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THERMAL PROTECTIVE DEVICE FOR ELECTRIC CIRCUITS

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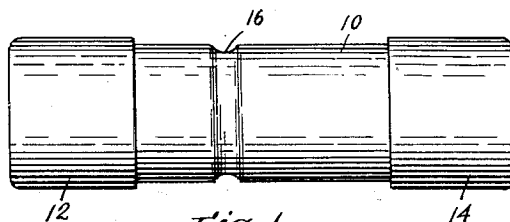


Fig. 1.

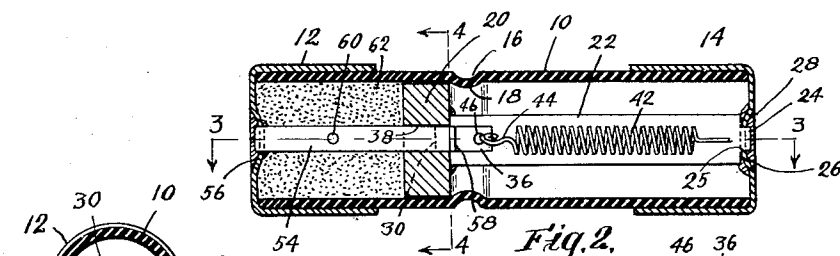


Fig. 2.

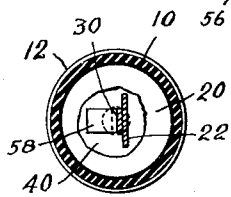


Fig. 4.

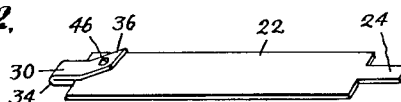


Fig. 5.

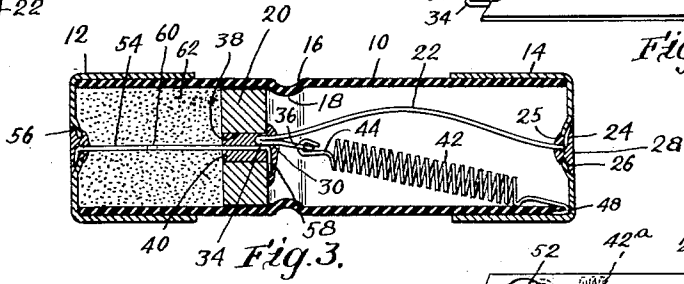


Fig. 3.

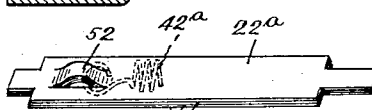


Fig. 6.

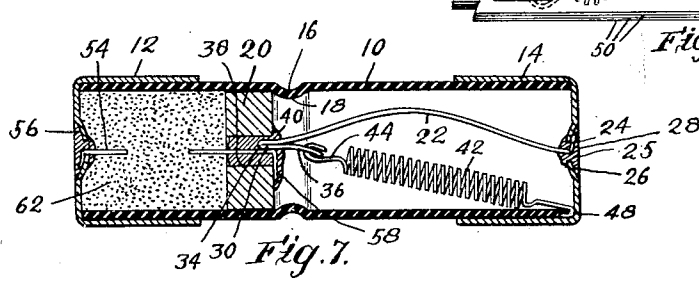


Fig. 7.

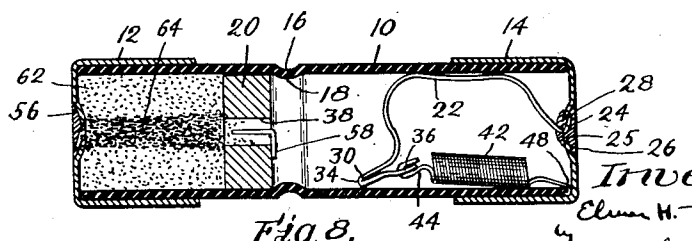


Fig. 8.

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UNITED STATES PATENT OFFICE

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THERMAL PROTECTIVE DEVICE FOR
ELECTRIC CIRCUITS

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35 Claims. (Cl. 200—123)

This invention relates to electric circuit interrupters and to thermal or fusible protective devices of the type wherein a movable circuit controlling or interrupting element is held in circuit closed position by means including a mass of readily fusible material which is adapted to be heated by current traversing the device to fuse or release its hold on the circuit controlling member and effect its movement into a circuit interrupting position, the character and arrangement of the parts being such as, or heat absorbing means being employed, to delay the fusing of the readily fusible material for a satisfactory period of time following the initiation of a moderate overload current so that the device will not open the circuit unnecessarily when traversed by moderate overloads of short duration which the circuit conductors and the apparatus therein can withstand safely.

