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G. F. LAING

2,787,684

HEATER ELEMENT FUSE

Filed Sept. 22, 1953

2 Sheets-Sheet 1

Fig. 1

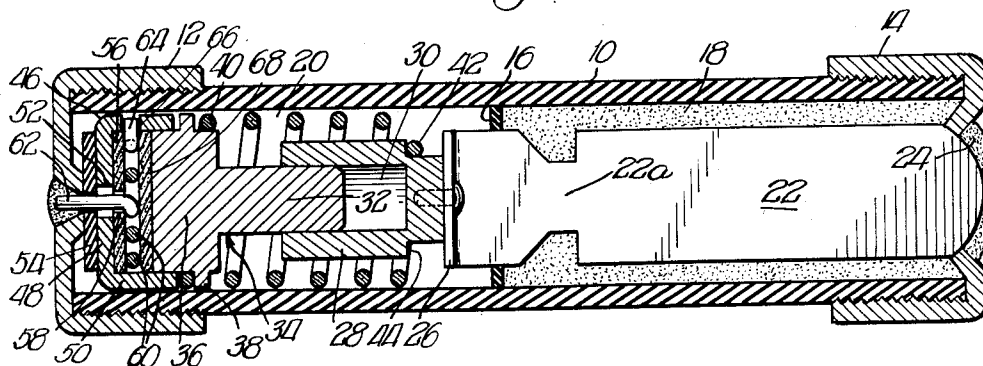


Fig. 2

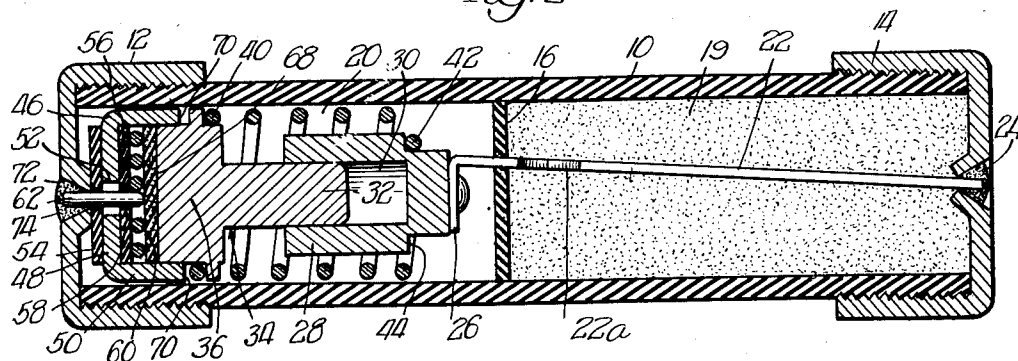


Fig. 3

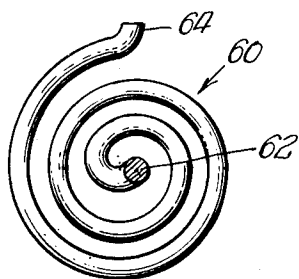
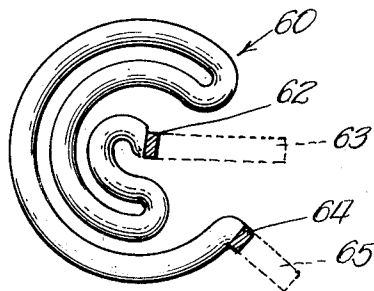


