PROTECTOR FOR ELECTRIC CIRCUIT

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References Cited

UNITED STATES PATENTS

3,593,249 7/1971 Sedgwick..........................337/244 X
2,303,661 12/1942 Schmidt..........................337/244
1,753,046 4/1930 Eustice..........................337/265

ABSTRACT

A small diameter, elongated, electric fuse has a casing which encloses and protects a fusible element, an indicating plunger, and a strain wire which normally holds that plunger in retracted position. The fusible element has a portion which is positioned adjacent the inner surface of the casing to permit unobstructed movement of the plunger, has a second portion which is spaced inwardly of the inner surface of the casing so it is largely unaffected by the temperature of the casing, and has a third portion which extends transversely of the casing and which develops a heat barrier and which has an opening to accommodate the strain wire.

18 Claims, 3 Drawing Figures
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PROTECTOR FOR ELECTRIC CIRCUIT

BACKGROUND OF THE INVENTION

A small diameter, elongated, electric fuse which is equipped with an indicator stand has a spring that biases an indicating plunger for movement toward the fuse terminal, and, as in other designs, the fusible element that normally holds that plunger in retracted position. The fusible element of such an electric fuse has one end thereof connected to one terminal of that fuse, and has the other end thereof connected to the plunger to connect that plunger to that one terminal; and that plunger is usually connected to the other terminal of that fuse by directly engaging that other terminal or by engaging a spring which engages that other terminal. Where the plunger of such an electric fuse is connected to the other terminal of that fuse by engaging the spring which engages that other terminal, the current which flows through the fusible element will also flow through that spring; and that current will heat that spring and also will generate heat at the points where the plunger engages that spring and that spring engages the other terminal. The heat that is generated at the points where the plunger engages the spring and the spring engages the other terminal can, under certain conditions, cause the electric fuse to open the circuit on some overloads which are not potentially harmful — and, while such opening of the circuit could not be hazardous, it could be annoying. In those instances where the rating of the electric fuse should be materially greater than five amperes, the value of the current which would flow through the spring could, under some conditions, heat that spring until the temperature thereof was high enough to impair the restorative force of that spring — and while the impairment of that restorative force would not keep the fuse from opening the circuit, it could keep the plunger from moving to indicating position. Heating of the spring and the generation of heat at the points where the plunger engages the spring and the spring engages the other terminal could be minimized by providing a conductor in parallel with that spring; but the space within the casing of a small diameter, elongated, electric fuse is so very limited that it has not heretofore been deemed practical to market such a fuse with a conductor connected in parallel with the spring.

SUMMARY OF THE INVENTION

The present invention provides an electric fuse which has an eyepet mounted in one end of the casing thereof, has part of an indicating plunger disposed within that eyepet, has a plunger-biasing spring disposed within that eyepet, has one end of a fusible element disposed within the space between the outer surface of that eyepet and the inner surface of that casing, and has one end of a shunting wire for the fuse disposed within that space but displaced circumferentially from the end of the fusible element. The shunting wire minimizes the flow of current through the spring, and thus permits the electric fuse to conduct large values of current without causing the temperature of that spring to rise to a level at which the restorative force of that spring could be impaired. The positioning of the end of the shunting wire within the space between the outer surface of the eyepet and the inner surface of the casing keeps that end from obstructing movement of the indicating plunger; and, similarly, the positioning of the end of the fusible element within that space keeps that end from obstructing movement of that plunger. However, the positioning of the end of the fusible element, within the space between the outer surface of the eyepet and the inner surface of the casing, permits that casing to absorb a substantial proportion of the heat generated by that end of that fusible element. Because the temperature of the casing of an electric fuse is directly affected by ambient temperature, and because ambient temperatures can vary widely from installation to installation, the amount of heat which the casing of the electric fuse of the present invention can absorb from the one end of the fusible element can vary widely — and thus can keep that one end from effectively determining the ampere rating of that fuse. The present invention makes it possible to provide a precisely determined and effectively maintained ampere rating for the fuse by spacing the other end of the fusible element inwardly of the inner surface of the casing. That other end will be largely unaffected by the temperature of the casing, and thus will be largely unaffected by ambient temperatures or by changes in those temperatures; and hence that other end can be calibrated to provide the desired ampere rating for the fuse. It is, therefore, an object of the present invention to provide an electric fuse that has an eyepet in one end of the casing thereof, a spring and part of an indicating plunger within that eyepet, a wire shunting that spring, and a fusible element that has one end thereof disposed within the space between the outer surface of that eyepet and the inner surface of the casing but has the other end thereof disposed inwardly of that inner surface.

The one end of the fusible element of the electric fuse provided by the present invention has a number of “weak spots” therein, and the other end of that fusible element has at least one “weak spot” therein. The “weak spots” in the one end of the fusible element will help open the circuit if a “short circuit” or a heavy overload occurs; but the casing of the electric fuse will absorb a large proportion of the heat which those “weak spots” generate when load overloads occur, and thus will keep those “weak spots” from opening the circuit as a result of such overloads. The action of the casing in absorbing heat from the one end of the fusible element causes a temperature gradient to develop in that fusible element; and that temperature gradient will tend to cause the one end of the fusible element to absorb heat from the other end of that fusible element. Any absorption of heat by the one end of the fusible element from the other end of that fusible element could be very objectionable, because it could affect the ampere rating of the electric fuse, and the present invention obviates any such absorption of heat by interposing a heat barrier between the two ends of the fusible element. That heat barrier makes the temperature of the other end of the fusible element essentially independent of the temperature of the one end of the fusible element, and thus essentially independent of the temperature of the fuse casing, and thereby enables that other end of the fusible element to provide a precisely determined and effectively maintained ampere rating for the fuse. It is, therefore, an object of the present invention to provide an electric fuse that has a fusible element with one end thereof in close proximity to the inner surface of a casing, with the other end thereof spaced inwardly of that inner surface, and with a heat barrier between those two ends.