With such a device there is sometimes associated a fusible link that is adapted to blow promptly when traversed by heavy overloads to interrupt the circuit.

One of the objects of the present invention is the provision of an improved and simplified form of fusible protective device of the order above described and particularly one wherein the fusible element or link also constitutes the heating means for the readily fusible material.

Another object of the invention is the provision of a fusible circuit interrupter having its parts contained within and carried by a tubular enclosing casing of the cartridge fuse type.

A further object of the invention is the provision in a fusible circuit interrupter of a novel arrangement of heat absorbing member; also its relation and cooperation with the cartridge fuse type of casing.

A yet further object of the invention is a fusible protective device wherein the heat absorbing member forms a partition of the enclosing casing and which member separates the fuse link compartment from the delayed circuit opening compartment and which, as one advantage, permits the fusible link to be surrounded by an arc quenching medium or filler, while keeping the other compartment free from the filler.

It is also an object of the invention to provide a thermal protective device of the type described wherein spring means is employed to open the circuit upon moderate sustained overload and wherein the fusible link, and also preferably the major part of the circuit interrupting member is free from spring-applied stress.

Applicant has found that quartz sand is an

excellent filler for short circuit current operation as it quickly extinguishes a heavy arc without permitting the creation of an elevated internal gas or vapor pressure that is liable to rupture the casing. Applicant has found, however, that quartz sand is liable to have a temperature-conduction effect. That is to say, when the sand is subjected to a heavy arc, although the arc is extinguished quickly, the sand may be sufficiently heated to become a partial conductor and, if potential is maintained on the terminals of the fuse for a sufficient time following the blowing of the fusible link, some current passes through the heated strata of the sand and maintains itself or the current may even increase, the temperature of the sand also rising due to its decreasing resistance which allows the passage of an increasing current. Thus a hazardous condition is created.

It is an object of the present invention to provide means associated with a fuse having a filler liable to give a temperature-conduction effect, the means being responsive to heat generated by said effect to secure the positive interruption of the circuit.

It is a further object of the invention to provide a protective device including a fusible link surrounded by a filler and a fusible circuit interrupting device, the circuit interrupting device receiving heat due to the temperature-conduction effect of the filler and being in series with the fuse and the filler to effect the interruption of the circuit.

A yet further object of the invention is generally to improve the construction and operation of fusible protective devices.

Fig. 1 is a side elevation of a fusible protective device embodying the present invention.

Fig. 2 is a longitudinal section taken through the longitudinal axis of the device of Fig. 1.

Fig. 3 is a longitudinal section taken at right angles to Fig. 2 or along line 3—3 of Fig. 2.

Fig. 4 is a section taken along line 4—4 of Fig. 2.

Fig. 5 is a perspective view of the movable flexible circuit interrupting element of Figs. 2 and 3.

Fig. 6 is a perspective view of a modified form of circuit interrupting element.

Fig. 7 is a view similar to Fig. 3 but illustrating the relation of the parts when the circuit is interrupted by the blowing of the fusible link.

Fig. 8 is a view similar to Fig. 7 but showing the circuit open position of the movable circuit controlling member caused by a temperature-

conduction effect of the filler surrounding the fusible link.

The fusible protective device embodying the present invention is here shown in association with the cartridge fuse type of casing including the insulating tubular casing 10 composed preferably of fibre and having suitable end terminals 12 and 14 in the form of end caps which are secured upon the ends of the tubular casing in any suitable manner.

The casing is provided with an annular inset groove 16 intermediate its ends and preferably somewhat nearer the left hand end than the right hand end. Said groove may be formed by rolling or other suitable operation and provides the interior of the tube with an inwardly directed annular flange 18.

