

April 12, 1966

A. URANI

3,246,105

PROTECTOR FOR ELECTRIC CIRCUITS

Filed Feb. 6, 1963

2 Sheets-Sheet 1

FIG. 1.

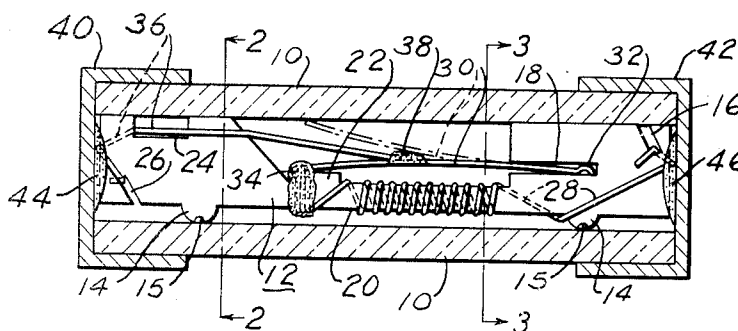


FIG. 2.

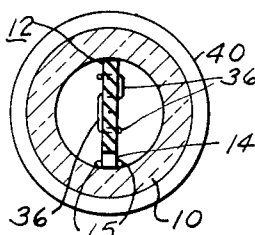


FIG. 4.

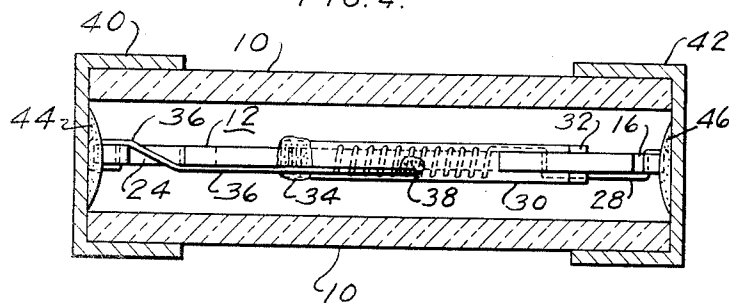


FIG. 3.

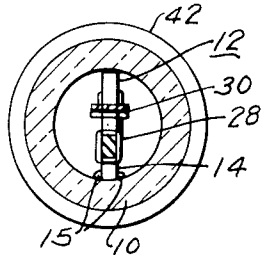


FIG. 5.

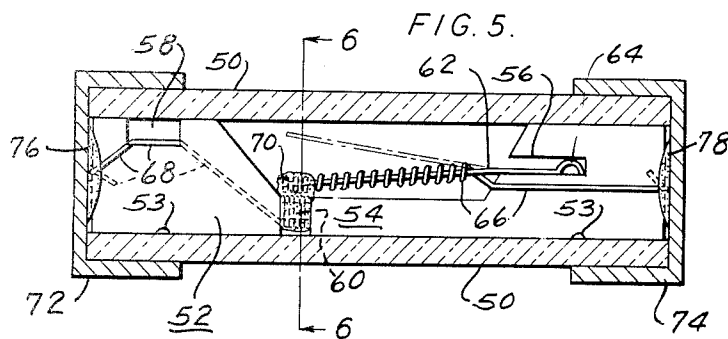
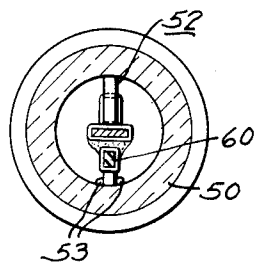


FIG. 6.



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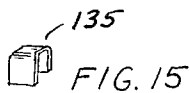
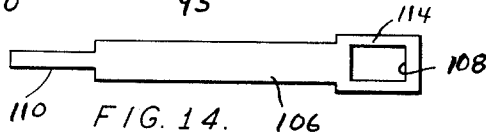
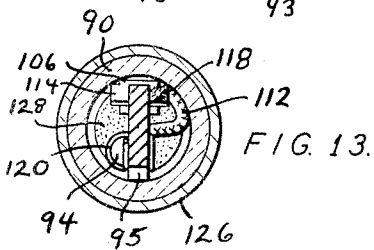
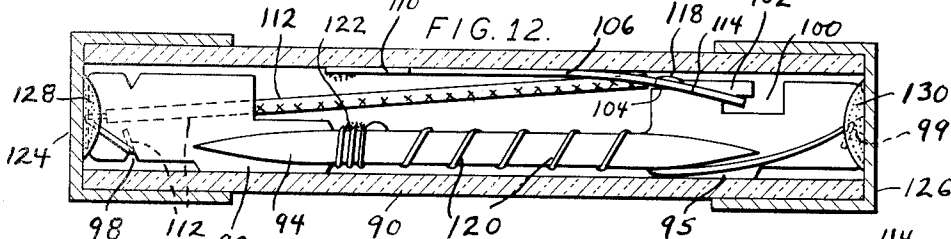
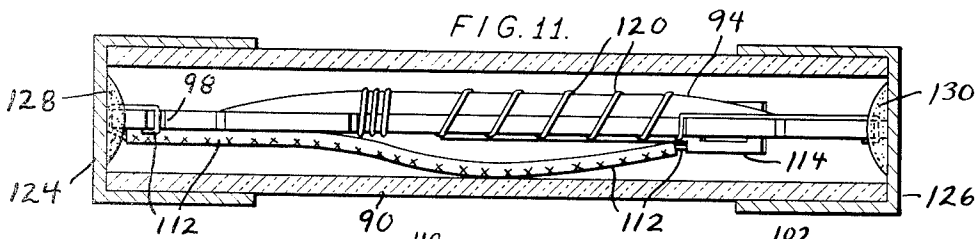
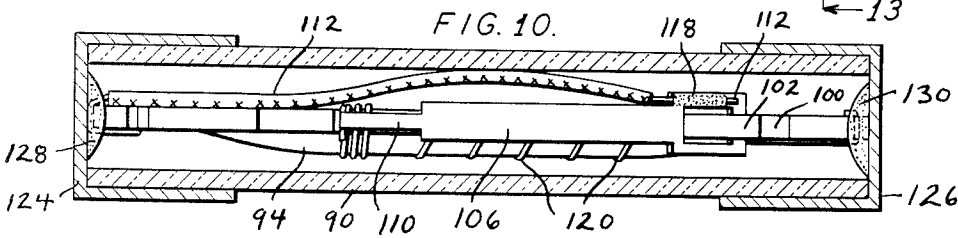
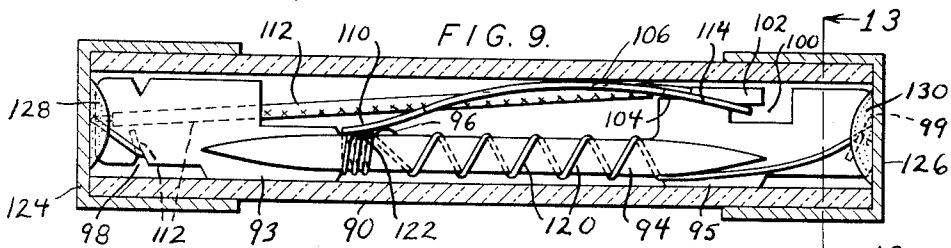
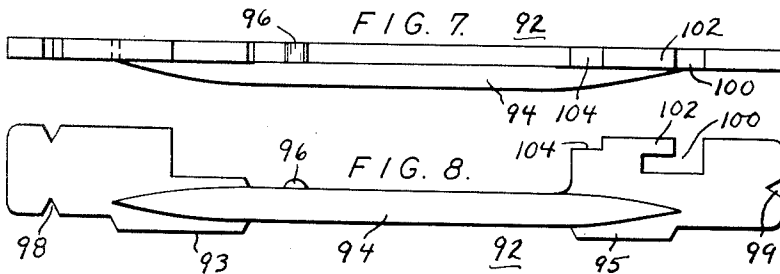
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2 Sheets-Sheet 2



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PROTECTOR FOR ELECTRIC CIRCUITS

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Filed Feb. 6, 1963, Ser. No. 256,766
15 Claims. (Cl. 200—123)

This invention relates to improvements in electric fuses. It is, therefore, an object of the present invention to provide an improved electric fuse.

