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ELECTRIC PROTECTIVE DEVICE

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Fig. 2.

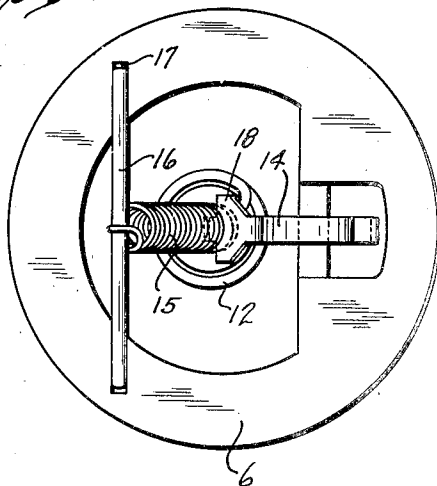


Fig. 1.

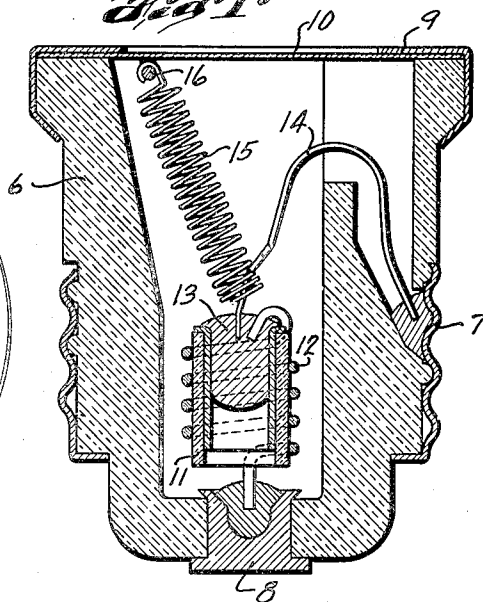


Fig. 3.

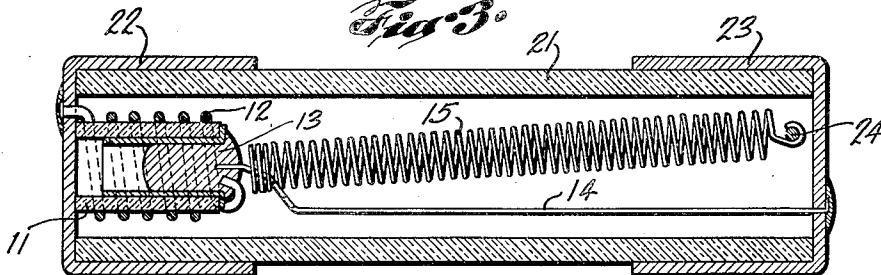
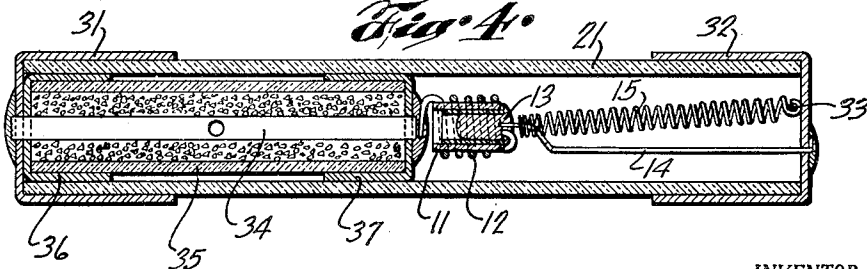


Fig. 4.



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ELECTRIC PROTECTIVE DEVICE

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54 Claims. (Cl. 200—123)

My invention relates to electrical protective devices and it is the object of my invention to provide a protector for electric circuits which will protect electric circuits as well as apparatus served thereby, from damage arising from relatively small overloads which may become harmful by reason of their sustained duration, as well as from heavy overloads and short circuits, but that will not operate or open the circuit on harmless overloads—overloads having a magnitude and/or duration so small that no injury could result therefrom.

It is a well known fact that electric motors, particularly alternating current motors when being started draw currents very much in excess of the currents required to keep them running under full load. For example, a motor drawing five amperes when running at full load might require a starting current of from 12 to 40 amperes, depending on the type of motor and the load under which it is started. While it is true that the duration of these starting currents is relatively short, yet the time lag of the ordinary electric fuse in the small sizes is still shorter.

As a result, if an attempt is made to protect a small motor with the ordinary fuse, it will be found that a 5 or 6 ampere fuse on a 5 ampere motor will blow every time the motor is started. A larger size fuse must therefore be used, possibly a 10 ampere fuse. In that event it is easy to see, that if the motor were overloaded 100%, the fuse still would not blow and as a consequence the motor would be destroyed.