A heat absorbing member 20 comprising a thick metal disc or cylinder of a metal having good heat absorbing ability such, for instance, as copper, and a diameter which fits freely yet without undue looseness within the tubular casing is seated upon the flange 18 and forms a partition wall which isolates the tube compartments on opposite sides of it. The character and mass of the member largely govern the period of delay of operation of the device upon moderate overloads. A flexible conductor 22 preferably of copper or other material of high electrical conductivity and of such dimensions as to offer low resistance and heating comprises a movable circuit interrupting element or member of the device and is located within the right hand compartment of the casing and is electrically connected permanently with the end cap 14 and removably with the heat absorbing member 20. For this purpose the outer end part of the conductor is provided with an extension 24 of reduced width which is extended through the perforation 25 formed in the bottom wall of the depression 26 in the end wall of the end cap 14 and is soldered permanently thereto by a mass 28 of relatively high melting temperature solder although other suitable securing means may be employed. The other end of the flexible conductor is provided with a reduced extension 30 which is folded upon itself to provide a doubled projecting part 34 and a spring attaching part 36 that overlies the broad face of the conductor. The doubled part of the extension is located in an axial hole 38 extended through the heat absorbing member 20 and is removably retained therein by a mass 40 of relatively low melting point material as solder which solder may more or less completely fill the hole 38.

A tensile spring 42 has one end 44 hooked into a perforation 46 of the extension part 36 of the conductor. The other end of the spring is provided with a hook 48 which is hooked over the end of the casing 10 under the end cap 14. Thus the spring exerts a constant tension on that end of the conductor retained by the low melting point solder in the hole of the heat absorbing member 20. When said solder is heated to the fusing point or sufficiently to release its hold on the conductor the spring action causes the conductor to be withdrawn out of the hole and away from the heat absorbing member into some position as illustrated in Fig. 8, thereby interrupting the circuit through the device. The conductor 22 is flexible for this purpose.

A modified form of conductor and circuit interrupting member is illustrated in Fig. 6. In this figure the conductor 22a is composed of a

plurality of laminations herein illustrated as three laminations, 50 which are free from each other except at their ends where they are intended to be soldered at one end to the end cap 14 and at the other end to the heat absorbing member 20 as with the conductor 22. The conductor 22a near the heat absorbing member is provided with a struck out loop part 52 over which the end of the spring 42a is adapted to be hooked to withdraw the conductor from the heat absorbing member to effect circuit interruption when the low melting point solder is fused. This type of conductor is adapted to carry a relatively heavy current without undue heating and yet by its laminated construction is flexible and can be flexed by the spring to effect circuit interruption upon the fusing of the low melting point solder.

Associated with the parts above described is a fusible link 54 which also constitutes a heater for the fusible metal 40. Said fusible link is conveniently in the form of a straight flat ribbon and has one end extended through the bottom of the cup 56 of the end cap 12 and soldered therein with relatively high melting point solder. The other end of the fuse link is extended through the hole 38 in the heat absorbing member 20 and has a reflexed end 58 that is bent over upon the right hand face of the member and is electrically and thermally connected thereto and to the circuit interrupting member 22 by the low melting point solder 40. Thus the fusible link is in good heat conducting relation with the heat absorbing member. The fusible link preferably is provided with an intermediate portion of reduced cross-sectional area as by the perforation 60 therein which defines the region of fusion of the link.

The link is so arranged that it will not blow at currents which ultimately cause the fusion of the low melting temperature solder and the release of the circuit interrupting member 22. The fuse link, however, is designed to blow promptly on heavier currents approaching short-circuit value and before the low melting temperature solder can release its hold on the circuit interrupting member 22. The fusible protective device thus provides delayed interruption of the circuit on moderate overloads and prompt interruption of the circuit on heavier overloads.

The fusible link 54 for carrying continuously current of about 30 amperes and upwards can be made conveniently of copper. It is, however, smaller in cross section, or consumes more power, than the conductor 22, which also is of copper, so that it generates sufficient heat to fuse the low melting temperature solder on moderate overloads without the link of itself fusing. For low continuous currents, say below 30 amperes, the fuse link preferably is made of some material having a higher electrical resistance than copper as, for instance, a copper-nickel alloy so that it will generate sufficient heat when traversed by a moderate overload current to fuse the low melting point material 40 and effect the operation of the circuit interrupting member 22. The heat generated in the fusible link is absorbed by the heat absorbing member 20 so that said member and the low melting point material 40 become elevated in temperature substantially together. While the low melting point material is here shown as completely filling the hole 38 in the heat absorbing member in practice it may not completely fill the hole. This is of no particular importance so long as sufficient low melting point

material is used to secure the fuse link, the circuit interrupting member 22 and the heat absorbing member in electrical and thermal engagement.