Electric fuses frequently must be used in installations where they can be subjected to shock or to vibration; and, in some installations, electric fuses can be subjected to extremely heavy shock and vibration. Where electric fuses are large, they are usually strong enough to withstand extremely heavy shock and vibration; but where electric fuses are small, they may not be strong enough to withstand extremely heavy shock and vibration—particularly where those electric fuses are of the dual-element type. Some small, dual-element, electric fuses are so adversely affected by shock and vibration that they can break down and prematurely open the circuit; and, as a result, those electric fuses should not be used in installations where they could be subjected to extremely heavy shock or vibration. It would be desirable to provide a small, dual-element, electric fuse that was strongly resistant to shock and to vibration; because such an electric fuse could be used in installations wherein it could be subjected to extremely heavy shock and vibration. The present invention provides such a small, dual-element, electric fuse; and it is, therefore, an object of the present invention to provide a small, dual-element, electric fuse that is strongly resistant to shock and vibration.

The small, dual-element, electric fuse provided by the present invention has a mounting which can be telescoped within the casing of that electric fuse and which can support the various components of that electric fuse. That mounting can be made sturdy and strong; and that mounting can support the components of the electric fuse so fully and so solidly that the electric fuse can readily withstand extremely heavy shocks and vibration. It is, therefore, an object of the present invention to provide a small, dual-element, electric fuse that has a sturdy and strong mounting which can support the components of that electric fuse.

The mounting for the small, dual-element, electric fuse provided by the present invention is also desirable because it enables the various components of that electric fuse to be interconnected to form a complete sub-assembly which can be fabricated, checked, and tested before it is telescoped within the casing for that electric fuse. Such a sub-assembly can be fabricated quickly and with precision; and it can be checked and tested quickly and with precision. As a result, the small, dual-element electric fuse provided by the present invention can be fabricated, checked, and tested quickly and with precision. It is, therefore, an object of the present invention to provide a small, dual-element, electric fuse wherein the various components can be supported on a mounting and can be interconnected to form a complete sub-assembly which can be fabricated, checked, and tested before it is telescoped within the casing of that electric fuse.

The small, dual-element, electric fuse provided by the present invention has a spring; and that spring and the mounting for that electric fuse are formed with interacting surfaces. Those interacting surfaces force part of that spring to be bent as it is assembled with that mount-

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ing; and those interacting surfaces thereafter respond to the restorative forces within that spring to maintain that spring and that mounting in assembled relation. Furthermore, those interacting surfaces are formed so that spring can be assembled with the mounting without any need of tools. It is, therefore, an object of the present invention to provide a small, dual-element, electric fuse with a spring and a mounting that have interacting surfaces thereon which can maintain that spring and that mounting in assembled relation and which permit that spring to be assembled with that mounting without any need of tools.

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, three 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 vertical sectional view through one preferred form of small, dual-element, electric fuse that is made in accordance with the principles and teachings of the present invention,

FIG. 2 is a sectional view through the electric fuse of FIG. 1, and it is taken along the plane indicated by the line 2—2 in FIG. 1,

FIG. 3 is another sectional view through the electric fuse of FIG. 1, it is taken along the plane indicated by the line 3—3 show in FIG. 1,

FIG. 4 is a horizontal sectional view through the electric fuse of FIG. 1,

FIG. 5 is a vertical sectional view through a second preferred form of small, dual-element electric fuse that is made in accordance with the principles and teachings of the present invention,

FIG. 6 is a sectional view through the electric fuse of FIG. 5, and it is taken along the plane indicated by the line 6—6 in FIG. 5,

FIG. 7 is a plan view of the mounting used in a third preferred form of small, dual-element, electric fuse that is made in accordance with the principles and teachings of the present invention,

FIG. 8 is a side elevational view of the mounting of FIG. 7,

FIG. 9 is a vertical sectional view through the electric fuse in which the mounting of FIGS. 7 and 8 is used,

FIG. 10 is a horizontal sectional view through the electric fuse of FIG. 9,

FIG. 11 is a bottom sectional view through the electric fuse of FIG. 9,

FIG. 12 is a vertical sectional view which is similar to the view of FIG. 9 but it shows the spring in its moved position,

FIG. 13 is another sectional view through the electric fuse of FIG. 9, and it is taken along the plane indicated by the line 13—13 in FIG. 9,

FIG. 14 is a plan view of the spring used in the electric fuse of FIG. 9, and FIG. 15, is a perspective view of a heat-absorbing member that could be used in the electric fuses of FIGS. 1, 5 and 9.

Referring to FIGS. 1—4 in details, the numeral 10 denotes the casing of one preferred form of small, dual-element, electric fuse that is made in accordance with the principles and teachings of the present invention. That casing will be made of insulating material; and it can be

made of glass. The numeral 12 denotes a mounting of insulating material; and that mounting is made thick enough to be sturdy and strong. That mounting can be made of fiber, of laminated plastic, or the like. That mounting has protuberances 14 at the bottom thereof; and those protuberances have small projections 15 on them. Those projections will engage one part of the interior of the casing 10 and will force the top of the mounting 12 into engagement with the opposite part of the interior of that casing. The projections 15 are made so they are yieldable; and they are dimensioned so that total distance from the top of the mounting 12 to the bottom of either of the projections 15 is slightly greater than the average inner diameter of the casing 10. With such an arrangement, the projections 15 will yield as the mounting 12 is telescoped within the casing 10, but will thereafter urge the top of that mounting against the interior of that casing. In this way, the support 12 will hold itself against shifting axially or radially relative to the casing 10.

If the mounting 12 is made of ceramic material, glass melamine, or the like, the projections 15 will be deleted; and the bottom faces of the protuberances 14 will be coated with rubber or some other resilient material. That rubber or other resilient material will provide the forces which are needed to hold the top of the mounting 12 in engagement with the interior of the casing 10.

The numeral 16 denotes a notch which is formed in the upper edge of the mounting 12 adjacent the right-hand end of that mounting, as that mounting is viewed in FIGS. 1 and 4. As indicated particularly by FIG. 1, the notch 16 inclines downwardly from upper left to lower right; and that notch is relatively short. A horizontally-directed slot 18 is formed in the mounting 12; and that slot opens to an open area which overlies a reduced-width portion 20 of the mounting 12. The width and thickness of the reduced-width portion 20 are large enough to make the mounting 12 sturdy and strong, but the width of the portion 20 is materially smaller than that of the rest of that mounting. As indicated particularly by FIG. 1, the slot 18 is spaced a short distance above the top edge of the reduced-width portion 20.

A short projection 22 extends vertically upwardly from the top edge of the reduced width portion 20 of the mounting 12. That projection is close to, but is spaced a short distance from, the left-hand end of the reduced-width portion 20, as that reduced-width portion is viewed in FIG. 1. That projection subdivides the reduced-width portion 20 into an elongated section and a short section.

A generally rectangular notch 24 is provided in the upper edge of the mounting 12 adjacent the left-hand end of that mounting, as that mounting is viewed in FIGS. 1 and 4. That notch is shallow, and it is spaced from the left-hand end of the mounting 12.

A notch 26 is provided in the mounting 12 adjacent the left-hand end of that mounting, as that mounting is viewed in FIG. 1. That notch projects upwardly from the bottom edge of that mounting; and that notch inclines upwardly from lower right to upper left. As indicated particularly by FIG. 1, the lower end of the notch 26 underlies the left-hand end of the notch 24 in the mounting 12.

The mounting 12 is dimensioned so it is slightly shorter than the casing 10. As a result, when the mounting 12 is centered within the casing 10, there will be small spaces between the ends of that mounting and the planes defined by the ends of that casing.

Resistance wire 28 has one end thereof passed through the notch 16, at the right-hand end of the mounting 12, and then bent over against the front face of that mounting to prevent accidental separation of that end from that notch. That resistance wire inclines downwardly toward, and is then bent around, the right-hand end of the mounting 12. That resistance wire then extends forwardly and downwardly along the front face of the mounting 12 until

it passes beyond the left-hand edge of the right-hand protuberance 14. Thereafter, that resistance wire passes under the bottom edge of the mounting 12 and inclines forwardly and upwardly along the rear face of that mounting toward the right-hand end of the reduced-width portion 20 of that mounting. That resistance wire is then recurrently wound in helical fashion around the elongated section of the reduced-width portion 20 of the mounting 12. As the resistance wire 28 approaches the right-hand edge of the projection 22, it extends forwardly and downwardly along the front face of the mounting 12 until it is generally in register with the left-hand edge of that projection; and then that resistance wire is recurrently wound around the short section of the reduced-width portion 20 of the mounting 12.