Thermal overload devices having an operating time lag greater than that of the ordinary type of fuse have been used heretofore, but such devices do not lend themselves to protection against short circuit and are usually destroyed by a short circuit unless the additional protection of a fuse in the circuit is provided. In other words, with that type of device a fuse must also be installed.

One of the difficulties with many forms of electrical protective devices is that they cannot be used in any and all locations because of their large size and/or because of their not being sufficiently enclosed to prevent the ignition of readily inflammable material that might be near the device when it operates.

By my invention, I provide a device which embodies within itself the desirable characteristics of both thermal cutout and fuse, and it is a further object of my invention to provide such a device in an enclosure and of comparatively small dimensions, so that it may be used wherever an

ordinary fuse was formerly employed and so that it may be employed as a replacement unit for all fuses of ordinary type.

Another object of my invention is to provide a protective device of the class described adapted for introduction in an electric circuit, which has its operating elements positively bonded in circuit relation, to avoid undue heating that might cause needless and useless blows, and to avoid sparking and radio interference.

Yet a further object of my invention is to provide a protective device of the class described, of simple and economical construction and which may be manufactured at a cost closely approximating the manufacturing cost of an ordinary fuse of corresponding capacity.

These and additional objects and advantages will hereinafter appear from the following detailed description and accompanying drawing describing and illustrating several presently preferred embodiments of my invention.

In the drawing Fig. 1 is a sectional elevation through a protective device of the plug type; Fig. 2 is a plan view of the device illustrated in Fig. 1; Fig. 3 is a longitudinal sectional view of a protective device of cartridge type, and Fig. 4 is a longitudinal sectional view through a protective device of cartridge type of modified construction, as compared to the device illustrated in Fig. 3. Referring now by characters of reference to the drawing, 6 is a body of insulation material on which are carried contacts comprising screw shell 7 and center contact 8. 9 is a top cap which in combination with the disc 10 serves as a closure for the device. 11 is a heat coil unit or resistance element having wire 12 wound thereon, to serve as a heat coil, said wire being electrically connected to the center contact 8. 13 is a quantity of low melting point solder or fusible material held within the heat coil unit 11 and connected to the wire 12. 14 is a fuse link connected to the solder 13 at one end and to the contact 7 at the other end. 15 is a spring attached to the fuse link 14 near the solder 13. 16 is a bar seated in the groove 17 of the body and is employed to keep the spring 15 in tension.

Figure 3 shows a cross-sectional view of my invention embodied in a cartridge. 21 is a tube made of insulation material to which are attached contacts 22 and 23, (method of fastening not shown). 11 is a heat coil unit or resistance element having wire 12 wound thereon to serve as a heat coil, said wire being electrically connected to the contact 22. 13 is a quantity of low melting point solder or fusible material held

within the heat coil unit 11 and connected with the wire 12. 14 is a fuse link connected to the solder 13 at one end and to the contact 23 at the other end. 15 is a spring attached to the fuse link 14 near the solder 13. 24 is a bar and is employed to keep the spring 15 in tension.

The fuse link 14 in either of these types may be a one piece fuse wire or strip or a multiple of them or it may be a fuse wire or strip with terminals of other or same material attached at one or both ends. In either type, the fuse link is considerably heavier than would be used in an ordinary fuse having the same ampere rating as the protector. For example in a 5 ampere protector the link used might be such as would ordinarily be used in a 15 ampere fuse. The fuse link, however, is not depended on to determine the rating of my protector but is designed to blow only on extremely heavy overloads or short circuits. The heat coil is so designed that when the current exceeds that for which a protector of this kind is designed sufficient heat will in time be generated and conducted to the holding means 13 to cause it to soften or release its hold. As soon as this happens the spring pulls out the end of the fuse strip and thereby opens the circuit. On extremely heavy overloads or short circuits the fuse link will fuse and open the circuit before sufficient heat has been conducted to the solder 13 to soften or melt it.

In other words this device has two separate and distinct points of operation. The point at which operation will take place is dependent on circuit conditions. On the lower overloads the circuit is opened at the low melting point solder 13 by means of the spring; on the heavier overloads the fuse link is melted and on short circuits is volatilized without the spring having become operative.

The wire 12 might burn out at reasonably heavy overloads but it is so proportioned and arranged that it will not volatilize on short circuits, so that only the fuse link is volatilized and thereby the amount of metal volatilized on a short circuit and the pressure generated thereby are held to a minimum. Therefore the device will operate safely, and without igniting readily inflammable material that might be near the device, all of which are absolutely necessary requirements on any device of the enclosed type.

