Aug. 5, 1969 A. J. FISTER 3,460,086

PROTECTORS FOR ELECTRIC CIRCUITS

Filed Sept. 25, 1967

FIG. 1.

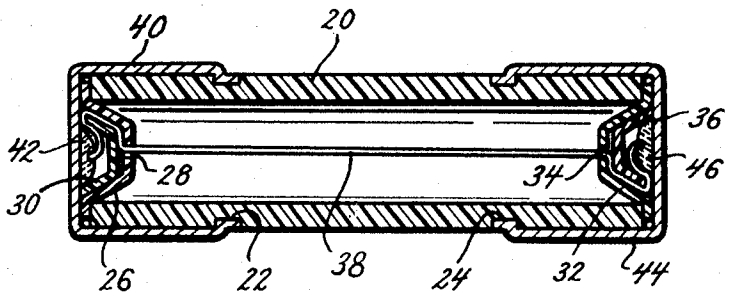


FIG. 3.

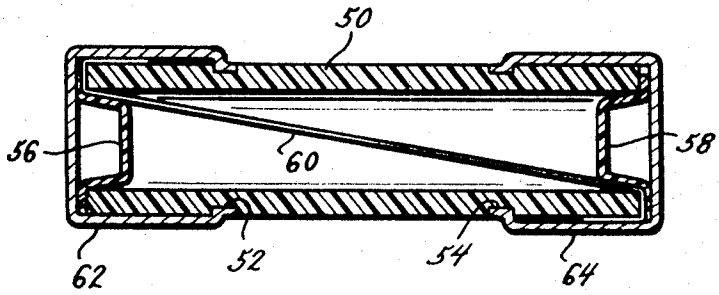


FIG. 2.

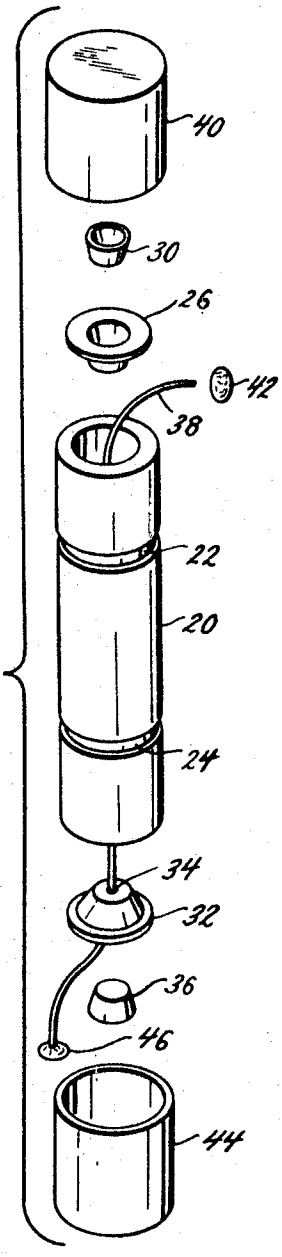


FIG. 4.

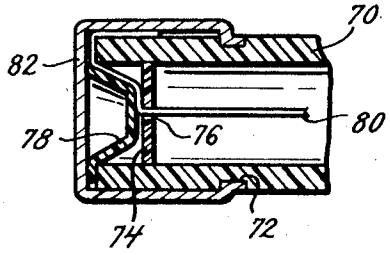
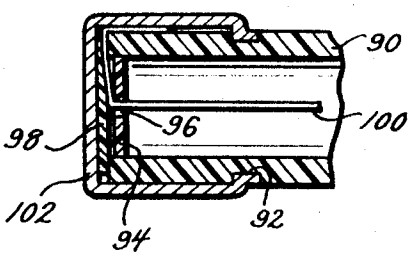


FIG. 5.



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PROTECTORS FOR ELECTRIC CIRCUITS

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U.S. Cl. 337—202 12 Claims

ABSTRACT OF THE DISCLOSURE

A small amperage, relatively-high voltage fuse is provided with a short casing which is devoid of arc-extinguishing filler material in which the position of the fusible element of the fuse is fixed within the casing and if barriers of insulation are disposed immediately adjacent the inner faces of the terminals at the opposite ends of the casings to prevent arc plasma from extending between those inner faces.