The portion of the resistance wire 28 which is recurrently wound around the elongated section of the reduced-width portion 20 of the mounting 12 preferably has the turns thereof spaced apart so they do not engage each other. With such an arrangement, the resistance wire 28 can be bare; and bare wire is preferably to insulated wire because it is less expensive, it does not have to have the ends thereof stripped of insulation, and it can radiate heat more rapidly. The portion of the resistance wire 28 which is recurrently wound around the short section of the reduced-width portion 20 of the mounting 12 preferably has the turns thereof close to, or even touching, each other. With such an arrangement, those turns can readily serve as an internal contact for the electric fuse of FIG. 1.

In some instances, the resistance wire 28 must be so long that it cannot have the turns, of the portion thereof which is recurrently wound around the elongated section of the reduced-width portion 20 of the mounting 12, spaced apart; and, instead, must have at least some of those turns touching each other. Where that is the case, that resistance wire must have the portion thereof which is recurrently wound around the elongated section of the reduced-width portion 20 of the mounting 12 suitably insulated. However, the rest of that resistance wire could, and should, be bare.

The numeral 30 denotes an elongated, metal, leaf spring which has a generally semicylindrical bend 32 in one end thereof; and that bend is formed so its normal height is greater than the width of the slot 18. As a result, the bend 32 must be stressed as it is pressed into the slot 18. That stressing of the bend 32 is desirable, because it will develop restorative forces within that bend which will be large enough to hold the spring 30 within the slot 18 and to prevent accidental dislodgment of that spring from that slot.

The free end of the spring 30 extends in cantilever-like fashion toward the left-hand end of the mounting 12, as that mounting is viewed in FIG. 1. That free end is biased for movement toward a position which is above the dotted line position shown in FIG. 1; but that free end will normally be held in the solid line position shown in FIG. 1 by a mass 34 of low melting point solder. That mass is bonded to the free end of the spring 30 and is also bonded to that portion of the resistance wire 28 which is wound around the short section of the reduced-width portion 20 of the mounting 12. The mass 34 of low melting point solder will hold the free end of the spring 30 in electrically conducting relation with the resistance wire 28 as long as the current flowing through the electric fuse of FIG. 1 does not exceed the rating of that electric fuse. However, if the current flowing through the electric fuse of FIG. 1 exceeds the rating of that electric fuse by a predetermined amount and for a predetermined length of time, the mass 34 will soften and will release the free end of the spring 30 and permit that free end to move upwardly from the solid line position to the dotted line position in FIG. 1.

The numeral 36 denotes an elongated fusible conductor that has the left-hand end thereof passed through the

notch 26, in the left-hand end of the mounting 12, and then bent over to prevent accidental separation of that end of that fusible conductor from that end of that mounting. The conductor 36 inclines upwardly and to the left along the front face of the mounting 12 until that conductor reaches, and is bent around, the left-hand end of that mounting; and then that fusible conductor inclines upwardly and to the right along the rear face of the mounting 12 until it reaches, and passes forwardly through, the notch 24. That conductor then extends along the front face of the mounting 12 until it reaches the open area above the reduced-width portion 20 of that mounting; and thereafter that fusible conductor extends to a point on the spring 30 which is intermediate the ends of that spring. That fusible conductor is permanently bonded to the spring 30 at that point by a mass 38 of high melting point solder.

The fusible conductor 36 is shown as a conductor of constant cross section; and that cross section can be circular, triangular, rectangular, or irregular. Further, that conductor could, if desired, be made of varying cross section, and it could, if desired, be made with a "weak spot" therein.

The resistance wire 28, the spring 30 and the fusible conductor 36 can be readily secured to the mounting 12; and that mounting will solidly support that resistance wire, will solidly support the right-hand end of the spring 30, and will solidly support most of the length of the fusible conductor 36. The mass 34 of low-melting point solder and the portion of the resistance wire 28 which is recurrently wound around the short section of the reduced-width portion 20 of the mounting 12 will coat with the mounting 12 to solidly support the left-hand end of the spring 30; and the mass 38 of high melting point solder will enable the spring 30 to solidly support the right-hand end of the fusible conductor 36. As a result, all of the components of the electric fuse of FIG. 1 will be solidly supported on the mounting 12. That mounting, in turn, will be solidly supported within the casing 10; and hence all of the components of the electric fuse of FIG. 1 will be solidly supported within that casing. This means that the electric fuse of FIG. 1 will be able to withstand extremely heavy shock and vibration.

The resistance wire 28 can be wound onto the mounting 12, the bend 32 of the spring 30 can be telescoped into the notch 18, the fusible conductor 36 can be secured to the mounting 12, the right-hand end of that fusible conductor can be secured to the spring 30 by the mass 38, and the left-hand end of the spring 30 can be soldered to the portion of the resistance wire 28 which is recurrently wound around the short section of the reduced-width portion of the mounting 12 before that mounting is telescoped into the casing 10. This is desirable because it greatly facilitates the assembling of the various components of the electric fuse with the mounting 12. Also, this is desirable because it facilitates prompt and precise checking and testing of those components.

The mounting 12, the resistance wire 28, the spring 30, the mass 34, the fusible conductor 36, and the mass 38 constitute a rugged and sturdy subassembly which can be readily handled without injuring any portion thereof. That subassembly can be aligned with the geometric axis of the casing 10, and then telescoped into position within that casing. If the protuberances 14 on the mounting 12 are equipped with projections 15, those projections will yield as that mounting is telescoped within that casing; and those projections will thereafter hold the top edge of the mounting 12 in intimate engagement with the interior of the casing 10. If the protuberances 14 on the mounting 12 are not equipped with projections 15 but, instead, have resilient coatings thereon, those coatings will yield as that mounting is telescoped within that casing; and those coatings will thereafter hold the top edge of the mounting 12 in intimate engagement with the interior of the casing 10. As a result, the subassembly will,

after it has been telescoped within the casing 10, be held against axial or radial movement relative to that casing.

The numeral 40 denotes one of the terminals for the electric fuse of FIG. 1, and the numeral 42 denotes the other terminal for that electric fuse; and those terminals are shown as ferrules. A mass of high melting point solder 44 is provided within the interior of the terminal 40 to bond that terminal to the fusible conductor 36; and a mass 46 of high melting point solder is provided within the interior of the terminal 42 to bond that terminal to the resistance wire 28. In bonding the mass 44 of solder to the fusible conductor 36, the electric fuse is set so it rests upon the terminal 40 and it is heated until the mass 44 flows and bonds to the interior of the terminal 40 and to the fusible conductor 36. In bonding the mass 46 of solder to the resistance wire 28, the electric fuse is set so it rests upon the terminal 42 and it is heated until the mass 46 flows and bonds to the interior of the terminal 42 and to the resistance wire 28.

The terminals 40 and 42 can be connected into a circuit by fuse clips or fuse holder of standard design. Under normal conditions of operation, the current supplied to the terminal 40 will pass through the mass 44 of solder to the fusible conductor 36, through the mass 38 of solder, through the left-hand end of the spring 30, through the mass 34 of solder, through the resistance wire 28 to the mass 46 of solder, and then to the terminal 42. As that current passes through the fusible conductor 36 and through the resistance wire 28, that current will cause that fusible conductor and that resistance wire to generate heat. As the current passes through the left-hand end of the spring 30, that current will generate substantially no heat, because the cross section of that spring is materially greater than the cross sections of the fusible conductor 36 or of the resistance wire 28.

Although heat will be generated by the fusible conductor 36 and by the resistance wire 28, whenever current flows through the electric fuse of FIG. 1, the heat that will be generated, as long as that current does not exceed the rating of that electric fuse, will not be great enough to cause the mass of solder 34 to release the free end of the spring 30. Consequently, the electric fuse of FIG. 1 will be able to carry its rated current continuously.

If a short circuit or a very heavy overload is applied to the circuit, which is being protected by the electric fuse of FIG. 1, the current passing through the fusible conductor 36 will promptly heat part of that fusible conductor to its melting temperature; and, thereupon, that fusible conductor will fuse. In fusing, that fusible conductor will prevent further passage of current through the electric fuse of FIG. 1, and will thereby protect the circuit from injury.