In view of the fact that the lighter overloads cannot cause fusing of the fuse link and that the opening of the circuit on such overloads is dependent upon the time it takes the wire 12 to heat up the unit 11 and soften or melt the solder 13, it is obvious that an extremely long time lag on such lower overloads can be provided by my invention.

At the same time, the fuse link blows on extremely high overloads or short circuits thereby opening the circuit without any delay whatever. The nature of my device accordingly is such that it can be made to provide extremely long time lag at low overloads and yet perform on heavy overloads or short circuits as well as the ordinary enclosed fuse.

It will be seen that the fuse link 14 is connected directly to the solder 13 and held thereby. This construction is preferred as it provides an extremely simple form, one that makes it possible to put the complete protector in a case no larger than that required for plain fuses of similar capacity. This is important, as millions of fuse blocks are already installed, in which fuses are now being used, and from which entirely inade-

quate protection, in fact no motor protection, is now being obtained. These blocks are almost entirely equipped with contacts of standardized dimensions in accordance with the National Electric Code. With my device, it is possible to remove the fuse and insert in its place without any installation expense whatsoever, one of these protectors, giving all the protection obtainable from thermal cutouts, and retaining all the line and short circuit protective qualities of the fuse that was replaced.

This construction also makes it possible to manufacture such a device at the lowest possible cost. It eliminates all useless or unnecessary parts and provides a construction so extremely simple as to apparently preclude any possibility of failure of any of these devices. Being attached directly to the solder of the heat coil unit, it insures positive contact and makes possible a device having the lowest electrical resistance, eliminating sources of possible trouble. Another important feature is that it keeps down to a minimum the amount of metal, so as to insure safe operation on short circuits.

Metals of high current carrying capacity can be used for the fuse link 14 in my device as the high melting points such metals usually have is not objectionable. Such metals make it possible to reduce to an absolute minimum the amount of metal required, thereby keeping the pressures generated on a short circuit down to a minimum. The high melting point of such metals is not particularly objectionable as far as short circuit operation is concerned because the action is so rapid that the enclosure and the parts thereof cannot be raised to a very high temperature. If a metal of high melting point is used in a link that must operate or blow on light overloads, as in an ordinary fuse, such high melting point is highly objectionable because the fuse strip is raised to its melting point slowly, so slowly that the enclosure might be destroyed or the soldered connections be melted by the high temperature continued for some time. In my device, the fuse link 14 is not called upon to function on light overloads. Its purpose is practically limited to operation on short circuits and it remains comparatively cool when the device is subjected to a light overload. Thereby full advantage can be taken of the desirable qualities of high melting point metals without any of their disadvantages being experienced.

While the fuse link may consist of a wire or strip with one or two terminals of various designs attached I prefer to make this link without any terminals at the end thereof. When the heat coil is overloaded and heats the solder to the softening point, and the spring pulls the fuse link out of the solder, opening the circuit, an arc naturally occurs. By using the link without any terminal this arc occurs on fuse metal specially selected for handling an arc without prolonging the arc unnecessarily, and without generating excessive pressures.

The spring is attached to the fuse link 14 at a point near an end of the link, which would of course be near the solder 13, or actually within such solder. When the protector operates on a light overload, the arc occurs at the ends of the fuse link. By attaching the spring near the end of the link, maximum distance is obtained for breaking the arc. This is particularly important due to the usually extremely limited dimensions of the enclosure. By this arrangement only an extremely small portion of the fuse link is sub-

jected to the strain of the spring, and obviously none of the fusing portion is subjected to such a strain. Thus the possibility of injury to the protector from jolts or jars, or from vibration is reduced to a minimum, if not completely eliminated.

The spring is attached to the fuse link in an extremely simple manner. By using a coil spring, and making the link flat with a widened portion 18 near the inner end, it is possible to attach the spring to the link by merely passing the link through one of the coils of the spring, and then fastening the link to or in the solder, the widened portion of the link serving to hold the spring at the correct point.

It will also be seen that the spring is removed as much as possible from the link. In this way, injury to the spring from the heat of the fuse link is reduced to a minimum, so that the spring will retain its effectiveness, no matter how long the protector may be in service. This arrangement also guards against the possibility of the link bearing on the spring to prevent its functioning. This is particularly important when it is desirable to use an extremely light spring, which could be held from operating very easily.