The present invention provides a heat barrier between the two ends of the fusible element by forming an opening in an intermediate portion of that fusible element. The metal which defines the edges of that opening defines areas of reduced cross section; and those areas will be hotter than the contiguous parts of the two ends of the fusible element, and thus will act as a heat barrier. The opening in the intermediate portion of the fusible element will permit the strain wire, for the indicating plunger, to pass through that fusible element and be connected to the terminal adjacent the other end of the fusible element. As a result, the opening in the intermediate portion of the fusible element performs a dual function. It is, therefore, an object of the present invention to provide an electric fuse that has a fusible element with an opening in a portion thereof that is intermediate the ends thereof and that has a strain wire passing through that opening.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is a greatly enlarged, longitudinal section through one preferred embodiment of a small diameter, elongated, electric fuse that is made in accordance with the principles and teachings of the present invention.

FIG. 2 is a sectional view, on the scale of FIG. 1, and it is taken along the broken line indicated by the broken line —— in FIG. 1, and
FIG. 3 is a plan view, on a less enlarged scale, of another form of fusible element that is usable in the electric fuse of Figs. 1 and 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing in detail, the numeral 10 denotes a tubular casing of insulating material, such as fiber or paper. In one preferred embodiment of the present invention, the outer diameter of the casing 10 is a few thousandths of an inch less than one-quarter of an inch, and the overall length of that casing is a few thousandths of an inch less than one and one-quarter inches. A ferrule-like metal terminal is generally denoted by the numeral 12; and the open end of that terminal is flared outwardly, as indicated by the numeral 14. The closed end of the terminal 12 has an inwardly spaced end wall portion 16, and an L-shaped tang 18 is punched outwardly from that inwardly spaced end wall portion. The outward punching of the L-shaped tang 18 forms a slot 20 in the inwardly spaced end wall portion 16, as shown particularly by FIG. 1. The ferrule-like terminal 12 is intended to have the flared open end thereof telescoped over the open end of the casing 10 and to have the inwardly spaced end wall portion 16 telescoped within that end of that casing, as shown particularly by FIG. 1.

The numeral 22 denotes a ferrule-like metal terminal which has a circular opening 24 in the end wall thereof. The open end of that terminal is intended to telescope over the opposite end of the casing 10, as shown particularly by FIGS. 1 and 2. Where the casing 10 is made from fiber or paper, the open end of the terminal 22 will be crimped or otherwise pressed into the outer surface of that casing, as shown by FIGS. 1 and 2, to firmly secure that terminal to that casing. Where the casing 10 is made from glass or other hard material, the open end of the terminal 22 will not be crimped into holding engagement with that casing, and, instead, that terminal will be secured to that casing by a suitable cement or adhesive.

The numeral 26 denotes a metal eyelet which has an opening 28 in the inner end thereof, and which has a radially extending annular flange 30 at the outer end thereof. The outer diameter of the flange 30 is greater than the inner diameter of the circular opening 24 in the end wall of the ferrule-like terminal 22; and hence the outer portions of that flange overlie the portions of the end wall of terminal 22 which define the opening 24.

The numeral 32 generally denotes a metal indicating plunger, and that plunger has a shank 34, a head 36, a planished end 38 and a notch 40. The diameter of the shank 34 of plunger 32 is smaller than the diameter of the opening 28 in the inner end of the eyelet 26, and hence that plunger can move relative to that eyelet. The planished end 38 of the plunger 32 is too large to pass through the opening 28; and, consequently, that end must be planished after the shank 34 of that plunger has been passed through that opening. The notch 40 is formed in, and extends to, one side of the planished end 38. The diameter of the head 36 of the plunger 32 is larger than the inner diameter of the eyelet 26, and hence the periphery of that head projects outwardly beyond the inner surface of that eyelet. A helical compression spring 42 is disposed within the eyelet 26, and one end of that spring bears against the end wall of that eyelet, while the other end of that spring bears against the head 36 of the plunger 32.

The numeral 44 generally denotes a fusible element, and that fusible element is elongated, relatively narrow, and thin. In the said one preferred embodiment of the present invention, that fusible element has a length greater than one and one-quarter inches, has a width less than three-sixteenths of an inch, has a thickness of about two thousandths of an inch wherein the electric fuse has a rating of eight amperes, has a thickness of about thirty-eight ten-thousandths of an inch where that fuse has a rating of twelve amperes, and has a thickness of about five thousandths of an inch where that fuse has a rating of 15 amperes. The fusible element 44 has a first portion 46 that is parallel to the elongated axis of the casing 10 but is displaced radially outwardly from that axis so it is close to the inner surface of that casing. A second portion of the fusible element 44 is denoted by the numeral 48, and that second portion is parallel to the axis of the casing 10 but is displaced inwardly from the inner surface of that casing so it is essentially independent of the temperature of that casing. The two portions 46 and 48 of the fusible element 44 are disposed on opposite sides of the elongated axis of the casing 10, and those portions are interconnected by a portion 50 that is shorter than the inner diameter of that casing and that extends transversely of that axis. An opening 52 is formed in the portion 48 of the fusible element 44, and the sides of that opening are defined by two areas 52 of reduced cross section which constitute "weak spots." An opening 56 is provided in the portion 50 of the fusible element 44, and openings 58 and 60 are provided in the portion 46 of that fusible element. Each of the openings 56, 58 and 60 has the sides thereof defined by two areas of reduced cross section which constitute "weak spots." Those areas of reduced cross section will coact with the areas 52 of reduced cross section to provide a number of serially connected weak spots intermediate the ends of the fusible element 44. The areas of reduced cross section which define the sides of the opening 56 develop a heat barrier which will keep the portion 46 of the fusible element 44 from absorbing heat from the portion 48 of that fusible element.