Preferably the fusible link 54 is imbedded within a loose mass 62 of discrete particles of an arc interrupting filler. The heat absorbing member 20 is in endwise contact with the filler mass and forms one enclosing end wall for the filler while the end cap 12 forms the other wall.

The device as thus described is particularly convenient to assemble. The link, circuit interrupting member, heat absorbing member, and spring are inserted into the enclosing casing 10 from the left hand end until the heat absorbing member seats on the flange 18. The spring is then hooked onto the other end of the casing and the reduced end 24 of the circuit interrupting member is threaded through the hole in the end cap 14 and the end cap is pushed on the end of the casing. The spring thus holds the internal elements in position. The filler material is then put into the other end of the casing and the end cap 12 is applied thereon, the end of the fuse link being threaded through the hole in the end cap. Preferably the free end of the fuse link and the extension 24 of the circuit interrupting member are initially longer than is necessary so as to facilitate the threading of the end caps thereon. Prior to the soldering operation the unwanted portion of these ends is cut off.

The circuit interrupting member 22 is arranged to have greater current carrying capacity than the fuse link so that the fuse link is the heater for the fusible mass 40. The circuit interrupting member is not intended to fuse under any condition of normal operation of the device. However, no harm would result upon the fusing of the member as the member would then act like a fuse link in interrupting the circuit. While the spring 42 is in parallel with the circuit interrupting member and under some conditions of manufacture of the device might be an electrical contact with the end cap 14 its resistance is relatively high as compared with the resistance of the circuit interrupting member so that the spring carries no current injurious to it and, if the circuit interrupting member 22 should happen to fuse the spring 42 would also fuse thereby interrupting the circuit.

The filler material 62 surrounding the fusible link preferably is a quartz sand. Applicant has found that quartz sand is particularly effective in extinguishing the circuit interrupting arc formed upon the blowing of the fuse link on short-circuit current without permitting the generation of a high gas or vapor pressure within the enclosing casing that might rupture the casing or discharge dangerous hot flame and gas therefrom. Applicant has found, however, that quartz sand while being particularly effective for suppressing the arc without the formation of dangerous pressures sometimes has a temperature-conduction effect. That is to say, the sand becomes conducting due to the heat of the arc. This is not detrimental in cases where the circuit is interrupted at some other point than the protective device, as by the opening of a disconnecting switch promptly following the blowing of the fuse link. When, however, the circuit is not opened elsewhere and potential is thus maintained between the terminals of the device the temperature-conduction effect may increase and ultimately generate heat enough to destroy the casing while at the same time maintaining po-

tential on and a current flow through the circuit.

The present construction prevents a serious increase in the temperature-conduction effect and utilizes such effect to open the circuit by the circuit interrupting member 22. That is to say, when the particles of the filler are heated sufficiently to become conducting and form a conducting path 64 between the end cap 12 and the end of the fuse link that remains unconsumed, or the heat absorbing member 20, as illustrated in Fig. 8, the heat is imparted to the heat absorbing member and causes the readily fusible material 40 to fuse or release its hold upon the circuit interrupting member 22 so that the spring 42 is effective in moving this circuit interrupting member away from electrical contact with the heat absorbing member thereby to interrupt the circuit.

It is to be noted that the arrangement of parts is such that the fusible link and the circuit interrupting member are free from spring tension at least for the major parts of their lengths and that the heat absorbing member mainly supports the tension of the spring. This is advantageous for some types of fusible links which might stretch by heating and change their calibration when traversed for long periods of time by currents close to but under their blowing currents.

It is further to be noted that the arrangement of the parts is such that the entire current traversed by the device flows through the fusible link and that the circuit interrupting spring is not in parallel with the link and thereby does not divert current, uncertain in amount, therefrom. Thus the link once calibrated can be expected to operate on currents close to the current for which it has been calibrated.

I claim:

1. In a thermal circuit protector, a fusible link, a flexible conductor, a readily fusible material connecting the ends of said link and conductor and disposed in good heat receiving relation with said link, and operative when sufficiently heated by said link to free said conductor, and spring means responsive to the freeing of said conductor to move said conductor away from said link.