If an overload of predetermined value is applied to the circuit, which is being protected by the electric fuse of FIG. 1, the current passing through the resistance wire 28 and the fusible conductor 36 will cause that resistance wire and that fusible conductor to generate greater-than-normal amounts of heat. Some of that heat will be absorbed by the terminals 40 and 42, other of that heat will be absorbed by the mounting 12, still other of that heat will be radiated into the air within the casing 10, and yet other of that heat will be absorbed by the spring 30 and the solder masses 34 and 38. The absorption of heat by these various components and the radiation of heat into the air are desirable because they avoid premature softening of the solder mass 34. However, if the said overload is large enough, and if it continues for a predetermined length of time, the amount of heat supplied to the solder mass 34 will be great enough to cause that solder mass to soften and release the free end of the spring 30. That free end will then move to the dotted-line position of FIG. 1 and thereby halt further flow of current through the circuit being protected by the electric fuse of FIG. 1. If an electric arc tends to form between the released free end of the spring 30 and the

contact, constituted by the portion of the resistance wire 28 which is wound upon the short section of the reduced-width portion 20 of the mounting 12, that arc will become extinguished as that free end moves to the dotted line position of FIG. 1. As the free end of the spring 30 moves upwardly, the fusible conductor 36 will flex freely and thereby offer substantially no resistance to that upward movement.

The cross section, and hence the thermal mass, of the fusible conductor 36 will be largely dictated by the short circuit characteristics desired for the electric fuse of FIG. 1. As a result, the cross section of that fusible conductor cannot be varied to vary the time required for the solder mass 34 to reach its softening temperature. However, the cross sections of the spring 30, of the resistance wire 28, and of the solder masses 34 and 38 can be varied to vary the thermal masses of those components—the length of the resistance wire 28 being balanced against the cross section of that resistance wire to enable that resistance wire to generate the desired amounts of heat. In providing an electric fuse wherein the cross sections of the spring, of the resistance wire, and of the solder masses can be varied to vary the thermal masses of those components, the present invention makes it possible to provide desirable time delays in the softening of the solder mass 34.

Referring to FIGS. 5 and 6 in detail, the numeral 50 denotes a casing for a second preferred form of small, dual-element, electric fuse that is made in accordance with the principles and teachings of the present invention. That casing will be made of insulating material; and it can be made of glass. The numeral 52 denotes a mounting of insulating material; and that mounting is made thick enough to be sturdy and strong. That mounting can be made of fiber, of laminated plastic, or the like. That mounting has projections 53 at the bottom thereof; and those projections will be similar to, and will perform the functions performed by, the projections 15 of FIG. 1. The projections 53 are made so they are yieldable; and they are dimensioned so the total distance from the top of the mounting 52 to the bottom of either of the projections 53 is slightly greater than the average inner diameter of the casing 50. With such an arrangement, the projections 53 will yield as the mounting 52 is telescoped within the casing 50, but will thereafter urge the top of that mounting against the interior of that casing.

If the mounting 52 is made of ceramic material, glass melamine, or the like, the projections 53 will be deleted; and small quantities of rubber or some other resilient material will be affixed to the bottom edge of that mounting. That rubber or other resilient material will provide the forces which are needed to hold the top of the mounting 52 in engagement with the interior of the casing 50.

The mounting 52 has a reduced-width portion 54 intermediate the ends thereof; and that reduced-width portion has a section 60 of even smaller width. The section 60 is adjacent the left-hand end of the reduced-width portion 54, as that reduced-width portion is viewed in FIG. 5. A horizontally-directed slot 56 is formed in the mounting 52 adjacent the right-hand end of that mounting; and that slot opens to the open space above the level of the reduced-width portion 54 of the mounting 52. The slot 56 is similar to, and performs the functions of, the slot 18 in FIG. 1.

A generally rectangular notch 58 is provided in the mounting 52 adjacent the left-hand end of that mounting; and that notch is formed in the top edge of that mounting. That notch is shallow; and it is spaced from the left-hand end of the mounting 52. That notch is similar to, and performs the functions of, the notch 24 in FIG. 1.

The numeral 62 denotes a leaf-type spring which is made of glass melamine; and that spring is formed with a generally semicylindrical bend 64 in the right-hand end thereof. That bend is formed so its normal height is

greater than the width of the slot 56 in the mounting 52. As a result, the bend 64 must be stressed as it is pressed into the slot 56. That stressing of that bend is desirable because it will develop restorative forces within that bend which will be large enough to hold the spring 62 within the slot 56 and to prevent accidental dislodgment of that spring from that slot.

The free end of the spring 62 extends in cantilever-like fashion toward the left-hand end of the mounting 52, as that mounting is viewed in FIG. 5. That free end is biased for movement toward a position which is above the dotted line position shown in FIG. 5; but that free end will normally be held in the solid-line position shown in FIG. 5 by a mass 70 of low melting point solder.

Resistance wire 66 has one end thereof bent around the right-hand end of the mounting 52; and that resistance wire passes along the front face of the mounting 52 until it reaches the portion of that mounting which inclines downwardly and to the left of the reduced-width portion 54 of that mounting. That resistance wire is then recurrently wound around the spring 62 in generally helical fashion. Where possible, most of the turns of the resistance wire 66 will be spaced apart so they do not touch each other; but the turns of that resistance wire which are wound on the free end of the spring 62 are close to, and may touch, each other.

Where most of the turns of the resistance wire 66 can be spaced apart, that resistance wire can be bare—because the mounting 52 and the spring 62 are made of insulating materials. However, where that resistance wire is too long to have most of the turns thereof spaced apart, those turns should be suitably insulated. However, the turns of resistance wire 66 which are wound onto the free end of the spring 62 should be bare and should touch each other.

The numeral 68 denotes the fusible conductor for the electric fuse of FIG. 5; and that fusible conductor is elongated. The conductor 68 is shown as a conductor of constant cross section; and that cross section can be circular, triangular, rectangular, or irregular. Further, that conductor could, if desired, be made of varying cross section, and it could, if desired, be made with a weak spot therein.

The left-hand end of the fusible conductor 68 is bent around the left-hand end of the mounting 52; and that fusible conductor then inclines upwardly and to the right to enter and pass forwardly through the notch 58 in that mounting. That fusible conductor then inclines downwardly and to the right along the rear face of the mounting 52 to the section 60 of the reduced-width portion 54 of the mounting 52. That fusible conductor is then wound tightly in helical fashion about the section 60.

This means that there is a tightly-wound helix of the fusible conductor 68 on the section 60 of the mounting 52, and that there is a tightly-wound helix of the resistance wire 66 on the free end of the spring 62. Those tightly-wound helices are in vertical registry; and they are normally held in electrically-conducting relation by the mass 70 of low melting point solder.

The mounting 52, the spring 62, the resistance wire 66, the fusible conductor 68, and the mass 70 of solder constitute a sub-assembly. The mounting 52 will solidly support the right-hand end of the spring 62, will solidly support the fusible conductor 68, and will solidly support the right-hand end of the resistance wire 66, and the spring 62 and the mass 70 of solder will solidly support the rest of the resistance wire 66. As a result, all of the components of the electric fuse of FIG. 5 will be solidly supported on the mounting 52. That mounting, in turn, will be solidly supported within the casing 50; and hence all of the components of the electric fuse of FIG. 5 will be solidly supported within that casing. This means that the electric fuse of FIG. 5 will be able to withstand heavy shock and vibration.

The fusible conductor 68 can be wound onto the mount-

ing 52, the left-hand end of the resistance wire 66 can be wound onto the spring 62, the bend 64 of that spring can be telescoped into the slot 56, the right-hand end of that resistance wire can be held against the mounting 52, and the mass 70 of solder can bond the resistance wire 66 to the fusible conductor 68 before the mounting 52 is telescoped into the casing 50. This is desirable because it greatly facilitates the assembling of the various components of the electric fuse of FIG. 5. Also, this is desirable because it facilitates prompt and precise checking and testing of those components.

The mounting 52, the resistance wire 66, the spring 62, the fusible conductor 68, and the mass 70 of solder constitute a rugged and sturdy sub-assembly which can be readily handled without injuring any portion thereof. That sub-assembly can be aligned with the geometric axis of the casing 50, and then telescoped into position within that casing. The rubber or other resilient material on the bottom edge of the mounting 52 will yield as that mounting is telescoped into that casing; but will thereafter hold the top edge of that mounting in intimate engagement with the interior of that casing. As a result, the sub-assembly will, after it has been telescoped within the casing 50, be held against axial or radial movement relative to that casing.