The portion 48 has a length which is less than one-half of the length of the casing 10, and that portion extends from the portion 50 to the left-hand end of that casing. The outer end of the portion 48 extends through the slot 20 in the inwardly spaced end wall portion 16 of the ferrule-like terminal 12. The portion 48 has a length which is greater than one-half of the length of the casing 10, and that portion extends from the portion 50 to the right-hand end of that casing. In doing so, the portion 46 extends through the space between the outer surface of the eyelet 26 and the inner surface of the casing 10, and the outer end of that portion is bent radially outwardly to lie between the right-hand end wall of the ferrule-like terminal 22 and the inner face of the flange 30.

The numeral 62 generally denotes a strain wire which is made so it is sturdy but is readily flexible. The left-hand end of that strain wire is denoted by the numeral 64, and that end is wound around the L-shaped tang 18 on the ferrule-like terminal 12. The numeral 66 denotes a portion of the strain wire which is wound around the portion of the planished end 38 of plunger 32 that is intermediate the notch 40 and the left-hand edge of that planished end. The numeral 68 denotes a portion of the strain wire 62 which is wound loosely around the left-hand portion of the shank 34 of plunger 32, and the numeral 70 denotes a portion of that strain wire which is wound through the space between the outer surface of the eyelet 26 and the inner surface of the casing 10. As indicated by FIG. 1, the portion 70 of the strain wire 62 is displaced circumferentially from the portion 46 of the fusible element 44.

Solder 72 mechanically secures the portion 66 of strain wire 62 to the portion of the planished end 38 of plunger 32 which is intermediate the notch 40 and the left-hand edge of that planished end. That solder also will electrically connect that strain wire to that planished end; but that connection is not significant, because the ends of that strain wire are directly connected to the terminals of the fuse. Thus, the left-hand end 64 of the strain wire 62 is wound around the tang 18 and is bonded to that tang by solder 74, while the right-hand end of that strain wire engages the end wall 24 of ferrule-like terminal 22 and is bonded to that end wall by solder 76. As a result, the strain wire 62 normally constitutes a continuous, uninterrupted connection between the terminals 12 and 22.

The portion 70 of the strain wire 62 constitutes an electrical conductor which is coextensive with the helical compression spring 42, and which will tend to keep current from flowing through that spring. The eyelet 26 and the right-hand portion of the shank 34 of plunger 32 also constitute conductors which are coextensive with that helical compression spring, and which will tend to keep current from flowing through that...
spring. All of this means that no current need flow through the spring 42; and, that if any current does flow through that spring, that current will be much too small to cause any appreciable heating of that spring. As a result, the temperature of the spring 42 will remain well below the temperature at which that spring could lose its restorative force. Consequently, the spring 42 will continuously bias the plunger 32 for movement to its indicating position, but the left-hand portion of the strain wire 62 will normally hold that plunger in the retracted position of FIGS. 1 and 2. In continually biasing the plunger 32 for movement to its indicating position, the spring 42 will keep the left-hand portion of the strain wire 62 taut; and thus will keep that portion from sagging down into engagement with the metal of portion 50 that defines the opening 56.

By disposing the portion 46 of the fusible element 44 so it is immediately adjacent the inner surface of the casing 10, and by disposing the portion 70 of the strain wire 62 so it is immediately adjacent that inner surface, the present invention keeps those portions from obstructing movement of the plunger 32 towards its indicating position. Further, by disposing the spring 42 within the eyelet 26, and by disposing the portion 46 of fusible element 44 and the portion 70 of strain wire 62 exteriorly of that eyelet, the present invention keeps those portions out of the spaces between adjacent terms of that spring. The portion 68 of strain wire 62 has a heat of reduction, and is wound around the shank 34 of plunger 32 so loosely, that it can permit relatively unobstructed movement of that plunger to the right in FIGS. 1 and 2.

The strain wire 62 will carry current whenever current flows through the electric fuse; but, because the resistance of that strain wire is much greater than the resistance of the fusible element 44, only a small proportion of the current which flows through that electric fuse will flow through that strain wire. The current which flows through the fusible element 44 will generate appreciable amounts of heat at the areas 52 of reduced cross section in the portion 48 of that fusible element, and also at the areas of reduced cross section adjacent the opening 56 in the portion 50 and at the areas of reduced cross section adjacent the openings 58 and 60 in the portion 46. Because the portion 46 is immediately adjacent the inner surface of the casing 10, that casing will absorb a substantial proportion of the heat generated by the areas of reduced cross section adjacent the openings 58 and 60. Because the temperature of the casing 10 will be a function of the ambient temperature, and because ambient temperatures can vary widely from installation to installation, the temperature of the portion 46 of the fusible element 44 can not be closely controlled. As a result, that portion of the fusible element 44 can not be precisely determined and effectively maintain a desired amperage reading for the electric fuse. The portion 48 of the fusible element 44, on the other hand, is spaced inwardly from the inner surface of the casing 10; and hence that portion will be essentially unaffected by the temperature of the casing 10 or by any changes in that temperature. Also, the areas of reduced cross section adjacent the opening 56 in the portion 50 will generate heat that will act as a heat barrier to keep the portion 46 of the fusible element 44 from absorbing heat from the portion 48. The overall result is that the portion 48 of the fusible element 44 will be essentially unaffected by the temperature of the casing 10 and also will be essentially unaffected by the temperature of the portion 46 of that fusible element. Consequently, the portion 48 of the fusible element can be relied upon to precisely determine and effectively maintain a desired amperage reading for the electric fuse.