Fig. 4



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Fig. 5

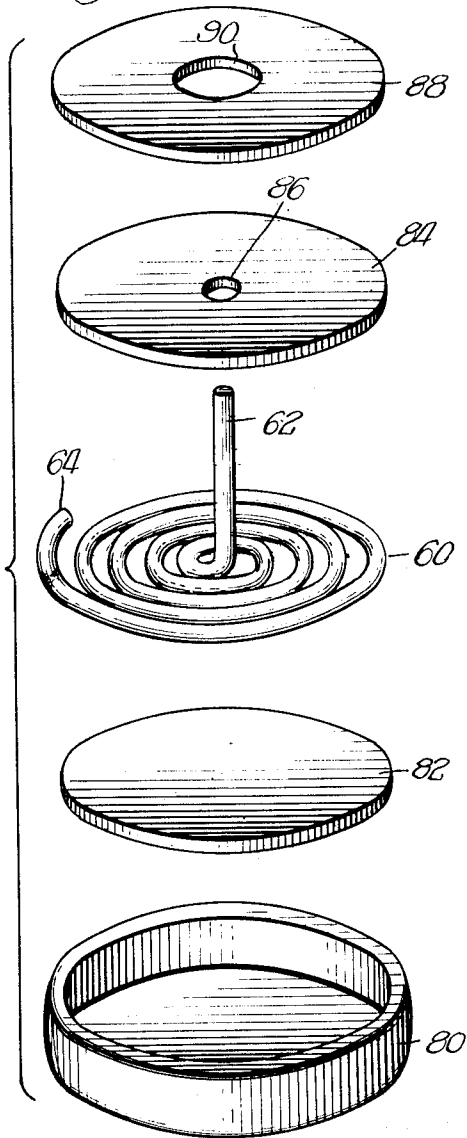


Fig. 6

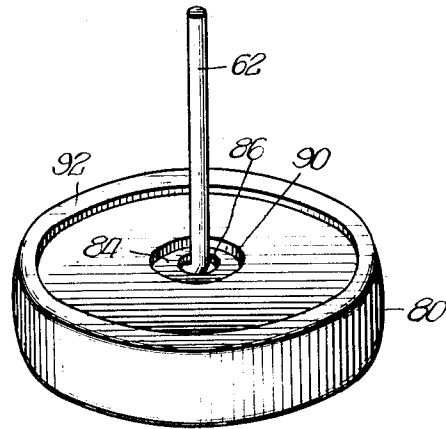
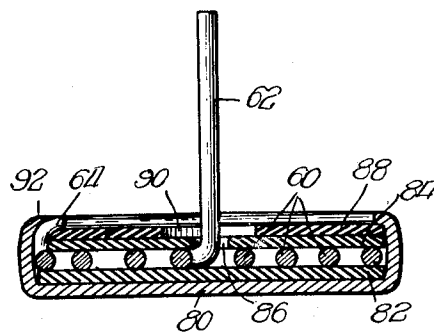


Fig. 7



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HEATER ELEMENT FUSE

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13 Claims. (Cl. 200—123)

This invention is directed to dual element fuses having both a fuse link that is adapted to blow out and open circuit upon excessive overloads of current, and a lag fuse circuit breaker which is adapted to receive smaller overloads of current over a period of time before the circuit breaker elements are caused to move into open circuit position.

Heretofore fuses of this kind have been constructed with a fuse link in series with a circuit breaker assembly which is made up of relatively massive metal parts, one of which is usually reciprocable axially of the fuse by means of a helical spring. The reciprocable element is held in closed circuit position by solder, and a heater coil, usually of the helical type, is disposed in series circuit with the reciprocable element, where, in response to gradual overloads, it becomes hot and transmits heat to the reciprocable element and associated parts until the solder melts, permitting the reciprocable element to be withdrawn to open circuit position.

The heater elements have been disposed either within a metallic sleeve or in surrounding relation thereto, to which sleeve the reciprocable element is soldered to maintain the parts in closed circuit position. As the heater coil responds to conditions of gradual overload, the heat transfer is from the coil to the sleeve and then to the reciprocable element which is released therefrom as soon as the resident heat in the parts attains the melting point of the solder.