This invention relates to improvements in protectors for electric circuits. More particularly, this invention relates to improvements in electric fuses which are used to protect relatively-high voltage circuits.

It is, therefore, an object of the present invention to provide an improved electric fuse which can be used to protect relatively-high voltage circuits.

Where fuses are used to protect relatively-high voltage circuits and are provided with short casings, it is customary to fill those casings with arc-extinguishing filler material. However, where the amperages of such fuses are small, the cross-sections of the fusible elements of those fuses are so small that it is difficult to obtain uniform transference of heat from those fusible elements to the surrounding arc-extinguishing filler material. For example, if the arc-extinguishing filler material is a granular material such as quartz sand, there will be minute voids between the grains of that arc-extinguishing filler material and the fusible elements, and those voids will have a lower heat-transferring capability than will those grains. On the other hand, if the arc-extinguishing filler material is an amorphous material, such as calcium sulfate, the forces which must be used to compact that arc-extinguishing filler material within the casings of the electric fuses can displace the fusible elements from their intended positions within those casings, and can even break those fusible elements. Furthermore, even if the amorphous arc-extinguishing material could be compacted around the fusible element without breaking that fusible element, that arc-extinguishing filler material would tend to develop cracks or voids as the electric fuse was handled; and those cracks or voids would have a lower heat-transferring capability than would that arc-extinguishing filler material. Consequently, it would be desirable to provide an electric fuse which could be used to protect relatively high-voltage circuits but which could be provided with a short casing that was devoid of arc-extinguishing filler material. The present invention provides such an electric fuse; and it is, therefore, an object of the present invention to provide an electric fuse which can be used to protect relatively-high voltage circuits and which can be provided with a short casing that is devoid of arc-extinguishing filler material.

The present invention makes it possible to provide an electric fuse which can be used to protect relatively-high voltage circuits and which has a short casing that is devoid of arc-extinguishing filler material by fixing the position of the fusible element of that fuse within that casing and by disposing imperforate barriers of insulation adjacent the inner faces of the terminals at the ends of that casing. The fixing of the position of the fusible element within that casing provides a determinable rate at which heat will radiate from that fusible element to the walls of that casing, and thus enables the electric fuse to have a predictable and uniform rating. The positioning of the imperforate barriers of insulation adjacent the inner faces of the terminals of the electric fuse will keep arc plasma from extending between those terminals when the fusible element fuses. The overall result is that the electric fuse provided by the present invention has a predictable uniform rating and can safely interrupt a relatively-high voltage circuit. It is, therefore, an object of the present invention to provide an electric fuse wherein the position of the fusible element within the casing is fixed and wherein imperforate barriers of insulation are disposed adjacent the inner faces of the terminals at the ends of that casing.

Other and further objects and advantages of the present invention should become apparent from an examination of the drawing and accompanying description.

In the drawing and accompanying description, several preferred embodiments of the present invention are shown and described but it is to be understood that the drawing and accompanying description are for the purpose of illustration only and do not limit the invention and that the invention will be defined by the appended claims.

In the drawing, FIG. 1 is a longitudinal section through one preferred embodiment of electric fuse that is made in accordance with the principles and teachings of the present invention,

FIG. 2 is an exploded view of the electric fuse shown in FIG. 1,

FIG. 3 is a longitudinal section through another preferred embodiment of electric fuse that is made in accordance with the principles and teachings of the present invention,

FIG. 4 is a longitudinal section through one end of a third preferred embodiment of electric fuse that is made in accordance with the principles and teachings of the present invention, and

FIG. 5 is a longitudinal section through one end of a fourth preferred embodiment of electric fuse that is made in accordance with the principles and teachings of the present invention.

Referring to the drawing in detail, the numeral **20** denotes the casing of one preferred embodiment of electric fuse that is made in accordance with the principles and teachings of the present invention. That casing is made of insulating material; and it is tubular in form. An annular groove **22** is formed in the exterior of that casing adjacent the left-hand end of that casing; and a similar annular groove **24** is formed in the exterior of that casing adjacent the right-hand end of that casing. The annular grooves **22** and **24** are made shallow so they will not unduly weaken the casing **20**.