Fig. 4 shows a cross-sectional view of a cartridge type protector designed particularly for higher voltages, such as 600 volt circuits. 21 is a tube of insulating material to which are attached contacts 31 and 32 (method of fastening not shown), 11 is a heat coil unit or resistance element having wire 12 wound thereon to serve as a heat coil, 13 is a quantity of low melting point solder or fusible material held within the heat coil unit 11. 14 is a fuse link connected to the solder 13 at one end and to the contact 32 at the other end. 15 is a spring attached to the fuse link 14 near the solder 13. 33 is a bar, rod or pin which rests on the end of the tube 21 to keep the spring 15 in tension. 34 is an auxiliary fuse link surrounded by arc extinguishing filler and enclosed in the tube 35 and contacts 36 and 37. With this type of protector, an extra fuse link is provided to insure safe operation on short circuits of high voltage and great capacity. When the protector is subjected to a heavy short circuit, both fuse links may be blown. On ordinary short circuits and heavy overloads, only the fuse link 34 would be blown. Therefore on most occasions when a protector of the kind shown in Fig. 4 is called upon to operate, the fuse link 14 is not volatilized. On light overloads this fuse link of course opens the circuit by being separated from the solder 13 by reason of the spring 15.

In Figs. 1 and 2 the spring 15 is completely eliminated from the electrical circuit. While the spring may be partly melted from the volatilization of the fuse strip, due to its close proximity, it is obvious that the spring will not add to the pressures generated when a short circuit occurs if it is so insulated. The importance of keeping the pressure generated on a short circuit down to a minimum is obvious when the protector is made with an enclosure or case of the same or approximately the same size as that used on a plain fuse of the same capacity. This arrangement also eliminates any possibility of heat being generated in the spring through the passage of an electric current, thus guarding against any loss of tension of the spring. Insulating one end of the spring is accomplished by reason of the bar 16 in Fig. 1 being seated in the groove 17 of the insulation body. In the

cartridge type fuse of Fig. 3 it can readily be accomplished by making the bar 24 of insulation material.

Fig. 4 shows the spring in electrical contact with the contact 32. The bar 33 may be of metal for purpose of economy in manufacture. With this construction the spring is in parallel with the fuse link 14. Whenever it might be of advantage to allow the spring to form a part of the electric circuit, I prefer to make such spring of the extension coil type. I thereby obtain less heating of the spring in ordinary service and less metal volatilized on short circuit. The coil form permits me to use a longer length of smaller spring metal than would any other practicable form. Spring material is usually of higher specific resistance than such metals as would be used for fuse links. Accordingly the resistance of the spring may easily be made so much greater than the resistance of the fuse link that when the two are in parallel but a very small portion of the total current will pass through the spring and consequently the spring is not heated on ordinary loads or overloads and is not volatilized on short circuit to add to the internal pressure.

For example, I find the resistance of a very effective spring to be 0.48 ohm and the resistance of a desirable form of fuse link to be 0.0033 ohm. It can be seen that even if the end of the spring were soldered to the ferrule of the fuse it would carry about 1/150th of the total current. In practice the contact between the spring and the ferrule not being soldered adds to the resistance and the coil shape of the spring causes it to have a considerable amount of self-inductance, consequently the current through the spring on a short circuit would be even less a part of the whole current than their measured resistances would indicate. Experiments in short circuiting these fuses show that a comparatively small proportion of the total current passes through the spring as it is left almost intact while the fuse link is for the most part consumed.

While I have shown and described several forms or embodiments of my invention I do not desire to be restricted to the exact details of construction noted herein for it will be apparent to those skilled in the art that various modifications of construction details, such for instance as the form of the heat producing resistance element and other details, can be made without departing from the spirit of my invention. What I claim as new and desire to secure by Letters Patent is:

1. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and an extension coil spring, one of which is held by said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material, said spring having the greater portion of its length spaced apart from said resistance element.

2. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and an extension coil spring, one of which is held by said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link having its fusing portion free from any tension provided by the spring, and disposed, relative to said spring, to carry substantially greater current than said spring.

3. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and an extension coil spring, one of which is held by said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said spring having the greater portion of its length spaced apart, and disposed relative to said fuse link whereby to carry substantially less current than said fuse link; said fuse link having its fusing portion free from any tension provided by the spring.

4. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, a fuse link, holding means to electrically connect said element and link, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said holding means can be heated sufficiently to weaken its holding power beyond a predetermined point, a spring adapted to disconnect said fuse link and resistance element when the holding power of said holding means has been weakened to a predetermined point, said spring engaging the fuse link at a point between its fusing portion and said resistance element.

5. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, a fuse link, holding means to electrically connect said element and link, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power, said fuse link being adapted to carry said current

without fusing but having a portion thereof adapted to be fused by greater currents before said holding means can be heated sufficiently to weaken its holding power beyond a predetermined point, a spring adapted to disconnect said fuse link and resistance element when the holding power of said holding means has been weakened to a predetermined point, said spring being an extension coil spring and connected in parallel with said fuse link.

6. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, a fuse link, holding means to electrically connect said element and link, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said holding means can be heated sufficiently to weaken its holding power beyond a predetermined point, a spring adapted to disconnect said fuse link and resistance element when the holding power of said holding means has been weakened to a predetermined point, said spring engaging the fuse link at a point between its fusing portion and said resistance element and having the greater portion of its length spaced apart from said fuse link.

7. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, a fuse link, holding means to electrically connect said element and link, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said holding means can be heated sufficiently to weaken its holding power beyond a predetermined point, a spring adapted to disconnect said fuse link and resistance element when the holding power of said holding means has been weakened to a predetermined point, said spring engaging the fuse link at a point between its fusing portion and said resistance element, one end of said spring being arranged to prevent transmission of current therethrough.

8. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, a fuse link, holding means to electrically connect said element and link, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said holding means can be heated sufficiently to weaken its holding power beyond a predetermined point, a spring adapted to disconnect said fuse link and resistance element when the holding power of said holding means has been weakened to a predetermined point, one end of

said spring being arranged to prevent transmission of current therethrough, said fuse link having its fusing portion free from any tension provided by the spring.

9. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, a fuse link, holding means to electrically connect said element and link, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said holding means can be heated sufficiently to weaken its holding power beyond a predetermined point, a spring adapted to disconnect said fuse link and resistance element when the holding power of said holding means has been weakened to a predetermined point, said spring engaging the fuse link at a point between its fusing portion and said resistance element, and having the greater portion of its length spaced apart from said fuse link, one end of said spring being arranged to prevent transmission of current therethrough.

10. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material, said spring having the greater portion of its length spaced apart from said resistance element.

11. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened and electrically disposed, relative to said fuse link, to carry substantially less current than said fuse link, said fuse link having its fusing portion free from any tension provided by the spring.

12. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element,

said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said spring being an extension coil spring and connected in parallel with said fuse link.

13. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material, said spring having the greater portion of its length spaced apart from said fuse link and said resistance element.

14. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material, one end of said spring being arranged to prevent transmission of current therethrough.

15. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, and having the greater portion of its length spaced apart from said fuse link, said fuse link being out of series relation with said spring and having its fusing portion free from any tension provided by the spring.

16. In a protector for electric circuits, an en-

closure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, one end of said spring being arranged to prevent transmission of current therethrough, said fuse link having its fusing portion free from any tension provided by the spring.

17. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material said spring having the greater portion of its length spaced apart from said fuse link, one end of said spring being arranged to prevent transmission of current therethrough.

18. In a protector for electric circuits, a resistance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material said spring having the greater portion of its length spaced apart from said resistance element.

19. In a protector for electric circuits, a resistance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link being out of series relation with said spring and having its fusing portion free from any tension provided by the spring.

20. In a protector for electric circuits, a resist-

ance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said spring being an extension coil spring and connected in parallel with said fuse link.

21. In a protector for electric circuits, a resistance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material, said spring having the greater portion of its length spaced apart from said fuse link and said resistance element.

22. In a protector for electric circuits, a resistance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material, one end of said spring being arranged to prevent transmission of current therethrough.

23. In a protector for electric circuits, a resistance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, and having the greater portion of its length spaced apart from said fuse link, said fuse link having its fusing portion free from any tension provided by the spring.

24. In a protector for electric circuits, a resistance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated

sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, one end of said spring being arranged to prevent transmission of current therethrough, said fuse link having its fusing portion free from any tension provided by the spring.

25. In a protector for electric circuits, a resistance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material, said spring having the greater portion of its length spaced apart from said fuse link, one end of said spring being arranged to prevent transmission of current therethrough.

26. In a protector of the plug type for electric circuits, an enclosure comprising a plug of insulation material having electrical contacts mounted thereon, one of said contacts being adapted for screw thread engagement, a protective device substantially enclosed therein, comprising a resistance element, a fuse link, holding means to electrically connect said element and link, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said holding means can be heated sufficiently to weaken its holding power beyond a predetermined point, a spring adapted to disconnect said fuse link and resistance element when the holding power of said holding means has been weakened to a predetermined point, said spring engaging the fuse link at a point between its fusing portion and said resistance element.