2. In a thermal circuit protector, the combination of a casing having terminals, a fusible link having one end connected to one terminal, a flexible conductor having one end connected to said other terminal, a fusible material having a stationary support in good heat transferring relation with said link and material absorbing heat from said link and material connecting the other ends of said link and conductor and disposed in good heat receiving relation with said link and operative when sufficiently heated by said fuse link to fuse and release its hold on said conductor, and spring means acting upon said conductor to move said conductor away from said link upon the fusing of said readily fusible material.

3. In a thermal circuit protector, an enclosing casing, a casing-partitioning block traversing the casing between its ends and separating it into two compartments, said block having a hole through it, a fusible heating conductor on one side of said block having one end extended in one direction into said hole, an arc quenching filler in only the compartment having the fusible heating conductor, a circuit interrupting conductor on the outer side of said block having one end extended in the opposite direction into said hole, a readily fusible material in the hole in said block joining the ends of said conductors, and means

for withdrawing said circuit interrupting conductor in response to the fusing of said material.

4. In a thermal circuit protector, a block having a hole through it, a heating conductor having one end in said hole, a circuit interrupting conductor having one end in said hole, a readily fusible material joining the ends of said conductors, and means for withdrawing said circuit interrupting conductor in response to the fusing of said material, said heating conductor also constituting a fusible link.

5. In a thermal circuit protector, a heat absorbing block having a hole through it, a heating conductor having one end inserted in one direction in said hole, a flexible conductor having one end inserted in the opposite direction in said hole, a readily fusible material in said hole connecting said conductors and receiving heat from said heating conductor and adapted to fuse and release its hold from said flexible conductor, and means responsive to the fusing of said fusible material for withdrawing said flexible conductor from said hole, said block having a large heat absorbing capacity as compared with the fusible material, and said heating conductor being fusible and arranged to fuse at a higher current maintained for a shorter period of time than will fuse said readily fusible material.

6. In a thermal circuit protector, a heat absorbing block, a fusible heating conductor having one end thermally connected with said block, a circuit interrupting conductor electrically connected in series relation with said heating conductor and thermally connected with said block by a mass of readily fusible material which is adapted to receive heat from said heating conductor and fuse and release its hold on said circuit interrupting conductor, and means responsive to the fusing of said material to withdraw said circuit interrupting conductor from said block, said block having a large heat absorbing capacity as compared with the fusible material.

7. In a thermal circuit protector, a relatively massive infusible heat absorbing block, a heating conductor having one end thermally connected with said block, a circuit interrupting conductor electrically connected in series with said heating conductor and thermally connected with said block by a relatively small mass of readily fusible material which is adapted to receive heat from said heating conductor and fuse and release its hold on said circuit interrupting conductor, means responsive to the fusing of said material to withdraw said circuit interrupting conductor from said block, and means independent of the aforesaid elements for supporting said block.

8. In a thermal circuit protector, a heat absorbing block, a heating conductor thermally connected with said block, a flexible conductor having a reflexed end thermally connected with said block and electrically connected in series with said heating conductor by a mass of readily fusible material that is adapted to receive heat from said heating conductor and fuse and release its hold on said flexible conductor, and a tension spring engaged with the reflexed end of said flexible conductor to move it in a circuit opening direction upon the fusing of said material.

9. In a thermal circuit protector, a heat absorbing block, a heating conductor thermally connected with said block, a flexible conductor having a reflexed end thermally connected with said block and electrically connected with said heating conductor by a mass of readily fusible material that is adapted to receive heat from said

heating conductor and fuse and release its hold on said flexible conductor, and a tension spring engaged with the reflexed end of said flexible conductor to move it in a circuit opening direction upon the fusing of said material, said heating conductor comprising a fusible link.

10. In a thermal circuit protector, a heat absorbing block having a hole through it, a heating conductor having one end in said hole, a flexible conductor having a reflexed end part in said hole, readily fusible material occupying said hole and connecting said conductors and block together, and a spring engaged with said reflexed end and operative to withdraw said flexible conductor from said hole upon the fusing of said material.

11. In a thermal circuit interrupter, a massive heat absorbing block, a fusible heating conductor in heat transferring relation with said block, an infusible flexible conductor having an end connected to said block by a readily fusible material, and a spring acting on the connected end of said flexible conductor and having the major part of the length of said flexible conductor free from tension operative to withdraw said flexible conductor from said block upon the fusing of said material, said block having a large heat absorbing capacity compared with the fusible material.