The numeral **26** denotes a cup-shaped washer of generally frusto-conical form; and that cup-shaped washer is formed so the frusto-conical portion thereof can be pressed into the left-hand end of the casing **20**, as that casing is viewed in FIG. 1. An annular flange projects outwardly from the large-diameter end of the frusto-conical portion of the washer **26**; and that flange is dimensioned to abut the left-hand end of that casing. A small opening **28** is formed in the center of the closed end of the frusto-conical portion of the cup-shaped washer **26**. The numeral **30** denotes a cup-shaped barrier of frusto-conical form; and that barrier is dimensioned to telescope within the recess in the frusto-conical portion of the cup-shaped washer **26**.

The numeral **32** denotes a second cup-shaped washer which can be identical to the cup-shaped washer **26**; and that second washer is dimensioned to be pressed within

the right-hand end of the casing **20**. A small opening **34** is formed in the center of the closed end of the frusto-conical portion of that second washer. The numeral **36** denotes a second cup-shaped barrier which can be identical to the cup-shaped barrier **30**; and that second cup-shaped barrier is dimensioned to telescope within the recess in the frusto-conical portion of the second washer **32**.

The cup-shaped washers **26** and **32** and the cup-shaped barriers **30** and **36** are made from insulating material; and they are made so they are flexible and resilient. One insulating material which has been found to be very useful in making those washers and barriers is forming-fibre. The cup-shaped washers **26** and **32** and the barriers **30** and **36** can be formed by simple pressing or punching operations.

The numeral **38** denotes an elongated, small-diameter, wire-like, fusible element; and one end of that fusible element is threaded through the opening **28** in the cup-shaped washer **26** while the other end of that fusible element is threaded through the opening **34** in the cup-shaped washer **32**. The left-hand end of the fusible element **38** passes between the inner surface of the cup-shaped washer **26** and the outer surface of the cup-shaped barrier **30**, passes around the rim of that cup-shaped barrier, and then is bent inwardly into the frusto-conical space defined by that cup-shaped barrier. The right hand end of the fusible element **38** passes between the inner surface of the cup-shaped washer **32** and the outer surface of the cup-shaped barrier **36**, passes around the rim of that cup-shaped barrier, and then is bent inwardly into the frusto-conical space defined by that cup-shaped barrier. The diameter of the fusible element **38** is so small that bends can readily be formed in that fusible element.

The numeral **40** denotes a ferrule-like, metal terminal which is telescoped over the left-hand end of the casing **20**; and the free edge of that terminal is rolled or crimped into the annular groove **22**. The numeral **44** denotes a second ferrule-like; metal terminal which is telescoped over the right-hand end of the casing **20**; and the free edge of that second terminal is rolled or crimped into the annular groove **24**. Solder **42** electrically bonds and physically connects the left-hand end of the fusible element **38** to the terminal **40**; and solder **46** electrically bonds and physically connects the right-hand end of that fusible element to the terminal **44**.