The fusible element 44 will carry the rated current of the electric fuse indefinitely, but it will respond to certain overloads by developing a reduced cross section adjacent the openings 58 and 60 and some, and possibly all, of the areas of reduced cross section adjacent the openings 56, 58 and 60 will respond to a short circuit or to a heavy overload to fuse and open the circuit. The areas of reduced cross section adjacent the openings 58 and 60 in the portion 46 of the fusible element 44 will be able to fuse in response to a short circuit or to a heavy overload, because the rate of generation of heat by those areas of reduced cross section during a short circuit or a heavy overload will be very much greater than the rate at which the casing 10 can absorb heat from the presen 46.

On lesser overloads that should be interrupted only after finite periods of time, the rates at which the areas of reduced cross section adjacent the openings 58 and 60 generate heat will be low enough to permit the casing 10 to absorb enough heat from the portion 46 to keep those areas of reduced cross section from fusing. Consequently, the portion 46 of the fusible element 44 will not fuse in response to most low overloads.

The areas 52 of reduced cross section adjacent the opening 56 in the portion 48 will, however, be able to generate sufficient heat to enable them to reach their fusing temperatures; because the casing 10 will absorb very little heat from that portion, and because the areas of reduced cross section adjacent the opening 56 in the portion 50 will develop a heat barrier that will keep the portion 46 from absorbing the heat generated in the portion 48. Although the heat which is generated by the areas of reduced cross section adjacent the opening 56 in the portion 50 will act as a heat barrier, the portion 46 of the fusible element 44 will absorb appreciable proportions of that heat; and hence the portion 46 of the fusible element 44 will not fuse in many instances where the areas 52 of reduced cross section will fuse. For this reason, the portion 48 of the fusible element 44 will generate most of the effective heat that is generated during low and moderate overloads.

The portion 48 of fusible element 44 will radiate heat toward the strain wire 62 as that portion responds to overloads to generate heat. If an overload continues long enough to cause the areas 52 of reduced cross section to fuse, those areas of reduced cross section will have radiated substantial amounts of heat toward the strain wire 62. In addition, at the moment the areas 52 having reduced cross sections fuse, they will generate very substantial amounts of heat; and those amounts of heat will tend to further increase the temperature of the strain wire 62. As soon as the areas 52 of reduced cross section have fused in response to an overload, the current flowing through the electric fuse will begin to flow through the strain wire 62; and the left-hand portion of that strain wire will quickly fuse. Thereupon, the spring 42 will move the plunger 32 out of the retracted position of FIGS. 1 and 2 and into indicating position. The portion 68 of the strain wire 62 is quite flexible, and it is loosely wound around the shank 34 of the plunger 32; and hence that portion will not keep that plunger from moving all the way into its indicating position. This means that the portion 48 of the fusible element 44 and the left-hand portion of the strain wire 62 will successively respond to a low or moderate overload to fuse and thereby enable the spring 42 to move the plunger 32 to indicating position.

When the fusible element 44 fuses in response to a short circuit or a heavy overload, the current flowing through the electric fuse will begin to flow through the strain wire 62; and the left-hand portion of that strain wire will quickly fuse. Thereupon, the spring 42 will move the plunger 32 into indicating position. This means that the portion 48 of the fusible element 44 and the left-hand portion of the strain wire 62 will successively respond to a short circuit or a heavy overload to fuse and thereby enable the spring 42 to move the plunger 32 to indicating position.

The left-hand portion of the strain wire 62 will fuse before any other portion of that strain wire can fuse; because that left-hand portion is under tension and because that left-hand portion is heated while the rest of that strain wire is cooled. Specifically, heat will be radiated toward the left-hand portion of the strain wire 62 by the portion 48 of the fusible element 44 whenever current flows through the electric fuse, whereas heat will be absorbed from the portion 66 of that strain wire by the plianished end 38 of the plunger 32, heat will be absorbed
from the portion 68 by the shank 34, and heat will be absorbed from the portion 70 by the eyelet 26 and the casing 10. Heat also will be radiated toward the right-hand end of the left-hand portion of the strain wire 62 by the portion 50 of the fusible element 44 whenever current flows through the electric fuse. This overall result is that the left-hand portion of the strain wire 62 is certain to fuse before any other portion of that strain wire can fuse; and hence the electric fuse of the present invention will always respond to the fusing of any portion of the fusible element 44 to cause the left-hand portion of the strain wire 62 to fuse and release the plunger 32.

The electric fuse provided by the present invention can have a preset result that is the least determined and effectively maintained ampere rating, although the outer diameter of the casing 10 is less than one-quarter of an inch and although the overall length of that casing is less than one and one-quarter inches; because the portion 48 of the fusible element 44 is spaced inwardly of the casing 10 and is thermally isolated from the portion 46 of that fusible element by the heat barrier developed within the portion 50. The plunger 32 of that electric fuse is able to move to indicating position whenever any portion of the fusible element 44 fuses; because the portion 46 of that fusible element and the portion 78 of the strain wire 62 are laterally displaced from the path of movement of that plunger, because the helical compression spring 42 is effectively shunted by the portions 68 and 70 of that shunt wire and by that plunger and the eyelet 26, and thus will not lose its restorative force, and because the left-hand portion of that strain wire will fuse before any other portion of that strain wire can fuse. In these ways, the electric fuse of the present invention can have a precisely determined and effectively maintained ampere rating and yet can inoffitably provide an indication whenever any part of the fusible element 44 thereof fuses.