Disadvantages in fuses of this type arise from the fact that frequently current surges, less in value than required to blow the fuse link, will cause the heater coil through which the current must pass to burn out before the intended conditions of lag are realized, thus causing premature opening of the circuit. This is partially due to the relatively long physical dimension of the heater coil and the heretofore relatively inefficient means of transferring the heat from the coil to the surrounding parts, which act as thermal reservoirs in storing heat over the period of time in which it is contemplated that the fuse shall remain effective to pass current. The resistance of the heater coil, its length as heretofore applied, and its poor heat transfer relationship to the associated parts, frequently cause failure of the coil before the proper interval of time at prescribed conditions of overload has transpired.

Another disadvantage has resided in the fact that the long physical dimension of heater elements heretofore employed has caused the associated fuse link to be shorter in dimension than is consistent with its accurate rating, and has delimited the space available for the damping of its flash as it blows out on short circuit. The overall dimensions of fuses are standardized by the spacing between fuse box terminals to which they are applied. The greater the space occupied by the lag circuit breaker assembly of the fuse construction, the less there remains for the accommodation of the fuse link, and hence the smaller the chamber in which it resides and the lesser

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amount of quenching powder available to guard it as it blows out.

The present invention is aimed at an improved fuse having a flat heater coil of electrically conductive resistance material in its lag circuit breaker assembly which may be either in the form of a planar volute wound spirally, or in the form of arcuate serpentine courses connected by reentrant bends. In either case, the planes of the principal areas of such coil will lie normal to the longitudinal axis of the fuse in such a way that the effective heating surfaces of the coil are completely contained in close heat exchange proximity to the surrounding parts of the fuse to which its heat is to be communicated. This insures efficient heat transference, making for increased operating efficiency, greater precision in calibrating, and prolongation of heater coil life.

A concomitant advantage resides in the fact that the flat coil takes up small space axially of the fuse and permits the fuse link to be correspondingly lengthened and the chamber in which it is accommodated lengthened accordingly, with a consequent increase in the amount of quenching powder contained therein for suppressing the flash of the fuse link upon blow-out.

A fuse constructed in accordance with the present invention is more economical to build and maintain; is capable of being rated with greater precision as to its capacity; and is far more efficient in its electrical function, and in the transference of heat throughout the lag circuit breaker elements, than has heretofore been possible in functionally similar constructions of the prior art.

In the drawings:

Figure 1 is a longitudinal mid-sectional elevation of a fuse link embodying the present invention;

Figure 2 is a view corresponding to Figure 1, taken along a central plane that is 90 degrees from the section of Figure 1;

Figures 3 and 4 show plan views of alternate heater coils made in accordance with the present invention;

Figure 5 is an exploded view of a heater coil assembly which may be prefabricated and applied to fuses similar to that shown in Figures 1 and 2;

Figure 6 shows the assembled heater element resulting from the assembly of parts of Figure 5; and

Figure 7 is a mid-sectional elevation of the device of Figure 6.

Referring now more particularly to the drawings, the usual insulating casing 10 of fiber or other suitable material is supplied with terminal caps 12 and 14 of metal or other conducting material, which are screw-threaded or riveted to the casing 10. Internally of the casing 10 is an insulating partition 16 which divides the casing into two chambers 18 and 20, respectively. In one chamber a fuse link 22 extends from the terminal cap 14, which is slotted to receive the outer end of the fuse link and depressed to receive solder 24 by which the fuse link is connected thereto, inwardly through an opening in the partition 16 into the chamber 20, where it is formed with an L-shaped offset 26 which is staked or otherwise connected to a stationary lag fuse connector element 28. The element 28 has an internal axial bore 30, within which a stem 32 of a reciprocable element 34 is adapted to telescope.

The enlarged head 36 on the reciprocable element is provided with a helical shoulder or screw-thread 38, on which the lead coils of a helical spring 40 are adapted to engage. The opposite end of the spring 40 is provided with a reduced coil 42 which is accommodated at an offset shoulder portion 44 on the stationary connector element 28 of the lag fuse circuit breaker. The reciprocable element 34 is extended into closed circuit position against the bias of the spring 40, as will now be described.