In assembling the electric fuse of FIG. 1, the left-hand end of the fusible element **38** is passed through the casing **20** and is then passed through the opening **28** in the closed end of the cup-shaped washer **26**. Thereafter, that cup-shaped washer has the frusto-conical portion thereof forced into the left-hand end of that casing, and has the annular flange thereof pressed against the left-hand end of that casing. The cup-shaped barrier **30** is then pressed into the frusto-conical recess defined by the frusto-conical portion of the cup-shaped washer **26**; and the outer surface of that cup-shaped barrier will bend the adjacent portion of the fusible element **38** so it intimately engages the inner surface of the cup-shaped washer **26** and so it assumes the configuration shown by FIG. 1. After the cup-shaped barrier **30** has bent the adjacent portion of the fusible element **38** into intimate engagement with the cup-shaped washer **26**, any excess length of the left-hand end of that fusible element will be cut off; and the remaining portion of the left-hand end will be bent into the recess defined by that cup-shaped barrier. A small quantity of solder **42** will be placed within the frusto-conical recess defined by the cup-shaped barrier **30**; and then the terminal **40** will be telescoped over the left-hand end of the casing **20**, and the free edge of that terminal will be rolled or crimped into the annular groove. Thereafter, the opening **34** in the cup-shaped washer **32** will be threaded over the right-hand end of the fusible element **38**; and that cup-shaped washer will have the frusto-conical portion thereof forced into the right-hand end of the casing **20** and will have the annular flange thereon disposed in abutting engagement with that right-hand end of that casing. The cup-shaped barrier **36** will then be pressed into the frusto-conical recess defined by the frusto-conical portion of the cup-shaped barrier **32** to force the adjacent portion of the fusible element **38** to assume the configuration shown by FIG. 1. A light tension should be maintained on the fusible element **38**, as the cup-shaped barrier **36** is pressed into the frusto-conical space defined by the frusto-conical portion of the cup-shaped washer **32**, so that fusible element will assume a position which is coincident with the geometric axis of the casing **20**. As the cup-shaped barrier **36** is pressed into intimate engagement with the inner surface of the cup-shaped washer **32**, any excess length of the right-hand end of the fusible element **38** will be cut off; and the remaining portion of that right-hand end will be bent inwardly over the rim of that cup-shaped barrier. Thereafter, a small quantity of solder **46** will be placed within the frusto-conical recess defined by the cup-shaped barrier **36**; and then the terminal **44** will be telescoped over the right-hand end of the casing **20**, and the free edge of that terminal will be rolled or crimped nito the annular groove **24**. The mechanically-assembled electric fuse will then be set with its elongated axis vertical and with the terminal **40** resting upon a heated plate to cause the lump **42** of solder, located in the frusto-conical space between the inner surface of that terminal and the cup-shaped barrier **30**, to melt. That molten solder will assume the configuration shown in FIG. 1, and it will then be cooled to electrically bond and mechanically connect the left-hand end of the fusible element **38** to the terminal **40**. At this time, the mechanically-assembled electric fuse will be inverted and the terminal **44** will be set upon the heated plate, so the lump **46** of solder within the frusto-conical space defined by the inner surface of that terminal and the cup-shaped barrier **36** will melt. That lump of solder will assume the configuration shown in FIGS. 1 and 2; and it will subsequently be permitted to cool to electrically bond and mechanically connect the right-hand end of the fusible element **38** to the terminal **44**.

The electric fuse of FIG. 1 will carry its rated current continuously; and that rated current can be established with a highly-desirable degree of accuracy, because that fusible element will have a fixed position within the casing **20**. Specifically, that fusible element will be coincident with the geometric axis of that casing, and it will be held there by the closed ends of the cup-shaped washers **26** and **32**, As a result, all points on the major portion of the length of that fusible element will be spaced the same radial distance from all portions of the interior of the casing **20**, and thus will have a uniform volume of air between them and that interior. Furthermore, the casing **20** will be devoid of arc-extinguishing filler material, and hence the fusible element **38** will not be contacted by arc-extinguishing filler material; and this means that the electric fuse of FIGS. 1 and 2 will not experience the variations in heat transference which are experienced by electric fuses that have small fusible elements that are surrounded by arc-extinguishing filler material. The overall result is that the electric fuse of FIGS. 1 and 2 can have a desirably-precise rating.

One embodiment of the electric fuse shown in FIG. 1 has an overall length of one and one-half inches, has a diameter of thirteen thirty-seconds of an inch, and has a rating of four and one-half amperes or less; and that embodiment of electric fuse can be used to interrupt circuits having voltages as high as six hundred volts applied thereto. When the current flowing through such a circuit exceeds the rating of the electric fuse of FIGS. 1 and 2 by a predetermined value for a predetermined period of time, the central portion of the fusible element **38** will fuse. The resulting arc can burn back the two ends of the fusible element **38** until the resulting arc plasma reaches the imperforate cup-shaped barriers **30** and **36**.

Those imperforate cup-shaped barriers will isolate the terminals **40** and **44** from the arc plasma, and thus will keep the metal of those terminals from "feeding" the arc. The arc will not be able to consume the portions of the fusible element **38** which are disposed between the interior surfaces of the cup-shaped washers **26** and **32** and the exterior surfaces of the cup-shaped barriers **30** and **36**; because those cup-shaped washers and those cup-shaped barriers will absorb heat from the arc, and because that arc will be unable to follow the bends in that fusible element. As a result, the arc will quickly become extinguished; and the pressures within the casing **20** will be unable to rise to objectionably high levels.

The forming-fibre from which the cup-shaped washers **26** and **32** and the cup-shaped barriers **30** and **36** are made is relatively soft. As a result, the bending of the fusible element **38** by those cup-shaped washers and by those cup-shaped barriers during the assembling of the electric fuse of FIGS. 1 and 2 will not subject that fusible element to hurtful stresses. This is important; because that fusible element **38** will be so small that it will be quite weak and must be protected against undue stresses.