The numeral 72 denotes one of the terminals for the electric fuse of FIG. 5, and the numeral 74 denotes the other terminal for that electric fuse; and those terminals are shown as ferrules. Masses of solder 76 and 78 bond the terminals 72 and 74 to the fusible conductor 68 and to the resistance wire 66, respectively.

The terminals 72 and 74 can be connected into a circuit by fuse clips or a fuse holder of standard design. Normally, the mass 70 of low melting point solder maintains the resistance wire 66 in electrically-conducting relations with the fusible conductor 68, and normally holds the left-hand end of the spring 62 in the position shown by solid lines in FIG. 5. However, in the event the circuit protected by the electric fuse of FIG. 5 is subjected to an overload of sufficient magnitude and of sufficient duration, the mass 70 of solder will be heated sufficiently by the fusible conductor 68 and the resistance wire 66 to soften and release the free end of the spring 62. Thereupon that spring will move upwardly to the dotted-line position shown in FIG. 5 and will interrupt the circuit. In doing so, that spring will protect that circuit from injury.

If a short circuit or a heavy overload occurs, part of the fusible conductor 68 will be heated to its melting temperature. That portion will promptly fuse and open the circuit, and thereby protect that circuit against injury.

By making the spring 62 of glass melamine, the form of invention shown in FIG. 5 makes it possible to wind bare resistance wire directly on the spring. Further, by making that spring of glass melamine, that form of the invention completely frees the spring of all need of carrying current.

Referring to FIGS. 7-14 in detail, the numeral 90 denotes the casing of a third preferred form of small, dual-element, electric fuse that is made in accordance with the principles and teachings of the present invention. That casing will be made of insulating material; and it can be made of glass. The numeral 92 denotes a mounting of insulating material; and that support is preferably made from a material which is sturdy, which has a low thermal coefficient of expansion, and which is substantially insensitive to heat and to flame. One material that has been found to be very useful is steatite.

The mounting 92 has two elongated protuberances 93 and 95 thereon, at the bottom edge thereof, and those protuberances can abut the interior of the casing 90. The central portion 94 of the mounting 92 is D-shaped in cross section—that central portion having one face thereof plane and flush with one face of that mounting, having the upper and lower faces thereof extending at right angles to that one face, and having the remaining face thereof

of semicircular configuration. The ends of the said remaining face of the D-shaped portion 94 taper into the opposite face of the mounting 92, and those ends are generally conical in configuration. The D-shaped configuration for the portion 94 of the mounting 92 is desirable because it makes that portion sturdy and strong while permitting that portion to have a reduced width.

A small protuberance 96 is formed on the upper face of the D-shaped portion 94 of the mounting 92, and that protuberance is spaced a short distance from the protuberance 93, as shown by FIGS. 9 and 12. A notch 98 is formed in the mounting 92, and that notch is disposed to the left of the protuberance 93, as that notch and protuberance are viewed in FIGS. 9 and 12. A J-shaped notch 100 is formed in the mounting 92 at a point above the protuberance 95; and that notch helps define an ear 102. A fulcrum 104 is formed on the mounting 92 at a point which is disposed to the left of the ear 102, as that fulcrum and ear are viewed in FIGS. 9 and 12. A generally V-shaped notch 99 is formed in the right-hand end of the mounting 92. The overall length of the mounting 92 is slightly less than the overall length of the casing 90; and hence a small space is provided between the ends of that mounting and planes defined by the ends of that casing.

The numeral 106 denotes an elongated, metal, leaf spring with a wide end 114 and with a narrow end 110. An opening 108 is provided in the wide end 114; and that opening is dimensioned so it can be telescoped over the ear 102, and so it can permit that portion of the end 114 which defines the left-hand end of the opening 108 to rest upon the fulcrum 104. The end 110 of the spring 106 extends in cantilever-like fashion toward the left-hand end of the mounting 92, as that mounting is viewed in FIGS. 9-12. Whenever the opening 108 is hooked over the ear 102 on the mounting 92, the end 110 of that spring will be biased toward a position above the position shown by FIG. 12. The end 114 and the opening 108 of the spring 106, and the ear 102 and the J-shaped notch 100 of the mounting 92 are formed so that spring and that mounting can be assembled without any need of tools.

The numeral 112 denotes a fusible conductor which has the left-hand end thereof bent around the left-hand end of the mounting 92 and then bent around the notch 98. The right-hand end of the fusible conductor 112 is suitably secured to the end 114 of the spring 106 adjacent the opening 108, as by a mass 118 of high-melting point solder.

The fusible conductor 112 has bare ends, but has the rest thereof suitably coated by, or encased within, insulating material.

Resistance wire 120 has one end thereof hooked within the notch 99 in the right-hand end of the mounting 92. That resistance wire then extends toward, and is recurrently wound around, the D-shaped portion 94 of the mounting 92; and it has the left-hand end thereof wound so that the turns thereof are close to, or even touching, each other. That left-hand end of the resistance wire 120 is disposed between the protuberances 93 and 96. Where the length of the resistance wire 120 is short enough so the various turns thereof, between the protuberances 96 and 95, can be spaced apart, that resistance wire can be bare throughout its length. However, where the length of the resistance wire 120 is so great that the various turns thereof, between the protuberances 96 and 95, must touch or overlap each other, that resistance wire should have the portions thereof intermediate the ends thereof encased within or coated by insulating material.

The turns of the resistance wire 120 which are intermediate the protuberances 93 and 96 underlie the end 110 of the spring 106. A mass 122 of low melting point solder normally holds the end 110 of the spring 106 in electrically-conducting relation with the left-hand end of the resistance wire 120. However, when that mass of solder is heated to a predetermined temperature, it will

permit the spring 106 to move the end 110 thereof away from the left-hand end of the resistance wire 120. It will be noted that the portion of the spring 106 which is intermediate the ends 110 and 114 extends above the level of the top edge of the mounting 92.

The fusible conductor 112, the spring 106, and the resistance wire 120 can be readily secured to the mounting 92; and that mounting will solidly support that resistance wire, will solidly support the right-hand end of the spring 106, and will solidly support the left-hand end of the fusible conductor 112. The mass 122 of low melting point solder and the turns of the resistance wire 120 which are intermediate the protuberances 93 and 96 will coact with the mounting 92 to solidly support the left-hand end of the spring 106; and the mass 118 of high melting point solder will enable the spring 106 to solidly support the right-hand end of the fusible conductor 112. As a result, all of the components of the electric fuse of FIG. 9 will be solidly supported on the mounting 92. That mounting, in turn, will be solidly supported within the casing 90; and hence all of the components of the electric fuse of FIG. 9 will be solidly supported within that casing. This means that the electric fuse of FIG. 9 will be able to withstand heavy shock and vibration.

The resistance wire 120 can be wound onto the mounting 92, the spring 106 can have the opening 103 therein hooked onto the ear 102, and the fusible conductor 112 can have the left-hand end thereof hooked within the notch 93 and can have the right-hand end thereof soldered to the end 114 of the spring 106, and the mass 122 of low melting point solder can bond the end 110 of that spring in the position shown by FIG. 9 before that mounting is telescoped within the casing 90. This is desirable because it greatly facilitates the assembling of the various components of the electric fuse with the mounting 92. Also, this is desirable because it facilitates prompt and precise checking and testing of those components.

The mounting 92, the spring 106, the fusible conductor 112, the resistance wire 120, and the solder masses 118 and 122 constitute a rugged and sturdy sub-assembly which can be readily handled without injuring any portion thereof. That sub-assembly can be aligned with the geometric axis of the casing 90, and then telescoped into position within that casing. The portion of the spring 106 which is intermediate the ends 110 and 114 will intimately engage the interior of that casing and will resiliently hold the protuberances 93 and 95 in engagement with that interior. As a result, the sub-assembly will, after it has been telescoped within the casing 90, be held against axial or radial movement relative to that casing.

The numeral 124 denotes one of the terminals for the electric fuse of FIG. 9, and the numeral 126 denotes the other terminal for that electric fuse; and those terminals are shown as ferrules. A mass 128 of high melting point solder is used to bond the terminal 124 to the left-hand end of the fusible conductor 112. A mass 130 of high melting point solder is used to bond the terminal 126 to the right-hand end of the resistance wire 120.