27. In a protector of the plug type for electric circuits, an enclosure comprising a plug of insulation material having electrical contacts mounted thereon, one of said contacts being adapted for screw thread engagement, a protective device substantially enclosed therein, comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link having the greater portion of its length spaced apart from said resistance element and being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened.

28. In a protector of the cartridge type for electric circuits, an enclosure comprising a tube of insulation material having electrical contacts mounted thereon, said contacts being adapted to removably fit the clips of fuse blocks made in accordance with the National Electric Code, a protective device substantially enclosed therein,

comprising a resistance element, a fuse link, holding means to electrically connect said element and link, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said holding means can be heated sufficiently to weaken its holding power beyond a predetermined point, a spring adapted to disconnect said fuse link and resistance element when the holding power of said holding means has been weakened to a predetermined point, said fuse link being disposed out of electrical series relation with said spring and having its fusing portion free from any tension provided by the spring.

29. In a protector of the cartridge type for electric circuits, an enclosure comprising a tube of insulation material having electrical contacts mounted thereon, said contacts being adapted to removably fit the clips of fuse blocks made in accordance with the National Electric Code, a protective device substantially enclosed therein, comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being electrically disposed, relative to said fuse link, to carry substantially less current than said fuse link, and being adapted to open the circuit when said fusible material becomes softened and said fuse link having its fusing portion free from any tension provided by the spring.

30. In a protector of the plug type for electric circuits, an enclosure comprising a plug of insulating material having electrical contacts mounted thereon, one of said contacts being adapted for screw thread engagement, a protective device substantially enclosed therein comprising a resistance element, a mass of electric-conducting material located adjacent the resistance element adapted to be heated and softened by a current of predetermined magnitude traversing the resistance element and having one end of the resistance element electrically connected thereto, a fuse link having one end connected to said mass of electric conducting material and having the greater portion of its length spaced apart from the resistance element and adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said mass of electric-conducting material can be heated sufficiently to soften and a spring engaging the link near its end connected to the mass of electric-conducting material and adapted to open the circuit when said mass of electric conducting material becomes softened.

31. In a protector of the cartridge type for electric circuits, an enclosure comprising a tube of insulation material having electrical contacts mounted thereon, said contacts being adapted to removably fit the clips of fuse blocks made in accordance with the National Electrical Code, a protective device substantially enclosed therein comprising a helically wound resistor coil, a fuse link, a mass of fusible material within the resistor coil, an end of the resistor coil and of the fuse

link being electrically connected with each other and one of said ends being held by said mass, the resistor coil being adapted to heat the mass of fusible material whereby a current of predetermined magnitude traversing the coil may cause the mass to soften and its holding power to decrease, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said mass can be heated sufficiently to reduce its holding power below a predetermined point and a spring having one end engaging the fuse link and adapted to disconnect the fuse link from the resistor coil when the holding power of said mass has been reduced to a predetermined point, said spring being disposed out of electrical series relation with said fuse link.

32. In a protector for electric circuits, a resistance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link having one end electrically connected to said fusible material, said fuse link being adapted to carry said predetermined current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften beyond a predetermined point and a spring engaging the fuse link and effective to open the circuit in the device when the same is traversed by a current of predetermined magnitude and rendered ineffective to interrupt the circuit when the device is traversed by currents of greater magnitude.

33. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a heat coil unit supported by and electrically connected to one of the electrical contacts and including an open coil helically wound resistor, and a mass of electric-conducting material within the resistor having one end of the resistor coil embedded therein, the resistance coil being adapted to heat the mass of electric-conducting material whereby a current of predetermined magnitude may cause a reduction in the holding power of the mass, a fuse link having one end embedded in the mass, the fuse link being adapted to carry said current of predetermined magnitude without fusing but having a portion thereof adapted to be fused by greater currents before said mass can be heated sufficiently to have its holding power reduced below a predetermined point, a spring adapted to disengage the fuse link from the mass when the holding power thereof has been reduced below a predetermined point, one end of the spring being arranged to prevent transmission of current therethrough, said fuse link having its fusing portion free from any tension provided by the spring.

34. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistor electrically connected to and supported by one of said contacts, a mass of fusible material supported by the resistor and having one end of the resistor connected thereto, the resistor being adapted to heat the mass whereby a current of predetermined magnitude may cause a reduction in the holding power of the mass, a fuse link having one end connected to the resistor, the fuse link being

adapted to carry said current of predetermined magnitude without fusing but having a portion thereof adapted to be fused by greater currents before said mass can be heated sufficiently to have its holding power reduced below a predetermined point and a spring engaging the fuse link near one end and adapted to move that end toward the other end upon softening of the mass and reduction of its holding power.