FIG. 3 shows a second preferred embodiment of electric fuse that is made in accordance with the principles and teachings of the present invention; and that fuse has a casing **50** which can be identical to the casing **20** of FIG. 1—having shallow annular grooves **52** and **54** which can be identical to the shallow annular grooves **22** and **24**. Ferrule-like, metal terminals **62** and **64**, which can be identical to the ferrule-like, metal terminals **40** and **44** of FIG. 1, are telescoped over the opposite ends of the casing **50** and have the free edges thereof rolled or crimped into the annular grooves **52** and **54**.

The numeral **60** denotes an elongated, small-diameter, wire-like fusible element; and one end of that fusible element is bent outwardly across the left-hand end of the casing **50** and then is bent into engagement with the outer surface of that casing. The other end of that fusible element is bent outwardly across the right-hand end of that casing, and then is bent along the outer surface of that casing. A cup-shaped barrier **56** of frusto-conical form is pressed into the left-hand end of the casing **50** before the ferrule-like terminal **62** is telescoped over that end. The frusto-conical portion of that barrier will be forced into the left-hand end of that casing, but the annular flange of that cup-shaped barrier will abut the left-hand end of that casing. That annular flange will be engaged and held by the ferrule-like terminal **62**; and that ferrule-like terminal will intimately engage the portion of the fusible element **60** which extends along the outer surface of the casing **50**—thereby making electrical contact with that portion. A similar cup-shaped barrier **58** will be pressed within the right-hand end of the casing **50** before the ferrule-like terminal **64** is telescoped over that end. The frusto-conical portion of that barrier will be forced into the right-hand end of that casing, but the annular flange of that cup-shaped barrier will abut the right-hand end of that casing. That annular flange will be engaged and held by the ferrule-like terminal **64**; and that ferrule-like terminal will intimately engage the portion of the fusible element **60** which extends along the outer surface of the casing **50**—thereby making electrical contact with that portion.

The ferrule-like terminals **62** and **64** would tend to force the outwardly-bent portions of the fusible element **60** into intimate engagement with the minute rough places, which inevitably exist at the ends of fuse casings, if the inner ends of those ferrule-like terminals engaged those outwardly-bent portions. However, the annular flanges on the cup-shaped barriers **56** and **58** keep those inner ends of those ferrule-like terminals from engaging those outwardly-bent portions; and, in addition, they will yield to limit the forces which the inner ends of those ferrule-like terminals can apply to those outwardly-bent portions. As a result, those annular flanges protect the

outwardly-bent portions of the fusible element **60** from injury.

The electric fuse of FIG. 3 will carry its rated current continuously; but it will respond to overloads of predetermined value and of predetermined duration to fuse. The arc which forms as that fusible element fuses can burn back the two ends of that fusible element until the resulting arc plasma reaches the imperforate cup-shaped barriers **56** and **58**. The arc will be cooled by the sides of those cup-shaped barriers and by the adjacent portions of the inner surface of the casing **50**; and hence that arc will be quickly extinguished, and the pressure within the casing **50** will be unable to rise to objectionably high levels.

Referring particularly to FIG. 4, the numeral **70** denotes a casing which can be identical to the casing **20** of FIGS. 1 and 2, the numeral **72** denotes a shallow annular groove which can be identical to the shallow annular groove **22**, and the numeral **82** denotes a ferrule-like, metal terminal which can be identical to the ferrule-like, metal material **40**. The numeral **74** denotes a disc-type washer which has a central opening **76** therein; and that washer is dimensioned so it can be forced into the casing **70**. The left-hand end of an elongated, small-diameter, wire-like, fusible element **80** will be passed through the opening **76**, and then will be bent outwardly by the closed end of a cup-shaped barrier **78**. That cup-shaped barrier has a frusto-conical portion which can be pressed into the left-hand end of the casing **70** and has a closed end which closely abuts the left-hand face of the washer **74**. An annular flange on that cup-shaped barrier abuts the left-hand end of the casing **70**; and that annular flange will be held in engagement with that left-hand end of the ferrule-like terminal **82**. The left-hand end of the fusible element **80** will pass outwardly across the outer end of the casing **70** and then will be bent along the outer surface of that casing; and it will be clamped in position by, and will make electrical engagement with, the ferrule-like terminal **82**. The right-hand end of the electric fuse of FIG. 4 can be a mirror-image of the left-hand end of that fuse.