At the end of the casing 10 adjacent the terminal cap 12, there is provided a metallic cup 46 comprised of a conducting plate 48, which defines the bottom of the cup, from which a peripheral flange 50 extends around its marginal portions. The plate 48 has an enlarged central aperture 52 that is coaxial with the longitudinal axis of the casing, and is electrically isolated from the terminal cap 12 by an insulating disk 54. The interior of the cup is provided with an electrical insulating disk 56 which is also a good conductor of heat. The disk 56 is provided with a central aperture 58 which lies in register with the aperture 52 in the metallic plate 48 in coaxial relation therewith, but is smaller in dimension than the latter for purposes presently to be described.

The heater element 60 may be in the form of that shown in Figure 3 or Figure 4, and in either event comprises a spiral coil or a plurality of serpentine arcuate courses of electrically conductive resistance material having an inner end 62 which is turned 90 degrees with respect to the plane of the coil, and an outer end 64 which is adapted to have electrical connection with the metallic cup 46, and more particularly with the annular flange 50 thereof.

In the embodiment of Figures 1 and 2, this may be accomplished by perforating the annular flange 50 radially, as at 66, to receive the end 64 of the coil, and securing it in position therein by solder or other suitable means. Another electrical insulating disk 68 having good heat conducting properties is disposed against the inner side of the coil so as to prevent short-circuiting between the turns of the latter by contact with the adjacent metal parts. The reciprocable element 34 is drawn in telescoping relation with the cup-shaped member 46 into engagement with the insulating disk 68 and is soldered in this position by solder 70, which is preferably of eutectic alloy of low melting point.

As will be seen from Figures 1 and 2, the inner end of the heater coil which projects in perpendicular relation from the coil proper is passed outwardly, through the aperture 58 of the insulating disk 56 and the aperture 52 in the plate portion 48 of the cup member 46, and thence through a suitable aligned opening in the insulator disk 54 to a depressed opening 72 in the metal cap 12, wherein it is mechanically secured and electrically connected by a ball of solder 74. The smaller dimensions of the aperture 58 in the insulating disk 56 preclude contact with the plate portion 48, which comprises the bottom of the metallic cup 46, and thus insures that the circuit will be completed, without short-circuiting, through the coil for its full length, into the annular flange 50 of the cup-shaped member, and thence through the reciprocable element and its stationary connector 28 to the fuse link, and in turn to the terminal cap member 14 at the opposite end of the casing.

In operation, the fuse link 22 is adapted to blow out upon excessive current overloads, which exceed the capacity of the fuse link. In this respect, the length of the fuse link 22 is such as to dispose its point of least dimension 22a, which is also its point of highest resistance, and hence is the point which defines the area at which the blow-out will occur, at the maximum distance from the end of the casing. This affords maximum damping action by the quenching powder 19 which is contained in the enlarged chamber 18 in surrounding relation to the fuse link. The lag circuit breaker is utilized upon the application of current overloads which are less than those at which the fuse link 22 will blow out. The current passes in series through the heater coil between the metallic cap 12 on the outer casing and the metallic cup-shaped member 46 within the casing to which the reciprocable element 34 is soldered, as previously described.

On continuation of the overloading current, the heater coil, by virtue of its resistance, becomes hot, and its heat is dissipated through the insulating disks 56 and 58 both ways, into the metallic cup-shaped member 46 on the one

hand, and into the reciprocable circuit breaker element 34 on the other.

As one example of material suitable for providing adequate electrical insulation while at the same time providing good heat transference, the disks 56 and 58 may be composed of mica. As soon as the heat supplied by the heater coil 60 has raised the temperature of the contiguous parts to a value equal to the melting point of the solder 70, the solder melts and the spring 40 withdraws the reciprocable element 34 into open circuit position within the stationary connector element 28, and thus opens the circuit and prevents the transmission of damaging amounts of overload current.