Referring particularly to FIG. 3, the numeral 78 denotes an alternate form of fusible element that could be used in the electric fuse of FIGS. 1 and 2. That fusible element has an opening 80 which can be identical to the opening 54 in the portion 48 of fusible element 44, has an opening 82 which can be identical to the opening 56 in the portion 50, and has openings 84, 86 and 88 which can be similar to the openings 58 and 60 in the portion 46. The left-hand portion of the fusible element 78 would be positioned where the portion 46 of the fusible element 44 is positioned in FIGS. 1 and 2; and it would perform essentially the same function as the portion 46 performs. The right-hand portion of the fusible element 78 would be positioned where the portion 48 of the fusible element 44 is positioned in FIGS. 1 and 2; and it would perform essentially the same function as the portion 48 performs. The portion of the fusible element 78 adjacent the opening 82 would be positioned where the portion of the fusible element 44 is positioned in FIGS. 1 and 2; and it would perform the same function as the portion 50 performs. When the fusible element 78 is provided with the openings 80, 82, 84, 86 and 88, it will be very similar in design and operation to the fusible element 44, but it will permit the electric fuse to protect a circuit that is subjected to higher voltages. This is due to the fact that the fusible element 78 has five serially connected pairs of reduced cross-section areas which can fuse on short circuits and heavy overloads.

If desired, the fusible element 78 could have two additional openings 90 and 92 formed therein. The opening 92 would enable that fusible element to be used in an electric fuse which had a very small ampere rating. The provision of the opening 90 in the fusible element 78 would permit the electric fuse to protect a circuit that is subjected to materially higher voltages. Whereas the drawing and accompanying description have shown and described one preferred embodiment of the present invention, it should be apparent to those skilled in the art that various changes may be made in the form of the invention without affecting the scope thereof.

What I claim is:

1. An electric fuse that comprises:
   an elongated casing that has an elongated axis,
said fusible element having a second portion which is disposed at the opposite side of said axis of said casing and which is displaced longitudinally from said portion of said plunger.

said fusible element having a third portion which is interposed between the first said and second portions of said fusible element and which is angularly displaced relative to said axis of said casing and which extends from said one side of said axis of said casing to said opposite side of said axis of said casing.

said third portion of said fusible element being displaced longitudinally from said portion of said plunger.

said third portion of said fusible element having an opening therethrough.

said strain wire extending from said plunger through said opening in said third portion of said fusible element and to said second terminal.

said fusible element being adapted to carry the rated current of said electric fuse indefinitely, but being adapted to respond to overloads of predetermined magnitude and duration to fuse, and thereby initiate the opening of the circuit of which said electric fuse is a part.

said strain wire being after said fusible element fuses, and thereby permitting said spring to move said one end of said plunger outwardly of said one end of said casing.

said first said portion of said fusible element being in close proximity to said portion of said inner surface of said casing and transferring substantial proportions of the heat generated thereby to said portion of said inner surface of said casing.

said second portion of said fusible element being spaced from said inner surface of said casing a distance greater than he distance between said first said portion of said fusible element and said portion of said inner surface of said casing and thereby not transferring substantial portions of the heat generated thereby to said inner surface of said casing.

the metal of said third portion of said fusible element which defines said opening in said third portion of said fusible element constituting strips of reduced cross section which generate heat and thereby act as barriers to the heat that otherwise would tend to flow from said second portion of said fusible element to said first said portion of said fusible element and thence to said portion of said inner surface of said casing.

3. An electric fuse that comprises:

an elongated casing that has an elongated axis,
an electrically conducting terminal secured adjacent one end of said casing,
a second electrically conducting terminal secured adjacent the opposite end of said casing,
a metallic fusible element disposed within said casing and having one end thereof electrically connected to the first said terminal and having the other end thereof electrically connected to said second terminal,
a plunger that has a portion thereof disposed within and movable relative to said casing,
said plunger being disposed adjacent said one end of said casing.

a spring that biases one end of said plunger for movement outwardly of said one end of said casing, and

a strain wire that is connected to said plunger and that normally overcomes the bias provided by said spring, and thereby normally holds said one end of said plunger against movement outwardly of said one end of said casing.

said fusible element having a portion which is disposed at one side of said axis of said casing and which is intermediate said plunger and a portion of the inner surface of said casing.

said fusible element having a second portion which is disposed at the opposite side of said axis of said casing and which is displaced longitudinally from said portion of said plunger.

said fusible element having a portion which is disposed at one side of said axis of said casing and which is intermediate said plunger and a portion of the inner surface of said casing.

said fusible element having a second portion which is disposed at the opposite side of said axis of said casing and which is displaced longitudinally from said portion of said plunger.

said fusible element having a third portion which is interposed between the first said and second portions of said fusible element and which is angularly displaced relative to said axis of said casing and which extends from said one side of said axis of said casing to said opposite side of said axis of said casing.

said third portion of said fusible element being displaced longitudinally from said portion of said plunger.

said third portion of said fusible element having an opening therethrough.

said strain wire extending from said plunger through said opening in said third portion of said fusible element and to said second terminal.

said fusible element being adapted to carry the rated current of said electric fuse indefinitely, but being adapted to respond to overloads of predetermined magnitude and duration to fuse, and thereby initiate the opening of the circuit of which said electric fuse is a part.

said strain wire being after said fusible element fuses, and thereby permitting said spring to move said one end of said plunger outwardly of said one end of said casing.

said strain wire being in close proximity to, and being generally parallel to, said axis of said casing.

said opening in said third portion of said fusible element encircling said axis of said casing, and

the force which said spring applies to said plunger keeping said strain wire taut and thereby keeping said strain wire from engaging the metal which defines said opening in said third portion of said fusible element.