Referring particularly to FIG. 5, the numeral **90** denotes a casing which can be identical to the casing **20** of FIGS. 1 and 2, the numeral **92** denotes a shallow annular groove which can be identical to the shallow annular groove **22**, and the numeral **102** denotes a ferrule-like, metal terminal which can be identical to the ferrule-like, metal terminal **40**. The numeral **94** denotes a washer of insulating material which has a central opening **96** therein; and that washer can be identical to the washer **74** in FIG. 4. The numeral **98** denotes a disc-like barrier which has a diameter larger than the inner diameter of the casing **90** but smaller than the inner diameter of the ferrule-like terminal **102**. The numeral **100** denotes an elongated, small-diameter, wire-like, fusible element which has the left-hand end thereof extending through the opening **96** in the washer **94** and then bent outwardly between that washer and the disc-like barrier **98**. That end of that fusible element passes along the left-hand end of the casing **90** and then is bent forwardly along the outer surface of that casing; and that end of that fusible element is held in position, and is electrically engaged by the terminal **102**. The right-hand end of the electric fuse of FIG. 5 can be a mirror-image of the left-hand end of that fuse.

The electrical fuses of FIGS. 4 and 1 resemble the electric fuses of FIGS. 1 and 2 in that they employ washers with centrally-located openings to hold the fusible elements thereof coincident with the geometric axes of the casings thereof. The electric fuses of FIGS. 4 and 5 resemble the electric fuse of FIG. 3 in that they rely upon the resilience of the insulating material of the imperforate barrier thereof to cushion the outwardly-bent end portions of the fusible elements thereof.

The annular grooves, in the exteriors of the casings of the electric fuses shown in the drawing, are necessary where those casings are made of substantially-unyielding

material such as glass melamine. However, where those casings are made from yieldable material such as fibre, those annular grooves are not needed; and the free edges of the ferrule-like, metal terminals of the electric fuses can be rolled or crimped directly into the exteriors of those casings.

In some instances it is desirable to pass the ends of the fusible element through openings in the closed ends of the ferrule-like, metal terminals of an electric fuse and then solder those ends of that fusible element to the outer faces of those closed ends of those terminals. In those instances, the ends of the fusible elements shown in the drawing will be bent around the imperforate barriers of insulating material, will be directed inwardly toward the geometric axes of the casings of the electric fuses, and then will be bent into alignment with those geometric axes to pass through the openings in the closed ends of the ferrule-like, metal terminals.

The barriers of insulating material shown in the drawing will, where they are made of fibre, evolve arc-extinguishing gases when an arc develops. If desired, those barriers of insulating material could be made of paper, cloth, asbestos or the like which has been impregnated with de-ionizing material, so those barriers will evolve de-ionizing vapors and gases when an arc develops.

Whereas the drawing and accompanying description have shown and described several preferred embodiments 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 which comprises:

a casing,

terminals permanently secured to said casing,

a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,

a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,

an elongated, fusible element that is disposed within said casing and that is electrically connected to said terminals,

said fusible element having a total overall length greater than the length of said casing,

said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engagement with said casing and wherein said major portion of the length thereof is engaged only by air,

said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,

said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surfaces of said terminals,

the bends in said fusible element being immediately adjacent said barriers of insulating material and being cushioned by said barriers of insulating material,

said barriers of insulated material and said bends in in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,

whereby said casing can be relatively short.

2. An electric fuse which comprises:

a casing,

terminals permanently secured to said casing,

a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,

a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,

an elongated, fusible element that is disposed within said casing and that is electrically connected to said terminals,

said fusible element having a total overall length greater than the length of said casing,

said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engagement with said casing and wherein said major portion of the length thereof is engaged only by air,

said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,

said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surfaces of said terminals,

the bends in said fusible element being immediately adjacent said barriers of insulating material and being cushioned by said barriers of insulating material,

said barriers of insulating material and said bends in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals, and being fed only by said terminals,

whereby said casing can be relatively short,

the ends of said fusible element being bent around the edges of said barriers of insulating material and being disposed between said inner surfaces of said terminals and those surfaces of said barriers of insulating material which confront said inner surfaces of said terminals.