As has previously been mentioned, the heater coil 60 may take the form shown in Figure 3, in which it is made from conventional round resistance wire wound into a spiral volute, the convolutions of which are essentially coplanar in their disposition, and the spacing between which is sufficient to preclude short-circuiting.

In the form shown in Figure 4, the heater coil is stamped from a flat sheet of resistance metal in which several arcuate courses are connected by reentrant bends in serpentine fashion, and the ends of which are in the original stamping and before being formed out of the plane of the coil disposed substantially radially as shown in the dotted lines 63 and 65, respectively, in Figure 4.

Although the form of coil shown in Figure 3 has been adopted throughout the other figures for purposes of illustration, it will be understood that the type of Figure 4 is equally applicable thereto and is intended to come within the meaning of the word "coil" as applied throughout the several embodiments in the description and claims.

In Figures 1 and 2, the heater coil and its associated parts are assembled in situ during the assembly of the entire fuse. For convenience, and to assist in the assembly operation, it is contemplated that the heater coil, whether of the type shown in Figure 3 or that of Figure 4, may be preassembled or prefabricated in a self-contained unit, the details of which will now be referred to in connection with Figures 5 to 7 of the drawings.

In this embodiment, a metallic cup-shaped member 80 is lined with an electrical insulating-heat conducting disk 82, such as mica; the coil 60 is disposed within the cup on top of the disk 82, so that its coils are electrically isolated from the cup except for the upturned outer end 64. Another insulating disk 84, having a central aperture 86, to accommodate the upturned inner end 62 of the coil, is then disposed on top of the coil within the cup-shaped member 80, and, optionally, a metallic closure disk 88, having an enlarged central opening 90, may be disposed on top of the insulating disk 84. The rim 92 of the cup-shaped member is then crimped or spun down upon the underlying disk to hold the assembly together in sandwiched relationship.

The larger opening 90 in the metallic closure disk 88 (which may be omitted if desired) affords clearance for the end 62 of the coil, which is held out of short-circuit engagement therewith by the insulating disk 84 and its confining central aperture 86. The outer end 64 of the heater coil extends upwardly to a point of electrical contact with the rim 92 of the cup-shaped member 80, by which it is confined between it and the underlying disk by the crimping or spinning of the edge 92 which holds the parts together.

The convolutions of the coil are held in spaced relation from the surrounding metallic parts so as to make sure that the current is conducted through the coil without short-circuit between its ends 62 and 64, and thence between the terminal cap 12 of the fuse and the cup-shaped member 46 and reciprocable element 34, all as has been described hereinbefore.

It will be understood that the heater unit shown as completely assembled in Figure 6 will lie within the cup-shaped member 46, in lieu of the heater coil 60 shown in

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Figures 1 and 2 and the insulating disks 56 and 68 associated therewith.

Where a metallic closure plate 88 is employed in the completed heater unit, an additional insulating disk (not shown) corresponding to the disk 56 shown in Figures 1 and 2 should be applied between the metallic cup-shaped member 46 and the metallic closure plate of the heater unit. This is necessary to preclude the possibility of short-circuiting between the end of the heater coil 62 and the plate 48 of the cup-shaped member through the metallic closure plate 88 of the heater unit. Otherwise, the application and function of the heater unit and the arrangement of parts are substantially the same as that of the heater coil and appurtenances as shown in Figures 1 and 2.

I claim:

1. A dual element lag fuse comprising a fuse link and a lag fuse circuit breaker assembly connected electrically in series and arranged in axial alignment along the longitudinal dimension of the fuse, said circuit breaker assembly having an electrically conductive fuse link connector element, an electrically conductive fuse terminal connector element in spaced relation to the former, and an electrically conductive reciprocable element soldered in bridging relation between said connector elements and retractible therefrom to break the circuit therebetween, a flat heater coil mounted by one of said connector elements so that it lies between the latter and said reciprocable element with the planes within which the coil lies being disposed substantially normal to the longitudinal axis of said fuse, said coil being electrically connected between said terminal connector element and said reciprocable element to constitute a part of the series circuit of said fuse and being electrically isolated against short circuit from said reciprocable element by means which affords heat exchange with the latter throughout substantially the entire effective surface area of said coil.