The terminals 124 and 126 can be connected into an electric circuit by fuse clips or a fuseholder of standard design. Normally, current will flow from the terminal 124 via solder mass 128, fusible conductor 112, solder mass 118, spring 106, solder mass 122, resistance wire 120, solder mass 130, and terminal 126. As long as that current does not exceed the rating of the electric fuse of FIG. 9, that electric fuse will be able to carry that current continuously.

In the event the current flowing through the electric fuse of FIG. 9 exceeds the rated current of that electric fuse by a predetermined amount and for a predetermined length of time, the heat generated by the resistance wire 120 and by the fusible conductor 112 will raise the temperature of the mass 122 of low melting point solder to a value at which that mass will be unable to withstand

the forces applied to it by the restorative forces within the spring 106. Thereupon, the end 110 of that spring will move away from the left-hand end of the resistance wire 120 and into engagement with the interior of the casing 90. The temperature of that casing will be less than that of the end 110 of the spring 106, and will act to cool that end. Such cooling is desirable because it helps quench any arcs that tend to form as the end 110 moves away from the left-hand end of the resistance wire 120. Also, the reduced width of the end 110 is desirable because it can not supply much metal to any arc which tended to form as the end 110 of the spring 106 moved. The fusible conductor 112 will flex readily when the free end 110 of the spring 106 moves, and will thus not substantially impede that movement. If a very heavy overload or a short circuit were to be applied to the circuit, which is protected by the fuse of FIG. 9, part of the fusible conductor 112 would promptly reach its melting point. That part of that fusible conductor would then fuse; and, in doing so, would open the circuit and thereby protect that circuit from injury.

The spring 106 of the electric fuse of FIG. 9 performs several functions. First, it urges the protuberances 93 and 95 of the mounting 92 into engagement with the interior of the casing 90, and thereby holds that mounting against shifting relative to that casing, despite manufacturing tolerances in the inner diameter of that casing or in the overall width of that mounting. Second, that spring conducts heat from the solder mass 122 to the casing 90, and thereby helps the electric fuse of FIG. 9 to carry transient overloads without interrupting the circuit. The spring 106 also conducts current from the fusible conductor 112 to the resistance wire 120; and, finally, that spring will respond to softening of the solder mass 122 to open the circuit.

Because the spring 106 is in engagement with the interior of the casing 90, that casing will keep that spring cool. This is desirable because it will keep that spring from becoming hot enough to lose any part of the resilience thereof. As a result, that spring will promptly move the end 110 thereof to the position shown by FIG. 12 whenever the solder mass 122 softens.

In the electric fuses of FIGS. 1 and 9, the lengths of the portions of the fusible conductors, which are intermediate the solder masses that secure those fusible conductors to the terminals and to the springs, are at least one-half of the overall lengths of the casings. This is desirable because it makes certain that those fusible conductors will be able to extinguish any arcs that form as those fusible conductors fuse to open the circuit. The fusible conductor 68 of FIG. 5 will be cooled by its engagement with the mounting 54, and also will be able to quench any arcs which form as that fusible conductor fuses to open the circuit.

The mountings 12 and 92, respectively, of the electric fuses of FIGS. 1 and 9 are made so they space the turns of the resistance wires 28 and 120 away from the casings 10 and 92. The spring 62 of the electric fuse of FIG. 5 is made so it spaces the turns of the resistance wire 66 away from the casing 50. Such spacing is desirable because it avoids erratic and unpredictable absorption of heat from those resistance wires by those casings.

FIG. 15 shows a heat-absorbing member 135 that could be interposed between the solder mass 34 and those turns of the resistance wire 28 which are wound onto the short section of the reduced-width portion 20 of the mounting 12 in FIG. 1. That heat-absorbing member also could be interposed between the solder mass 70 and the turns of the fusible conductor 68 in FIG. 5, and could be interposed between the solder mass 122 and those turns of the resistance wire 120 which are intermediate the protuberances 93 and 96. The heat-absorbing member 135 is made of copper, brass, or some other metal having a high value of thermal conductivity; and that member is made so it is U-shaped in configuration. That member

will have the closed end thereof placed over the upper ends of the turns which it is to engage, and will then have the arms thereof crimped into permanent engagement with the front and rear faces of those turns. As a result, that heat-absorbing member will, essentially become a part of those turns; and it will provide increased absorption of heat from the solder mass 34, 70 or 122.

Whereas the drawing and accompanying description have shown and described three 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. A small, dual-element, electric fuse that comprises:
 - (a) a tubular casing of insulating material,
 - (b) a mounting of insulating material that is telescoped within said casing,
 - (c) said mounting having protuberances thereon,
 - (d) protuberances having yieldable projections thereon,
 - (e) said mounting and said protuberances and said projections being dimensioned so said projections yielded as said mounting was telescoped within said casing,
 - (f) said projections holding said mounting against axial or radial movement relative to said casing,
 - (g) said mounting having an elongated portion of reduced-width which helps define a space adjacent said mounting,
 - (h) a projection on said reduced-width portion that divides said reduced-width portion into a long section and a short section,
 - (i) an elongated leaf spring of metal,
 - (j) said spring having a generally, semicylindrical bend in one end thereof,
 - (k) said mounting having a slot therein which opens to the space adjacent said reduced-width portion of said mounting and which can receive said bend in said spring,
 - (l) said slot in said mounting and said bend in said spring being dimensioned so said bend must be stressed as it is introduced into said slot and so said bend will continue to be stressed as long as it remains within said slot,
 - (m) said spring having the other end thereof extending away from said slot and into said space and having the central portion thereof coextensive with part of said reduced-width portion of said mounting,
 - (n) said other end of said spring being in register with, but being biased away from, said short section of said reduced-width portion of said mounting,
 - (o) said mounting having a notch therein adjacent one end thereof,
 - (p) said mounting having a second notch therein adjacent the other end thereof,
 - (q) a resistance wire having one end thereof disposed in the first said notch in said mounting having the major portion of the length thereof wound in helical fashion on said long section of said reduced-width portion of said mounting, and having the other end thereof wound in helical fashion on said short section of reduced-width portion of said mounting,
 - (r) said resistance wire being bare and having the turns of said major portion thereof spaced apart,
 - (s) said resistance wire having the turns of said other end thereof closely adjacent each other,
 - (t) a heat-absorbing member in engagement with said turns of said other end of said resistance wire,
 - (u) a fusible conductor having one end thereof disposed within said second notch in said mounting and having the other end thereof bonded to said spring,
 - (v) said fusible conductor having the portion thereof, which is intermediate said ends thereof, coextensive

with part of said reduced-width portion of said mounting, and

- (w) low-melting point solder that engages and releasably bonds said other end of said spring to said heat-absorbing member and to said other end of said resistance wire,
- (x) said resistance wire being supported directly by said mounting, said one end of said spring being supported by said mounting, said one end of said fusible conductor being supported by said mounting, said heat-absorbing member and said low-melting point solder and said other end of said resistance wire and said mounting supporting said other end of said spring, and said spring supporting said other end of said fusible conductor,
- (y) said spring coacting with said low-melting point solder, as long as said low-melting point solder, retains its holding power, to connect said fusible conductor to said heat-absorbing member and said other end of said resistance wire,
- (z) said spring responding to softening of said low-melting point solder to move away from said heat-absorbing member and said other end of said resistance wire to open the circuit,
 - (aa) said mounting, said heat absorbing member, and said spring absorbing heat from said low-melting point solder,
 - (ab) said other end of said spring normally being spaced from the interior of said casing but being adapted to engage and to be cooled by said interior of said casing when said low-melting point solder softens,
 - (ac) said mounting, said spring, said resistance wire, said heat-absorbing member, said fusible conductor, and said low-melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing,
 - (ad) said casing and said sub-assembly constituting a single operative structure.
2. An electric fuse that comprises:
 - (a) a casing and a mounting of insulating material disposed within said casing,
 - (b) said mounting having an elongated portion of reduced-width which helps define a space adjacent said mounting,
 - (c) a projection on said reduced-width portion that divides said reduced-width portion into a long section and a short section,
 - (d) an elongated leaf spring of metal,
 - (e) interacting surfaces on said mounting and on one end of said spring to hold said mounting and said spring in assembled relation,
 - (f) said spring having the other end thereof extending away from said interacting surfaces and into said space and having the central portion thereof coextensive with part of said reduced-width portion of said mounting,
 - (g) said other end of said spring being in register with, but being biased away from, said short section of said reduced-width portion of said mounting,
 - (h) said mounting having a notch therein adjacent one end thereof,
 - (i) said mounting having a second notch therein adjacent the other end thereof,
 - (j) a resistance wire having one end thereof disposed in the first said notch in said mounting, having the major portion of the length thereof wound in helical fashion on said long section of said reduced-width portion of said mounting, and having the other end thereof wound in helical fashion on said short section of said reduced-width portion of said mounting,
 - (k) said resistance wire having the turns of said other end thereof closely adjacent each other,
 - (l) a fusible conductor having one end thereof disposed