35. In a protector of the cartridge type for electric circuits, an enclosure comprising a tube of insulation material having electrical contacts mounted thereon, said contacts being adapted to removably fit the clips of fuse blocks made in accordance with the National Electric Code, a protective device located therein and comprising a fixed resistance element, a fuse link, a mass of fusible material rigidly supported by the resistance element, one end of the resistance element and of the fuse link being connected with each other and held by the mass, the resistance element being adapted to heat the mass relatively slowly by currents corresponding to moderate overloads in the circuit to cause the mass to have a reduced holding power, said fuse link being adapted to carry moderate overload currents without fusing but having a portion thereof adapted to be fused by greater currents before the holding power of the mass can be reduced below a predetermined point, a spring adapted to move the end of the fuse link held by the mass away from the mass and the resistance element when its holding power has been reduced below a certain value, said spring being rendered ineffective to move the end of the fuse link by the link itself when the protective device is traversed by currents of greater magnitude.

36. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, a fuse link, holding means to electrically connect said element and link, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said holding means can be heated sufficiently to weaken its holding power beyond a predetermined point, a spring adapted to disconnect said fuse link and resistance element when the holding power of said holding means has been weakened to a predetermined point, said spring engaging the fuse link at a point between its fusing portion and said resistance element and having the greater portion of its length spaced apart from said fuse link, said fuse link having its fusing portion free from any tension provided by the spring.

37. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible ma-

terial can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material, said fuse link having its fusing portion free from any tension provided by the spring.

38. In a protector for electric circuits, an enclosure comprising a body of insulation material having electrical contacts mounted thereon, a protective device substantially enclosed therein, said device comprising a resistance element, fusible material, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link being out of series relation with said spring and having its fusing portion free from any tension provided by the spring.

39. In a protector for electric circuits, a resistance element, fusible material attached thereto, said resistance element being adapted to heat said fusible material whereby it may be softened by a current of predetermined magnitude, a fuse link and a spring, one of which is attached to said fusible material, said fuse link being adapted to carry said current without fusing but having a portion thereof adapted to be fused by greater currents before said fusible material can be heated sufficiently to soften, said spring being adapted to open the circuit when said fusible material becomes softened, said fuse link and spring being attached to each other at a point relatively near the end of said fusible material.

40. In a protector for electric circuits, a resistance element, a fuse link having a portion adapted to fuse at currents in excess of a predetermined value, holding means in contact with the link normally maintaining it in electrical connection with the resistance element, said holding means being adapted to be heated by the resistance element and to lose its holding power at currents in excess of a second lower predetermined value and circuit opening means adapted to break the electrical circuit in the protector when the holding means has lost its holding power, the fusing portion of the link being free of stress caused by the circuit opening means.

41. In a protector for electric circuits, a unitary structure comprising a casing, a resistance element and a fuse link in said casing, means normally contacting one end of the link and one end of the resistance element to hold them in electrical connection with each other, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause it to lose its holding power and means engaging said one end of the fuse link and effective to open the circuit when the holding means has lost its holding power.

42. In a protector for electric circuits, a resistance element, a fuse link having a portion adapted to fuse at currents in excess of a predetermined value, holding means in contact with both said fuse link and said resistance element positively bonding them together in electrical conducting relation, said holding means being

adapted to be heated by the resistance element and to lose its holding power at currents in excess of a second lower predetermined value and means effective to open the circuit by breaking said bond when said holding means has lost its holding power, the fusing portion of the link being free of stress caused by the circuit opening means.

43. In an overload protective device, a unitary structure comprising a casing containing a resistance element, a fuse link having a portion adapted to fuse at currents in excess of a predetermined value, holding means normally maintaining the fuse link and the resistance element in series electric connection with each other, said resistance element being adapted to heat said holding means whereby a current of predetermined magnitude may cause said holding means to weaken its holding power and circuit opening means engaging said fuse link, becoming effective to break said electrical connection when said holding means loses its holding power, said circuit opening means being substantially free of current flow therethrough, said fusing portion of the link being free of stress caused by the disconnecting means.

44. In a protector for electric circuits, a resistance element, a fuse link having a fusing portion adapted to fuse at currents in excess of a predetermined value, holding means to effect positive bonding of one end of the fuse link and of the resistance element in electrical circuit relation with each other, said resistance element being adapted to heat said holding means when traversed by a current and to cause said holding means to lose its holding power when said current exceeds a second lower predetermined value for a predetermined length of time and means engaging said one end of the fuse link and effective to open the circuit when the holding means has lost its holding power, the circuit opening means having the major portion of its length out of close heat-receiving relation with the fuse link, said fusing portion of the fuse link being free of stress caused by the circuit opening means.