12. In a thermal circuit protector, a tubular enclosing casing having end terminals, a massive heat absorbing block in and engaged with a part of said casing and comprising a partition separating the casing into two compartments, a fusible and heating conductor in one compartment having one end connected with one terminal and the other end thermally connected with said block, an arc quenching filler in said one compartment and between said block and terminal and around said heating conductor, an infusible flexible conductor having one end connected with the other terminal and the other end connected with said block and heating conductor by a readily fusible material that is adapted to receive heat from said fusible heating conductor only and fuse and release its hold on said flexible conductor, and a spring engaged with said flexible conductor near said block and operative to move said conductor away from said block upon the fusing of said material, said block having a large heat absorbing capacity compared with the fusible material, said fusible and heating conductor being arranged to fuse and interrupt the circuit between the terminals before said fusible material when traversed by a high current for a short period.

13. In a thermal circuit protector, a tubular enclosing casing having end terminals, a heat absorbing block in and engaged with a part of said casing, a heating conductor having one end connected with one terminal and the other end thermally connected with said block, a flexible conductor having one end connected with the other terminal and the other end connected with said block and heating conductor by a readily fusible material that is adapted to receive heat from said heating conductor and fuse and release its hold on said flexible conductor, and a spring engaged with said flexible conductor near said block and operative to move said conductor away from said block upon the fusing of said material, said heating conductor also comprising a fusible link.

14. In a thermal circuit protector, a tubular enclosing casing having end terminals, a heat absorbing block in said casing and dividing it

into two chambers, a heating conductor in one chamber having one end connected with one terminal and its other end connected with said block, a flexible conductor in the other chamber connected at one end with said other terminal and having its other end connected with said block, a readily fusible material connecting at least said flexible conductor to said block, and a spring connected with said flexible conductor and operative to withdraw said flexible conductor from said block upon the fusing of said material.

15. In a fusible protective device, a tubular enclosing casing having end terminals, a conducting heat absorbing block in said casing and dividing it into two chambers, a heating conductor in one chamber connected with said block and with one terminal, a circuit interrupting conductor in the other chamber connected with one terminal and also connected with said block by a readily fusible metal in good heat receiving relation with said heating conductor and operative to be heated thereby to fuse to release its hold on said circuit interrupting conductor, and a spring in said second chamber responsive to the fusing of said material to move said circuit interrupting conductor in a circuit opening direction.

16. In a thermal circuit protector, an enclosing casing having an inwardly projecting part and terminals, an anchorage member on said inwardly projecting part, a circuit interrupting conductor connected between one terminal and said member and anchored to said member by a readily fusible material, spring means operative to maintain said member seated on said inwardly projecting part and to move said circuit interrupting member to circuit interrupting position in response to the fusing of said material, and a heating conductor connected between said other terminal and said circuit interrupting conductor and operative to heat and fuse said material.

17. In a thermal circuit protector, an enclosing casing having an inwardly projecting part and terminals, an anchorage member on said inwardly projecting part, a circuit interrupting conductor connected between one terminal and said member and anchored to said member by a readily fusible material, spring means operative to maintain said member seated on said inwardly projecting part and to move said circuit interrupting member to circuit interrupting position in response to the fusing of said material, and a heating conductor connected between said other terminal and said circuit interrupting conductor and operative to heat and fuse said material, said heating conductor also constituting a fusible link.

18. In a thermal circuit protector, an enclosing casing having an inwardly directed part and terminals, a member seated on said part, spring means holding said member on said part including a circuit interrupting conductor connected with one of said terminals, a fusible heating conductor connected with said other terminal and also with said circuit interrupting conductor by a readily fusible material adapted to fuse and release said circuit interrupting member for movement into a circuit interrupted position.

19. In a thermal circuit protector, a tubular enclosing casing having end terminals and an inwardly directed flange intermediate said terminals, a stationary heat absorbing member seated on said flange, a circuit interrupting conductor connected with one terminal and connected with said heat absorbing member by a readily fusible material, spring means associated with said member and conductor for holding said

member upon said flange and for moving said circuit interrupting member into a circuit opening position in response to the fusing of said material, and a heating conductor connected with the other terminal and with said circuit interrupting conductor and in thermal relation with said readily fusible material to impart heat thereto.

20. In a thermal circuit protector, an enclosing casing having terminals and an inwardly projecting part, a heat absorbing member seated upon said inwardly projecting part, and spring means urging said member against said part.