3. An electric fuse which comprises:

a casing,

terminals permanently secured to said casing,

a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,

a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,

an elongated, fusible element that is disposed within said casing and that is electrically connected to said terminals,

said fusible element having a total overall length greater than the length of said casing,

said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engagement with said casing and wherein said major portion of the length thereof is engaged only by air,

said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,

said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surfaces of said terminals,

the bends in said fusible element being immediately adjacent said barriers of insulating material and being cushioned by said barriers of insulating material,

said barriers of insulating material and said bends in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,

whereby said casing can be relatively short.

the ends of said fusible element being bent around the ends of said casing, and

portions of said barriers of insulating material being disposed between said ends of said fusible elements and said inner surfaces of said terminals to cushion the forces which said terminals apply to said ends of said fusible element.

4. An electric fuse which comprises:
a casing,
terminals permanently secured to said casing,
a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,
a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,
an elongated, fusible element that is disposed within said casing and that is electrically connected to said terminals,
said fusible element having a total overall length greater than the length of said casing,
said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engagement with said casing and wherein said major portion of the length thereof is engaged only by air,
said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,
said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surfaces of said terminals,
the bends in said fusible element being immediately adjacent said barriers of insulating material and being cushioned by said barriers of insulating material,
said barriers of insulating material and said bends in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,
whereby said casing can be relatively short,
said barriers of insulating material being cupshaped,
the cup-like portions of said barriers of insulating material extending inwardly of the ends of said casing, and
annular flanges on said barriers of insulating material which extend outwardly of said cup-like portions of said barriers of insulating material to abut the end faces of said casing.

5. An electric fuse which comprises:
a casing,
terminals permanently secured to said casing,
a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,
a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,
an elongated, fusible element that is disposed within said casing and that is electrically connected to said terminals,
said fusible element having a total overall length greater than the length of said casing,
said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engagement with said casing and wherein said major portion of the length is engaged only by air,
said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,
said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surfaces of said terminals,
the bends in said fusible element being immediately adjacent said barriers of insulating material and

being cushioned by said barriers of insulating material,
said barriers of insulating material and said bends in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,
whereby said casing can be relatively short,
washers of insulating material disposed inwardly of said barriers of insulating material, and
the ends of said fusible element extending through the openings in said washers of insulating material but not extending through said barriers of insulating material.

6. An electric fuse which comprises:
a casing,
terminals permanently secured to said casing,
a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,
a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,
an elongated, fusible element that is disposed within said casing and that is electrically connected to said terminals,
said fusible element having a total overall length greater than the length of said casing,
said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engagement with said casing and wherein said major portion of the length thereof is engaged only by air,
said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,
said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surfaces of said terminals,
the bends in said fusible element being immediately adjacent said barriers of insulating material and being cushioned by said barriers of insulating material,
said barriers of insulating material and said bends in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,
whereby said casing can be relatively short,
washers of insulating material disposed inwardly of said barriers of insulating material, and
said washers having openings therein that are spaced inwardly of the inner surface of said casing and that hold the fusible portion of said fusible element spaced inwardly from the inner surface of said casing.

7. An electric fuse which comprises:
a casing,
terminals permanently secured to said casing,
a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,
a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,
an elongated, fusible element that is disposed within said casing and that is electrically connected to said terminals,
said fusible element having a total overall length greater than the length of said casing,
said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engage-

ment with said casing and wherein said major portion of the length is engaged only by air,
said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,
said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surfaces of said terminals,
the bends in said fusible element being immediately adjacent said barriers of insulating material and being cushioned by said barriers of insulating material,
said barriers of insulating material and said bends in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,
whereby said casing can be relatively short,
washers of insulating material disposed inwardly of said barriers of insulating material,
the ends of said fusible element extending through openings in said washers of insulating material which are adjacent the geometric axis of said casing, and
said openings in said washers of insulating material holding the fusible portion of said fusible element adjacent the geometric axis of said casing.