- within said second notch in said mounting and having the other end thereof bonded to said spring,
- (m) said fusible conductor having the portion thereof, which is intermediate said ends thereof, coextensive with part of said reduced-width portion of said mounting, and
- (n) low melting point solder that engages and releasably bonds said other end of said spring to said resistance wire,
- (o) said resistance wire being supported directly by said mounting, said one end of said spring being supported by said mounting, said one end of said fusible conductor being supported by said mounting, said low melting point solder and said other end of said resistance wire and said mounting supporting said other end of said spring, and said spring supporting said other end of said fusible conductor,
- (p) said spring coacting with said low melting point solder, as long as said low melting point solder retains its holding power, to connect said fusible conductor to said other end of said resistance wire,
- (q) said spring responding to softening of said low melting point solder to move away from said other end of said resistance wire to open the circuit,
- (r) said mounting and said spring absorbing heat from said low melting point solder,
- (s) said other end of said spring normally being spaced from the interior of said casing but being adapted to engage and to be cooled by said interior of said casing when said low melting point solder softens,
- (t) said interacting surfaces including an ear and a slot in said mounting and an opening in said one end of said spring,
- (u) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a subassembly that can be handled as a unit and that can be bodily telescoped into said casing.
3. An electric fuse that comprises:
- (a) a casing and a mounting disposed within said casing,
- (b) said mounting having an elongated portion,
- (c) an elongated leaf spring of metal,
- (d) interacting surfaces on said mounting and on said spring to hold said mounting and said spring in assembled relation,
- (e) said spring having the other end thereof extending away from said interacting surfaces,
- (f) a resistance wire having one end thereof adjacent one end of said mounting, having the major portion of the length thereof wound on said mounting, and having the other end thereof intermediate the ends of said mounting,
- (g) a fusible conductor having one end thereof adjacent the other end of said mounting and having the other end thereof bonded to said spring,
- (h) said fusible conductor having the portion thereof, which is intermediate said ends thereof, supported by said mounting, and
- (i) low melting point solder that engages and releasably bonds said other end of said spring to said resistance wire,
- (j) said resistance wire being supported directly by said mounting, said one end of said spring being supported by said mounting, said one end of said fusible conductor being supported by said mounting, said low melting point solder and said other end of said resistance wire and said mounting supporting said other end of said spring, and said spring supporting said other end of said fusible conductor,
- (k) said spring coacting with said low melting point solder, as long as said low melting point solder retains its holding power, to connect said conductor to said resistance wire,
- (l) said spring responding to softening of said low melt-

- ing point solder to move away from said resistance wire to open the circuit,
- (m) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing.
4. A dual-element, electric fuse that comprises:
- (a) a casing and a mounting disposed within said casing,
- (b) a fusible conductor that is mounted on and supported by said mounting,
- (c) a resistance wire that is mounted on and supported by said mounting,
- (d) a spring that is mounted on and supported by said mounting, and
- (e) low melting point solder that engages and releasably holds said spring in stressed condition and that releasably maintains said resistance wire in electrically-conducting relation with said fusible conductor,
- (f) said low melting point solder being adapted to soften and release said spring and thereby enable said spring to cause interruption of said electrically-conducting relation between said fusible conductor and said resistance wire,
- (g) a portion of said resistance wire receiving said low melting point solder and thus serving as a contact for said electric fuse,
- (h) said portion of said resistance wire being adjacent one end of said resistance wire,
- (i) said spring coacting with said low melting point solder, as long as said low melting point retains its holding power, to connect said fusible conductor to said resistance wire,
- (j) said spring responding to softening of said low melting point solder to move and thereby interrupt said electrically-conducting relation between said fusible conductor and said resistance wire,
- (k) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing,
- (l) said casing and said sub-assembly constituting a single operative structure,
- (m) said mounting being elongated and engaging the interior of said casing at points spaced along the length of said interior to substantially prevent lateral relative movement between said mounting and said casing,
- (n) said mounting directly engaging and supporting said resistance wire and said spring and said fusible conductor and thereby substantially holding same against movement relative to each other and relative to said casing prior to the softening of said low melting point solder.
5. A dual-element, electric fuse that comprises:
- (a) a casing and a mounting disposed within said casing,
- (b) a fusible conductor that is mounted on and supported by said mounting,
- (c) a resistance wire that is mounted on and supported by said mounting,
- (d) a spring that is mounted on and supported by said mounting, and
- (e) low melting point solder that engages and releasably holds said spring in stressed condition and that releasably maintains said resistance wire in electrically-conducting relation with said fusible conductor,
- (f) said low melting point solder being adapted to soften and release said spring and thereby engage said spring to cause interruption of said electrically-

conducting relation between said fusible conductor and said resistance wire,

- (g) said spring being an elongated, leaf spring that is generally parallel to said mounting,
 - (h) said fusible conductor being, in part, coextensive with said spring and having portions thereof oppositely disposed of said low melting point solder,
 - (i) said spring coacting with said low melting point solder, as long as said low melting point solder retains its holding power, to connect said fusible conductor to said resistance wire,
 - (j) said spring responding to softening of said low melting point solder to move and thereby interrupt said electrically-conducting relation between said fusible conductor and said resistance wire,
 - (k) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing,
 - (l) said casing and said sub-assembly constituting a single operative structure,
 - (m) said mounting being elongated and engaging the interior of said casing at points spaced along the length of said interior to substantially prevent lateral relative movement between said mounting and said casing,
 - (n) said mounting directly supporting the major portion of the length of said resistance wire and said spring and at least a portion of said fusible conductor and thereby substantially holding same against movement relative to each other and relative to said casing prior to the softening of said low melting point solder.
6. An electric fuse that comprises:
- (a) a casing and a mounting disposed within said casing,
 - (b) a fusible conductor that is mounted on and supported by said mounting,
 - (c) a resistance wire,
 - (d) a spring that is mounted on and supported by said mounting, and
 - (e) low melting point solder that engages and releasably holds said spring in stressed condition and that releasably maintains said resistance wire in electrically-conducting relation with said fusible conductor,
 - (f) said low melting point solder being adapted to soften and release said spring and thereby enable said spring to cause interruption of said electrically-conducting relation between said fusible conductor and said resistance wire,
 - (g) said spring coacting with said low melting point solder, as long as said low melting point solder retains its holding power, to connect said fusible conductor to said resistance wire,
 - (h) said spring responding to softening of said low melting point solder to move and thereby interrupt said electrically-conducting relation between said fusible conductor and said resistance wire,
 - (i) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing,
 - (j) said casing and said sub-assembly constituting a single operative structure,
 - (k) said mounting being elongated and engaging the interior of said casing at points spaced along the length of said interior to substantially prevent lateral relative movement between said mounting and said casing,
 - (l) said mounting supporting said spring and the major portion of the length of said resistance wire and at least a portion of said fusible conductor and thereby substantially holding same against movement relative to each other and relative to said casing prior to the softening of said low melting point solder.

thereby substantially holding same against movement relative to each other and relative to said casing prior to the softening of said low melting point solder.