2. A heater coil assembly for lag fuses as defined in claim 1, comprising a metal cup, a heat conducting-electrically insulating means lining at least the bottom inside portion of said cup, a flat conducting coil of high electrical resistance disposed against said lining so as to have contact with said cup only at its outermost end, a centrally perforated heat conducting-electrically insulating closure overlying said coil firmly to position it against substantial movement within the cup, the inner end of said coil being formed substantially 90° so as to extend in normal relation to the coil at or adjacent its central axis, said inner end being projected through the central perforation in said closure, and means for holding the assembled parts in the described sandwiched relationship.

3. The invention of claim 2, in which a metallic centrally perforated closure is disposed to overlie the centrally perforated heat conducting-electrically insulating closure, the central perforation of the metallic closure being coaxial with the perforation in the underlying closure and being of greater diametric dimension than the latter.

4. The invention of claim 3, in which said means for holding the assembled parts together is the rim of said cup crimped or spun down upon the uppermost closure therein.

5. The invention of claim 1, in which said fuse link and lag fuse circuit breaker assembly are carried in an insulating casing, electrically conductive terminal caps closing said casing, and an insulating partition dividing the interior thereof into two chambers to accommodate, respectively, said fuse link and said circuit breaker assembly, said link and assembly being electrically connected in series through said partition, and quenching powder filling the chamber occupied by said fuse link.

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6. The invention of claim 2, wherein said coil is stamped from a flat blank of resistance metal in a continuous serpentine pattern of reentrant bends and parallel courses which are spaced sufficiently to preclude short circuit therebetween.

7. The invention of claim 2, wherein said coil is a continuous volute of resistance wire formed with its convolutions spaced sufficiently to preclude short circuit therebetween.

8. The fuse construction defined in claim 1, in which the connector element mounting said heater coil comprises an electrically conductive cup-shaped member with relation to the open end of which said reciprocable element is adapted to telescope, a pair of heat conducting-electrically insulating disks enclosed within said cup-shaped member, said heater coil being sandwiched between said disks, one end of said coil being connected to said cup-shaped member, an aperture in the bottom of the latter, the other end of said coil extending through said aperture and being electrically insulated therefrom by one of said disks.

9. The invention of claim 8, in which said reciprocable member is secured to said cup-shaped member by eutectic solder of low melting point.

10. A dual element fuse comprising a fuse link, a relatively massive conductor connected to said fuse link, a terminal plate in spaced axial relation to said conductor, a movable connector carried by said conductor, spring means urging said conductor and connector together in open circuit relation to said terminal plate, said connector being joined to the latter by a fusible substance against the bias of said spring in closed circuit position, and a flat heater coil lying between said connector and plate and being connected to said plate at one of its ends, said coil being otherwise electrically isolated therefrom but lying closely adjacent thereto in heat exchange relationship therewith throughout substantially the entire effective area of said coil.

11. The invention of claim 10, in which said connector at its portions confronting said plate and heater coil is flat and substantially parallel to the planar disposition of the convolutions of said coil.

12. The invention of claim 11, a pair of heat conducting-electrically insulating disks between which said coil is sandwiched to prevent its short circuiting against said connector on one side and said plate on the other.

13. A cartridge type fuse having time lag elements and instantaneous acting circuit breaking elements connected in series therein, comprising an insulating casing, electrically conducting terminal end plates closing said casing, a stationary lag conductor, a movable lag conductor movable in electrically conductive engagement with respect to said stationary lag conductor to make and break the series circuit of the fuse, and an electrically conductive heating coil of flat configuration in the series circuit of the fuse electrically connected between said movable lag conductor and one of said end plates, and lying between planes that are parallel to the latter, said coil being in heat conductive and electrically insulative relation to both of said lag elements.

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