21. In a thermal circuit protector, a tubular enclosing casing having end terminals and an inwardly directed flange intermediate said terminals, circuit interrupting elements within said casing including a partition member seated on said flange, and spring means pressing said member upon said flange.

22. In a thermal circuit protector, a fuse link and a conductor having their ends connected by a readily fusible material in good thermal relation with said link and operating to fuse when sufficiently heated by said link, means separating said link and conductor in response to the fusing of said material, a heat absorbing member in thermal relation with said material, and supporting means for said member stationary when said link and conductor separate.

23. In a thermal circuit protector, a fuse link and a conductor having their ends connected directly by a readily fusible material, means separating said link and conductor in response to the fusing of said material, a heat absorbing member in thermal relation with said material, and an enclosing casing for the aforesaid elements having a part engaged with and constituting a support for holding said member stationary when said link and conductor separate.

24. In a thermal circuit protector, a tubular enclosing casing having end terminals and an inwardly projecting flange, thermo-responsive circuit interrupting elements within said casing including a heat absorbing member in thermal relation with said elements seated upon said flange, and spring means pressing said member against said flange.

25. A circuit protective device comprising a fuse having a fusible element, and a thermal circuit interrupting device in series with said fuse having a movable member responsive to heat generated in the fuse following the blowing of the fusible element to effect the interruption of the circuit.

26. A circuit protective device comprising a fuse having a fusible element and a filler about said element, and a thermo-responsive circuit interrupting device in series with said fuse having a movable circuit interrupting member responsive to the heating of said filler to effect interruption of the circuit through the fuse.

27. A circuit protective device comprising a fuse having a fusible element and a filler, and a thermo-responsive circuit interrupting device having a thermo-responsive element, and means responsive to the heating of said element operative to interrupt the circuit, said thermo-responsive element being arranged in heat receiving relation with said filler and responsive to the heating thereof.

28. A circuit protective device comprising a fusible device responsive promptly to high overload to interrupt the circuit, a circuit interrupting device in series with said fusible device normally operative to give delayed circuit interrup-

tion upon moderate overload, and means including a thermo-responsive element for effecting the operation of said last named circuit interrupting device following improper operation of said fusible device.

29. A circuit protective device comprising a filler, a fuse link in said filler, a movable circuit interrupting member normally restrained from movement in a circuit interrupting direction by a readily fusible material in heat transferring relation with said filler and also with said fuse link and arranged to fuse and effect circuit interrupting movement of said circuit interrupting member in response to the heating of said fuse link and also to the heating of said filler.

30. In a circuit protective device, an enclosing casing containing a fuse link, a filler surrounding said link, a barrier in thermal relation with said filler, a readily fusible material carried by said barrier and in good heat transferring relation therewith, a movable circuit interrupting member normally held in circuit closed position by the solid fusible material, and means responsive to the fusing of said material to effect movement of said circuit interrupting member in a circuit opening direction.

31. A circuit protective device comprising a fuse having a fuse link and a quartz sand filler about said link adapted to carry current when unduly heated, and a thermo-responsive circuit interrupting device having a thermo-responsive member in heat transferring relation with said quartz sand filler, and a movable circuit interrupting member responsive to the heating of said thermo-responsive member to effect the interruption of the circuit through said filler.

32. A circuit protective device comprising a fuse having a fusible element and a quartz sand filler adapted to carry current when unduly heated, and a movable circuit carrying member in series with the filler responsive to the heating of said filler for interrupting the circuit there-through.

33. In a thermal circuit protector, a fuse link, a movable circuit interrupting conductor, a low melting point material connecting said link and conductor in series and arranged in good heat transferring relation with said fuse link to be heated and fused thereby, a spring acting on said conductor to move it to circuit open position upon the fusing of said material, and means isolating said fuse link from the force of said spring.

34. In a thermal circuit protector, a fuse link, a conductor, a readily fusible material adherent to both said link and conductor and connecting them in series, spring means for separating said fuse link and conductor upon the fusing of said material, and means for relieving at least the major portions of said fuse link and conductor from the force of said spring.

35. In a thermal circuit protector, an enclosing casing having an internal seat, a carrier having a readily fusible material, a fuse link and an unstressed conductor connected in series and connected together by said readily fusible material, and a spring connected through said fusible material with said carrier for holding it against said seat for relieving said fuse link from stress and arranged to separate said fuse link and conductor upon the fusing of said readily fusible material.

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