45. In a protector for electric circuits, a resistance element, a fuse link having a fusing portion adapted to fuse at currents in excess of a predetermined value, holding means to effect positive bonding of the resistance element and the fuse link in series electrical connection with each other, said resistance element being adapted to heat said holding means when traversed by a current and to cause said holding means to lose its holding power when said current exceeds a second lower predetermined value for a predetermined length of time and circuit opening means engaging the fuse link and adapted to break said electric connection when the holding means has lost its holding power, the fusing portion of the link being substantially free of stress caused by the circuit opening means.

46. In a protector for electric circuits, a resistance element, a fuse link, holding means in contact with said link normally maintaining it in electrical connection with said resistance element and adapted to lose its holding power when heated by said resistance element above a predetermined temperature, and circuit opening means adapted to break the electrical circuit in the protector when the holding means has lost its holding power, said fuse link having a fusing portion free of stress caused by the circuit opening means.

47. In a protector for electric circuits, a resistance element, a fuse link, means in contact with one of the foregoing members near the end of said member to hold them in electrical connection with each other and adapted to lose its holding power when heated above a predetermined temperature, and circuit opening means adapted to break the electrical circuit in the protector when the holding means has lost its holding power, said fuse link having a fusing portion free of stress caused by the circuit opening means.

48. In a protector for electric circuits, a casing having terminals therefor and enclosing a resistance element, a fuse link, means in contact with one of the foregoing members to positively bond them in electrical connection with each other and adapted to lose its bonding power when heated above a predetermined temperature and circuit opening means adapted to break the electrical circuit in the protector when said means has lost its bonding power, said fuse link having a fusing portion free of stress caused by the circuit opening means.

49. In a protector for electric circuits, a casing, terminals therefor adapted for connection in an electric circuit and an assembly therein electrically connecting said terminals and comprising a fuse link and means normally maintaining electrical connection between the link and one terminal, said means being adapted to be heated by a current therethrough, a portion of said means being in contact with said link and adapted to lose its power of maintaining said electric connection when heated to a predetermined temperature and means for breaking said electric connection when said portion of said first named means has lost its connection-maintaining power, said link having a fusing portion free of stress caused by the connection-breaking means.

50. A unitary structure for the protection of electric motors and other energy translating devices, comprising a casing, terminals therefor adapted for connection in an electric circuit, a fuse link in the casing, said casing being so constructed that on the blowing of the fuse link the vapors may expand throughout substantially the entire casing, means in the casing normally maintaining electrical connection between the link and one terminal, said means being adapted to be heated by a current therethrough, a portion of said means being adapted to lose its power of maintaining said electric connection when heated to a predetermined temperature and means in the casing for breaking said electric connection when said portion of said first named means has lost its connection-maintaining power, said fuse link having a fusing portion free of stress caused by the connection-breaking means.

51. A protector for electric circuits comprising a resistance element, a fuse link, holding means in contact with said resistance element normally maintaining it in electrical connection with said fuse link and adapted to lose its holding power when heated by said resistance element above a predetermined temperature and circuit opening means adapted to open the circuit by moving at least a portion of said link in a direction substantially longitudinally of said portion when said holding means has lost its holding power, the circuit opening means being substantially free from current flow therethrough.

52. A protector for electric circuits comprising a resistance element, a fuse link, holding means normally maintaining the resistance element in electrical connection with said fuse link and adapted to lose its holding power when heated by said resistance element above a predetermined temperature and circuit opening means engaging the fuse link and adapted to open the circuit by moving at least a portion of said link in a direction substantially longitudinally of said portion when said holding means has lost its holding power, the circuit opening means being substantially free from current flow therethrough.

53. A protector for electric circuits comprising a resistance element, a fuse link, holding means in contact with the resistance element and with the fuse link near one end thereof normally maintaining them in electrical connection with each other and adapted to lose its holding power when heated by said resistance element above a predetermined temperature and circuit opening means engaging the fuse link at a point relatively remote from the other end thereof and adapted to open the circuit when said holding means has lost its holding power, the circuit opening means being substantially free from current flow therethrough.

54. A protector for electric circuits comprising contact terminals, a resistance element, a fuse link, holding means normally maintaining the resistance element and fuse link in electrical connection with said contact terminals and adapted to lose its holding power when heated by a current traversing the protector and circuit opening means engaging the fuse link and adapted to open the circuit by moving at least a portion of said link in a direction substantially longitudinally of said portion when said holding means has lost its holding power, the circuit opening means being substantially free from current flow therethrough.

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