion of said flexible conductor to one end of said heating conductor, means for tensioning the fusing portion only of said flexible conductor for moving the flexible conductor to interrupt the circuit upon fusing of said readily fusible means, and a heat absorbent mass anchored at one end and electrically and thermally connected to said heating conductor and said flexible conductor for absorbing heat generated by said heating conductor, said heat absorbent mass being so arranged that the heating conductor is free from tension.

6. In a fusible protective device, a heating conductor free from tension, an infusible heat absorbent mass, a flexible conductor having a fusing portion, a mass of low melting temperature metal for securing one end of said heating conductor and said flexible conductor to one end of said infusible heat absorbent mass, and current-excluded means for tensioning the fusing portion only of the flexible conductor.

7. In a fusible protective device, a heating element, a flexible conductor having a fusing portion connected in series with said heating element, an anchored heat absorbing block having an end portion to which said heating element and said flexible conductor are directly connected, a mass of low melting temperature metal for electrically connecting said element and said conductor to said block, and means affixed to said fusing portion of said flexible conductor for tensioning said fusing portion only and arranged upon fusing of the fusible mass to separate said element and said conductor to interrupt the circuit.

8. In a fusible protective device, a heating element, a flexible conductor having a fusing portion connected in series with said heating element, a heat absorbing block having an anchored end portion and a free end portion to which said heating element and said flexible conductor are connected, a mass of low temperature melting metal for electrically connecting said element and said conductor to said block, means affixed to said fusing portion of said flexible conductor for tensioning only said fusing portion and arranged upon fusing of the fusible mass to separate said element and said conductor to interrupt the circuit, and means engaging said block for anchoring the block whereby the heating element is free from the tension of said tensioning means.

9. In a fusible protective device, an enclosing casing, a heating conductor, an infusible heat absorbent mass anchored in said casing independently of the conductor, a fusible conductor having a fusing portion and a flexible pigtail portion, a mass of low temperature melting metal for securing one end of the fusing portion of said fusible conductor and one end of the heating conductor to one end of the infusible heat absorbent mass, and spring means arranged to engage said fusible conductor adjacent to said fusing portion for tensioning only said fusing portion and arranged upon fusing of said low temperature melting metal to separate said fusible conductor and heat absorbent mass to interrupt the circuit and to flex said pigtail portion.

10. In a fusible protective device, an enclosing casing having an inwardly projecting shoulder adjacent to one end thereof and terminals on said casing, a heat absorbent plug having a head at one end, a member arranged to seat against said shoulder and engaging the head of said plug to support said plug, a helical heating coil surrounding said plug and having one end electrically and thermally connected to the end of the plug remote from its associated terminal, a flexible conductor having a fusing portion, a mass of low melting temperature metal for connecting one end of the fusing portion to the end of the plug connected to the end of the heating coil, the other end of said flexible conductor being connected to the other end terminal, and means for tensioning the fusing portion of the flexible conductor arranged to move the flexible conductor when the fusible portion thereof is released upon fusing of the low temperature metal.

11. In a fusible protective device, a heat absorbent mass, means for heating said mass, a fusible link having a most readily fusible portion and a portion of its length that is less readily fusible and flexible, a low melting temperature material connecting the more readily fusible portion of the link to said heat absorbent mass, and spring means acting on only the most readily fusible portion of said link and exerting tension thereon in a direction to separate fused parts thereof and also to separate the link from said heat absorbent mass, the less readily fusible portion of said link being adapted to flex freely upon separating-action of said spring.

12. In a fusible protective device, an enclosing casing, terminals on the casing, a heat-absorbing rod located in an end part of and extended axially of said casing, an insulating support for said rod engaged with the outer end thereof and also with said casing inwardly of an end thereof, a heating helix surrounding and spaced from said rod and having its one end connected to the inner end of said rod by a relatively fusible metal mass and its other end connected rigidly to a terminal, said helix being formed of a relatively stiff conductor that holds the helix in the aforesaid relation separately from said rod, a flexible conductor having its one end connected to another terminal and its other end anchored to said rod by said fusible mass, and spring means operative to move said flexible conductor away from said rod in response to the fusing of said fusible mass.

13. In a fusible protective device, a tubular enclosing casing, and terminals thereon, a shoulder within the casing, an insulating member seated on said shoulder, a metal rod in said member projecting therebeyond within the casing, a heater coil surrounding said rod having its one end connected therewith and its other end extended through said member and connected with an end terminal, a flexible conductor in said casing having its one end connected with the other terminal and its other end connected with the end of said rod by a fusible metal, and means responsive to the fusing of the fusible metal for moving said conductor away from said rod.

14. In a fusible protective device, a tubular enclosing casing, end terminals thereon, a shoulder within the casing near one end thereof, an insulating member seated on said shoulder, a metal rod in said member projecting therethrough toward the other end of the casing, a head on said rod overlying said member on the side thereof opposite said shoulder, heating means for said rod, a flexible conductor having its one end connected with said other terminal and its other end connected to the end of said rod by a fusible metal, and spring means exerting tension on a part of said conductor in a direction to maintain said head against said member and said member against said shoulder and responsive to the fusion of said fusible metal to separate said conductor from said rod.

15. In a fusible protective device, a tubular enclosing casing, end terminals thereon, a shoulder within the casing near one end thereof, an insulating member seated on said shoulder, a metal rod in said member projecting therethrough toward the other end of the casing, a head on said rod overlying said member on the side thereof opposite said shoulder, heating means for said rod, a flexible conductor having its one end connected with said other terminal and its other end connected to the end of said rod by a fusible metal, and spring means holding said rod and member in the aforesaid relation also responsive to the fusion of said fusible metal to effect separation of said rod and conductor.

16. In a fusible protective device, the combination of a heat absorbing member, a heater therefor supported in spaced relation from said heat absorbing member and independently thereof, a terminal, a flexible fusible conductor having its one end connected to said terminal and its other end connected to said heat absorbing member by a fusible metal, and spring means exerting tension on the fusible part only of the conductor most adjacent said member and responsive to the fusing of said fusible metal to separate said conductor from said metal and effect the flexing of the untensioned part of the conductor.

17. In a fusible protective device, a heat absorbing member, a flexible conductor connected with said member by a fusible mass, mean responsive to the heating of said member and the fusing of said fusible mass to effect separation of said conductor and member, and a heating member for said absorbent member supported at least in the main independently of said absorbent member and disposed in spaced relation therewith with an interposed air space and connected electrically at one end therewith.

18. In a unitary fusible protective device having a heat absorbent member, a heater therefor, a conductor, fusible means connecting said conductor and heat absorbent member and receiving heat from said member, means responsive to the fusing of said fusible means for separating said conductor and heat absorbent member, the combination therewith of means for supporting said heat absorbent member independently of said heater and one within the other in spaced relation.

ELMER H. TAYLOR.