4. An electric fuse that comprises:

an elongated casing that has an elongated axis,
an electrically conducting terminal secured adjacent one end of said casing,
a second electrically conducting terminal secured adjacent the opposite end of said casing,
a metallic fusible element disposed within said casing and having one end thereof electrically connected to the first said terminal and having the other end thereof electrically connected to said second terminal,
a plunger that has a portion thereof disposed within and movable relative to said casing.

said plunger being disposed adjacent said one end of said casing.

a spring that biases one end of said plunger for movement outwardly of said one end of said casing, and

a strain wire that is connected to said plunger and that normally overcomes the bias provided by said spring, and thereby normally holds said one end of said plunger against movement outwardly of said one end of said casing.

said fusible element having a portion which is disposed at one side of said axis of said casing and which is intermediate said plunger and a portion of the inner surface of said casing.

said fusible element having a second portion which is disposed at the opposite side of said axis of said casing and which is displaced longitudinally from said portion of said plunger.

said fusible element having a third portion which is interposed between the first said and second portions of said fusible element and which is angularly displaced relative to said axis of said casing and which extends from said one side of said axis of said casing to said opposite side of said axis of said casing.

said third portion of said fusible element being displaced longitudinally from said portion of said plunger.

said third portion of said fusible element having an opening therethrough.

said strain wire extending from said plunger through said opening in said third portion of said fusible element and to said second terminal.

said fusible element being adapted to carry the rated current of said electric fuse indefinitely, but being adapted to respond to overloads of predetermined magnitude and duration to fuse, and thereby initiate the opening of the circuit of which said electric fuse is a part.

said strain wire being after said fusible element fuses, and thereby permitting said spring to move said one end of said plunger outwardly of said one end of said casing.

said strain wire being in close proximity to, and being generally parallel to, said axis of said casing.

said opening in said third portion of said fusible element encircling said axis of said casing, and

the force which said spring applies to said plunger keeping said strain wire taut and thereby keeping said strain wire from engaging the metal which defines said opening in said third portion of said fusible element.
An electric fuse that comprises:

- an elongated casing that has an elongated axis,
- an electrically conducting terminal secured adjacent one end of said casing,
- a second electrically-conducting terminal secured adjacent the opposite end of said casing,
- a metallic fusible element disposed within said casing and having one end thereof electrically connected to the first said terminal and having the other end thereof electrically connected to said second terminal,
- a plunger that has a portion thereof disposed within and movable relative to said casing,
- said plunger being disposed adjacent said one end of said casing,
- a spring that biases one end of said plunger for movement outwardly of said one end of said casing, and
- a strain wire that is connected to said plunger and that normally overcomes the bias provided by said spring, and thereby normally holds said one end of said plunger against movement outwardly of said one end of said casing,
- said fusible element having a portion which is disposed at one side of said axis of said casing and which is intermediate said plunger and a portion of the inner surface of said casing,
- said fusible element having a second portion which is disposed at the opposite side of said axis of said casing and which is displaced longitudinally from said portion of said plunger,
- said fusible element having a third portion which is intersected between the first said and second portions of said fusible element and which is angularly displaced relative to said axis of said casing and which extends from said one side of said axis of said casing to said opposite side of said axis of said casing,
- said third portion of said fusible element being displaced longitudinally from said portion of said plunger,
- said strain wire extending from said plunger through said opening in said third portion of said fusible element and to said second terminal,
- said fusible element being adapted to carry the rated current of said electric fuse indefinitely, but being adapted to respond to overloads of predetermined magnitude and duration to fuse, and thereby initiate the opening of the circuit of which said electric fuse is a part,
- said strain wire fusing after said fusible element fuses, and thereby permitting said spring to move said one end of said plunger outwardly of said one end of said casing,
- said plunger being elongated and said portion of said plunger extending a substantial distance inwardly of said one end of said casing,
- said first said portion of said fusible element being longer than said portion of said plunger,
- said second portion of said fusible element being shorter than said portion of said plunger,
- said third portion of said fusible element being shorter than the inner diameter of said casing,

6. An electric fuse that comprises:

- an elongated casing that has an elongated axis,
against movement outwardly of said one end of said casing,
said fusible element having a portion which is disposed at
one side of said axis of said casing and which is inter-
mediate said plunger and a portion of the inner surface of
said casing,
said fusible element having a second portion which is
disposed at the opposite side of said axis of said casing
and which is displaced longitudinally from said portion of
said plunger,
said fusible element having a third portion which is inter-
posed between the first said and second portions of said
fusible element and which is angularly displaced relative
to said axis of said casing and which extends from said
one side of said axis of said casing to said opposite side of
said axis of said casing,
said third portion of said fusible element being displaced
longitudinally from said portion of said plunger,
said third portion of said fusible element being disposed
outwardly of said one end of said casing and which extends
from said one side of said axis of said casing to said opposite side of
said axis of said casing,
said third portion of said fusible element being displaced
outwardly of said one end of said casing, and which extends
from said one side of said axis of said casing to said opposite side of
said axis of said casing,
said third portion of said fusible element being displaced
longitudinally from said portion of said plunger,
said third portion of said fusible element being displaced
outwardly of said one end of said casing and to said second terminal,
said fusible element being adapted to carry the rated cur-
rent of said electric fuse indefinitely, but being adapted to
respond to overloads of predetermined magnitude and
duration to fuse, and thereby initiate the opening of the
circuit of which said electric fuse is a part,
said strain wire fusing after said fusible element fuses, and
thereby permitting said spring to move said one end of
said plunger outwardly of said one end of said casing,
said spring and a length of said plunger being encased within
an eyelet which is disposed within said one end of said
casing, and
part of said said first said portion of said fusible element being
disposed within the space between the outer surface of
said eyelet and the inner surface of said casing and being
cooled by said eyelet and by said casing.