8. An electric fuse which comprises:
a casing,
terminals permanently secured to said casing,
a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,
a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,
an elongated, fusible element that is disclosed within said casing and that is electrically connected to said terminals,
said fusible element having a total overall length greater than the length of said casing,
said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engagement with said casing and wherein said major portion of the length thereof is engaged only by air,
said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,
said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surfaces of said terminals,
the bends in said fusible element being immediately adjacent said barriers of insulating material and being cushioned by said barriers of insulating material,
said barriers of insulating material and said bends in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,
whereby said casing can be relatively short,
washers of insulating material disposed inwardly of said barriers of insulating material,
said barriers of insulating material being cup-shaped,
said washers of insulating material being cup-shaped,
and the cup-like portions of said washers of insulating material and the cup-like portions of said barriers of insulating material extending inwardly of the ends of said casing.

9. An electric fuse which comprises:
a casing,
terminals on said casing,
a barrier of insulating material disposed within said casing adjacent the inner surface of one of said terminals,
a second barrier of insulating material disposed within said casing adjacent the inner surface of the other of said terminals,
a fusible element that is disposed within said casing and that is electrically connected to said terminals,
said fusible element having a fixed position within said casing,
said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,
said barriers of insulating material keeping any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,
whereby said casing can be relatively short,
washers of insulating material disposed inwardly of said barriers of insulating material,
said washers of insulating material being cup-shaped,
said barriers of insulating material being cup-shaped, and
the cup-like portions of said barriers of insulating material extending into the cup-like portions of said washers of insulating material.

10. An electric fuse which comprises:
a casing,
terminals permanently secured to said casing,
a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,
a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,
an elongated, fusible element that is disposed within said casing and that is electrically connected to said terminals,
said fusible element having a total overall length greater than the length of said casing,
said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engagement with said casing and wherein said major portion of the length thereof is engaged only by air,
said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,
said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surface of said terminals,
the bends in said fusible element being immediately adjacent said barriers of insulating material and being cushioned by said barriers of insulating material,
said barriers of insulating material and said bends in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,
whereby said casing can be relatively short,
washers of insulating material disposed inwardly of said barriers of insulating material, and
the ends of said fusible element being bent outwardly relative to the geometric axis of said casing and extending between confronting surfaces of said washers of insulating material and of said barriers of insulating material until they reach said casing.

11. An electric fuse which comprises:
a casing,
terminals on said casing,
a barrier of insulating material disposed within said casing adjacent the inner surface of one of said terminals,

a second barrier of insulating material disposed within said casing adjacent the inner surface of the other of said terminals,

a fusible element that is disposed within said casing and that is electrically connected to said terminals,

said fusible element having a fixed position within said casing,

said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,

said barriers of insulating material keeping any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,

whereby said casing can be relatively short,

washers of insulating material disposed inwardly of said barriers of insulating material, and

the ends of said fusible element being bent outwardly relative to the geometric axis of said casing and extending between confronting surfaces of said washers of insulating material and of said barriers of insulating material until they reach said casing,

said barriers of insulating material and said washers of insulating material being cup-shaped to provide a plurality of bends in each end of said fusible element.

12. An electric fuse which comprises:

a casing,

terminals permanently secured to said casing,

a barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of one of said terminals,

a second barrier of insulating material disposed within said casing adjacent, but disposed inwardly of, the inner surface of the other of said terminals,

an elongated, fusible element that is disposed within said casing and that is electrically connected to said terminals,

said fusible element having a total overall length greater than the length of said casing,

said fusible element having a fixed position within said casing, wherein the major portion of the length thereof is spaced inwardly of and out of engagement with said casing and wherein said major portion of the length thereof is engaged only by air,

said fixed position of said fusible element within said casing enabling said fusible element to have a predictable rate of radiation of heat to said casing,

said barriers of insulating material being imperforate to said fusible element and being interposed between said inner surfaces of said terminals and said major portion of the length of said fusible element, and said fusible element being bent to reach said inner surfaces of said terminals,

the bends in said fusible element being immediately adjacent said barriers of insulating material and being cushioned by said barriers of insulating material,

said barriers of insulating material and said bends in said fusible element coacting to keep any arc, which may develop as said fusible element fuses, from extending to and being fed by said terminals,

whereby said casing can be relatively short,

washers of insulating material disposed inwardly of said barriers of insulating material, and

said washers of insulating material being cup-shaped, the closed ends of said cup-shaped washers having centrally-located openings therein to accommodate the ends of said fusible element and to thereby hold the fusible portion of said fusible element adjacent the geometric axis of said casing.

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