8. An electric fuse that comprises:
an elongated casing that has an elongated axis,
an electrically conducting terminal secured adjacent one
end of said casing,
a second electrically conducting terminal secured adjacent
the opposite end of said casing,
a metallic fusible element disposed within said casing and
having one end thereof electrically connected to the first
said terminal and having the other end thereof electrically
coupled to said second terminal,
a plunger that has a portion thereof disposed within and
movable relative to said casing,
said plunger being disposed adjacent said one end of said
casing,
a spring that biases one end of said plunger for movement
outwardly of said one end of said casing, and
a strain wire that is connected to said plunger and that nor-
mally overcomes the bias provided by said spring, and
thereby normally holds said one end of said plunger
against movement outwardly of said one end of said cas-
ing,
said fusible element having a portion which is disposed at
one side of said axis of said casing and which is inter-
mediate said plunger and a portion of the inner surface of
said casing,
said fusible element having a second portion which is
disposed at the opposite side of said axis of said casing
and which is displaced longitudinally from said portion of
said plunger,
said fusible element having a third portion which is inter-
posed between the first said and second portions of said
fusible element and which is angularly displaced relative
to said axis of said casing and which extends from said
one side of said axis of said casing to said opposite side of
said axis of said casing,
said first said portion of said fusible element being, throughout its length, immediately adjacent the inner surface of said casing and being effectively connected by said casing,
said second portion of said fusible element responding to long continued low overloads to develop most of the effective heat developed by said fusible element, and
said second portion of said fusible element being coextensive with part of said strain wire and radiating part of the heat which it develops toward said part of said strain wire, thereby helping said part of said strain wire fuse before the rest of said strain wire fuses.

10. An electric fuse that comprises:
an elongated casing that has an elongated axis,
an electrically conducting terminal secured adjacent one end of said casing,
a second electrically conducting terminal secured adjacent the opposite end of said casing,
a metallic fusible element disposed within said casing and having one end thereof electrically connected to the first said terminal and having the other end thereof electrically connected to said second terminal,
a plunger that has a portion thereof disposed within and movable relative to said casing,
said plunger being disposed adjacent said one end of said casing,
a spring that biases one end of said plunger for movement outwardly of said one end of said casing, and
a strain wire that is connected to said plunger and that normally overcomes the bias provided by said spring, and thereby normally holds said one end of said plunger against movement outwardly of said one end of said casing,
said fusible element having a portion which is disposed at one side of said axis of said casing and which is intermediate said plunger and a portion of the inner surface of said casing,
said fusible element having a second portion which is disposed at the opposite side of said axis of said casing and which is displaced longitudinally from said portion of said plunger,
said fusible element having a third portion which is interposed between the first said and second portions of said fusible element and which is angularly displaced relative to said axis of said casing and which extends from said one side of said axis of said casing to said opposite side of said axis of said casing,
said third portion of said fusible element being displaced longitudinally from said portion of said plunger,
said third portion of said fusible element having an opening therethrough,
said strain wire extending from said plunger through said opening in said third portion of said fusible element and to said second terminal,
said fusible element being adapted to carry the rated current of said electric fuse indefinitely, but being adapted to respond to overloads of predetermined magnitude and duration to fuse, and thereby initiate the opening of the circuit of which said electric fuse is a part,
said strain wire fusing after said fusible element fuses, and thereby permitting said spring to move said one end of said plunger outwardly of said one end of said casing,
a portion of said strain wire being wound around said plunger, and
a further portion of said strain wire being immediately adjacent the inner surface of said casing, whereby said portions of said strain wire are kept cooler than the portion of said strain wire which extends from said plunger to said second terminal.

11. An electric fuse that comprises:
an elongated casing that has an elongated axis,
an electrically conducting terminal secured adjacent one end of said casing,
a second electrically conducting terminal secured adjacent the opposite end of said casing,
a metallic fusible element disposed within said casing and having one end thereof electrically connected to the first said terminal and having the other end thereof electrically connected to said second terminal,
a plunger that has a portion thereof disposed within and movable relative to said casing,
said plunger being disposed adjacent said one end of said casing,
a spring that biases one end of said plunger for movement outwardly of said one end of said casing, and
a strain wire that is connected to said plunger and that normally overcomes the bias provided by said spring, and thereby normally holds said one end of said plunger against movement outwardly of said one end of said casing,
said fusible element having a portion which is disposed at one side of said axis of said casing and which is intermediate said plunger and a portion of the inner surface of said casing.
said fusible element having a second portion which is disposed at the opposite side of said axis of said plunger and which is displaced longitudinally from said portion of said plunger,
said fusible element having a third portion which is interposed between the first said and second portions of said fusible element and which is angularly displaced relative to said axis of said casing and which extends from said one side of said axis of said casing to said opposite side of said axis of said casing,
said third portion of said fusible element being displaced longitudinally from said portion of said plunger,
said third portion of said fusible element being adapted to carry the rated current of said electric fuse indefinitely, but being adapted to respond to overloads of predetermined magnitude and duration to fuse, and thereby initiate the opening of the circuit of which said electric fuse is a part,
said strain wire fusing after said fusible element fuse, and thereby permitting said spring to move said one end of said plunger outwardly of said one end of said casing, and part of said strain wire and said second portion of said fusible element being generally coextensive, whereby heat generated by said second portion of said fusible element as it fuses will facilitate heating and fusing of said part of said strain wire.

14. An electric fuse that comprises:
an elongated casing that has an elongated axis, electrically conducting terminals secured to said casing, a fusible element disposed within said casing and having one end thereof electrically connected to one of said terminals and having the other end thereof electrically connected to the other of said terminals,
said fusible element having an elongated portion which is generally parallel to said axis at one end of said casing but is displaced radially outwardly from said axis to be in close proximity to the inner surface of said casing and to transfer heat to said casing,
said fusible element having a second portion which is displaced longitudinally from said elongated portion of said fusible element, said second portion of said fusible element being in close proximity to said axis at the other end of said casing, said fusible element having a third portion which is interposed between said elongated portion and said second portion of said fusible element, said third portion of said fusible element being angularly displaced relative to said axis of said casing so that it extends transversely of said axis,
said third portion of said fusible element having a reduced cross-section part intermediate the ends thereof, said reduced cross-section part of said third portion of said fusible element generating more heat per unit of length than do the contiguous parts of said third portion of said fusible element, whereby said reduced cross-section part of said third portion of said fusible element acts as a barrier to the flow of heat which otherwise would flow from said second portion of said fusible element to said elongated portion of said fusible element and then be transferred to said inner surface of said casing,
said fusible element being adapted to carry the rated current of said electric fuse indefinitely but being adapted to respond to overloads of predetermined magnitude and duration to fuse and thereby initiate opening of the circuit of which said electric fuse is part.

15. An electric fuse that comprises:
an elongated casing that has an elongated axis, electrically conducting terminals secured to said casing, a fusible element disposed within said casing and having one end thereof electrically connected to one of said terminals and having the other end thereof electrically connected to the other of said terminals, said fusible element having an elongated portion which is generally parallel to said axis at one end of said casing but is displaced radially outwardly from said axis to be in close proximity to the inner surface of said casing and to transfer heat to said casing, said fusible element having a second portion which is displaced longitudinally from said elongated portion of said fusible element, said second portion of said fusible element being in close proximity to said axis at the other end of said casing, said fusible element having a third portion which is interposed between said elongated portion and said second portion of said fusible element.
said third portion of said fusible element being angularly displaced relative to said axis of said casing so it extends transversely of said axis,
said third portion of said fusible element having a reduced cross-section part intermediate the ends thereof,
said reduced cross-section part of said third portion of said fusible element generating more heat per unit of length than do the contiguous parts of said third portion of said fusible element,
whereby said reduced cross-section part of said third portion of said fusible element acts as a barrier to the flow of heat which otherwise would flow from said second portion of said fusible element to said elongated portion of said fusible element and then be transferred to said inner surface of said casing,
said fusible element being adapted to carry the rated current of said electric fuse indefinitely but being adapted to respond to overloads of predetermined magnitude and duration to fuse and thereby initiate opening of the circuit of which said electric fuse is part,
said elongated portion of said fusible element having a plurality of "weak spots" therein, and
said second portion of said fusible element having at least one "weak spot" therein.

16. An electric fuse that comprises:
an elongated casing that has an elongated axis,
electrically conducting terminals secured to said casing,
a fusible element disposed within said casing and having one end thereof electrically connected to one of said terminals and having the other end thereof electrically connected to the other of said terminals,
said fusible element having an elongated portion which is generally parallel to said axis at one end of said casing but is displaced radially outwardly from said axis to be in close proximity to the inner surface of said casing and to transfer heat to said casing,
said fusible element having a second portion which is displaced longitudinally from said elongated portion of said fusible element,
whereby said reduced cross-section part of said third portion of said fusible element acts as a barrier to the flow of heat which otherwise would flow from said second portion of said fusible element to said elongated portion of said fusible element and then be transferred to said inner surface of said casing,
said fusible element being adapted to carry the rated current of said electric fuse indefinitely but being adapted to respond to overloads of predetermined magnitude and duration to fuse and thereby initiate opening of the circuit of which said electric fuse is part,
said second portion of said fusible element having a length less than one-half of the length of said casing, and
said elongated portion of said fusible element having a length greater than one-half of the length of said casing.

17. An electric fuse that comprises:
an elongated casing that has an elongated axis,
electrically conducting terminals secured to said casing,
a fusible element disposed within said casing and having one end thereof electrically connected to one of said terminals and having the other end thereof electrically connected to the other of said terminals,
said fusible element having an elongated portion which is generally parallel to said axis at one end of said casing but is displaced radially outwardly from said axis to be in close proximity to the inner surface of said casing and to transfer heat to said casing,
said fusible element having a second portion which is displaced longitudinally from said elongated portion of said fusible element,
whereby said reduced cross-section part of said third portion of said fusible element acts as a barrier to the flow of heat which otherwise would flow from said second portion of said fusible element to said elongated portion of said fusible element and then be transferred to said inner surface of said casing,
said fusible element being adapted to carry the rated current of said electric fuse indefinitely but being adapted to respond to overloads of predetermined magnitude and duration to fuse and thereby initiate opening of the circuit of which said electric fuse is part,
said second portion of said fusible element having all surfaces thereof spaced inwardly of said inner surface of said casing
whereby said second portion of said fusible element can provide a precisely determined and effectively maintained ampere rating for said electric fuse.

18. An electric fuse that comprises:
an elongated casing that has an elongated axis,
electrically conducting terminals secured to said casing,
tion of said fusible element to said elongated portion of said fusible element and then be transferred to said inner surface of said casing.

said fusible element being adapted to carry the rated current of said electric fuse indefinitely but being adapted to respond to overloads of predetermined magnitude and duration to fuse and thereby initiate opening of the circuit of which said electric fuse is part, and

sae elongated portion of said fusible element being so close to said inner surface of said casing that said casing absorbs enough heat from said elongated portion of said fusible element to keep low and moderate overloads from melting any part of said elongated portion of said fusible element.

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