7. An electric fuse that comprises:

- (a) a casing and a mounting disposed within said casing,
 - (b) a fusible conductor that is mounted on and supported by said mounting,
 - (c) a resistance wire,
 - (d) a spring that is mounted on and supported by said mounting, and
 - (e) low melting point solder that engages and releasably holds said spring in stressed condition and that releasably maintains said resistance wire in electrically-conducting relation with said fusible conductor,
 - (f) said low melting point solder being adapted to soften and release said spring and thereby enable said spring to cause interruption of said electrically-conducting relation between said fusible conductor and said resistance wire,
 - (g) said resistance wire having the major portion of the length thereof spaced out of engagement with the casing for said electric fuse,
 - (h) said fusible conductor having the major portion of the length thereof spaced out of engagement with the casing for said electric fuse,
 - (i) said spring coacting with said low melting point solder, as long as said low melting point solder retains its holding power, to connect said fusible conductor to said resistance wire,
 - (j) said spring responding to softening of said low melting point solder to move and thereby interrupt said electrically-conducting relation between said fusible conductor and said resistance wire,
 - (k) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing,
 - (l) said casing and said sub-assembly constituting a single operative structure,
 - (m) said mounting being elongated and engaging the interior of said casing at points spaced along the length of said interior to substantially prevent lateral relative movement between said mounting and said casing,
 - (n) said mounting supporting said spring and the major portion of the length of said resistance wire and at least a portion of said fusible conductor and thereby substantially holding same against movement relative to each other and relative to said casing prior to the softening of said low melting point solder.
8. An electric fuse that comprises:
- (a) a casing and a mounting disposed within said casing,
 - (b) a fusible conductor that is mounted on and supported by said mounting,
 - (c) a resistance wire,
 - (d) a spring that is mounted on and supported by said mounting, and
 - (e) low melting point solder that engages and releasably holds said spring in stressed condition and that releasably maintains said resistance wire in electrically-conducting relation with said fusible conductor,
 - (f) said low melting point solder being adapted to soften and release said spring and thereby enable said spring to cause interruption of said electrically-conducting relation between said fusible conductor and said resistance wire,
 - (g) said resistance wire having the major portion of the length thereof wound on and supported by said spring,

- (h) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing, 5
- (i) said casing and said sub-assembly constituting a single operative structure,
- (j) said mounting being elongated and engaging the interior of said casing at points spaced along the length of said interior to substantially prevent lateral relative movement between said mounting and said casing, 10
- (k) said mounting supporting both ends of said spring and thereby supporting said major portion of said length of said resistance wire and also supporting at least a portion of said fusible conductor and thereby substantially holding same against movement relative to each other and relative to said casing prior to the softening of said low melting point solder. 15
- 9. An electric fuse that comprises: 20
 - (a) a casing and a mounting disposed within said casing,
 - (b) a fusible conductor that is mounted on and supported by said mounting,
 - (c) a resistance wire supported and carried by said mounting, 25
 - (d) a spring that is mounted on and supported by said mounting, and
 - (e) low melting point solder that engages and releasably holds said spring in stressed condition and that releasably maintains said resistance wire in electrically-conducting relation with said fusible conductor. 30
 - (f) said low melting point solder being adapted to soften and release said spring and thereby enable said spring to cause interruption of said electrically-conducting relation between said fusible conductor and said resistance wire, 35
 - (g) said resistance wire being bare but having adjacent portions thereof electrically isolated, 40
 - (h) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing,
 - (i) said casing and said sub-assembly constituting a single operative structure, 45
 - (j) said mounting being elongated and engaging the interior of said casing at points spaced along the length of said interior to substantially prevent lateral relative movement between said mounting and said casing, 50
 - (k) said mounting supporting said spring and the major portion of the length of said resistance wire and at least a portion of said fusible conductor and thereby substantially holding same against movement relative to each other and relative to said casing prior to the softening of said low melting point solder. 55
- 10. An electric fuse that comprises:
 - (a) a casing, 60
 - (b) a mounting that is telescoped within said casing,
 - (c) said mounting being substantially inflexible and having substantially inflexible protuberances thereon,
 - (d) said protuberances having yieldable projections thereon, 65
 - (e) said mounting and said protuberances and said projections being dimensioned so said projections yielded as said mounting was telescoped within said casing,
 - (f) said projections holding said mounting against axial or radial movement relative to said casing, 70
 - (g) a resistance wire supported and carried by said mounting,
 - (h) a fusible conductor supported and carried by said mounting, and 75

- (i) low melting point solder that engages and releasably holds said resistance wire and said fusible conductor in electrically-conducting relation,
- (j) said mounting, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing,
- (k) said casing and said sub-assembly constituting a single operative structure.
- 11. An electric fuse that comprises:
 - (a) a casing,
 - (b) a mounting that is telescoped within said casing,
 - (c) said mounting being substantially inflexible and having substantially inflexible protuberances thereon,
 - (d) said protuberances having yieldable projections thereon,
 - (e) said mounting and said protuberances and said projections being dimensioned so said projections yielded as said mounting was telescoped within said casing,
 - (f) said projections holding said mounting against axial or radial movement relative to said casing,
 - (g) a fusible conductor supported on and carried by said mounting, and
 - (h) terminals on said casing that are normally in electrically-conducting relation with said fusible conductor,
 - (i) said fusible conductor and said mounting interacting with each other to make said fusible conductor resistant to shock and fatigue,
 - (j) said mounting and said fusible conductor constituting a sub-assembly that can be handled as a unit and that can be bodily inserted into said casing,
 - (k) said casing and said sub-assembly constituting a single operative structure.
- 12. An electric fuse that comprises:
 - (a) a casing and a mounting disposed within said casing,
 - (b) a fusible conductor that is mounted on and supported by said mounting,
 - (c) a resistance wire that is mounted on and supported by said mounting,
 - (d) a spring that is mounted on and supported by said mounting,
 - (e) one end of said resistance wire being adjacent one end of said spring,
 - (f) a heat-absorbing member secured to said one end of said resistance wire, and
 - (g) low melting point solder that engages and releasably holds said spring in stressed condition and that releasably maintains said free end of said spring adjacent said heat-absorbing member, whereby said low melting point solder can hold said resistance wire in electrically-conducting relation with said fusible conductor,
 - (h) said low melting point solder being adapted to soften and release said spring and thereby enable said spring to cause interruption of said electrically-conducting relation between said fusible conductor and said resistance wire,
 - (i) said mounting, said spring, said resistance wire, said heat-absorbing member, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing,
 - (j) said casing and said sub-assembly constituting a single operative structure,
 - (k) said mounting being elongated and engaging the interior of said casing at points spaced along the length of said interior to substantially prevent lateral relative movement between said mounting and said casing,
 - (l) said mounting supporting said spring and the major portion of the length of said resistance wire and at least a portion of said fusible conductor and thereby substantially holding same against movement relative

to each other and relative to said casing prior to the softening of said low melting point solder.

13. An electric fuse that comprises:

- (a) a casing,
 - (b) a mounting that is telescoped within said casing, 5
 - (c) an elongated leaf spring having one end thereof secured to said mounting,
 - (d) a resistance wire having the major portion of the length thereof wound on said mounting and having one end thereof secured to said mounting, 10
 - (e) a fusible conductor having one end thereof secured to said mounting and having the other end thereof bonded to said spring,
 - (f) said fusible conductor having the portion thereof, which is intermediate said ends thereof, coextensive with part of said mounting, and 15
 - (g) low melting point solder that engages and releasably bonds the other end of said spring to said resistance wire,
 - (h) said one end and said major portion of the length 20 of said resistance wire being supported directly by said mounting, said one end of said spring being supported by said mounting, said one end of said fusible conductor being supported by said mounting, said low melting point solder and said resistance wire 25 and said mounting supporting said other end of said spring, and said spring supporting said other end of said fusible conductor,
 - (i) whereby said electric fuse is strongly resistant to shock and vibration, 30
 - (j) said spring coacting with said low melting point solder, as long as said low melting point solder retains its holding power, to connect said fusible conductor to said resistance wire,
 - (k) said spring responding to softening of said low 35 melting point solder to move away from said resistance wire to open the circuit,
 - (l) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be 40 handled as a unit and that can be bodily telescoped into said casing,
 - (m) said mounting being sturdy and extending from end to end of said casing and being held substantially stationary within said casing, 45
 - (n) said mounting substantially holding said resistance wire and said spring and said fusible conductor against movement relative to each other and relative to said casing prior to the softening of said low melting point solder, 50
 - (o) said casing and said sub-assembly constituting a single operative structure.
- 14. An electric fuse that comprises:**
- (a) a casing and a mounting disposed within said casing, 55
 - (b) a conductor that engages and that extends from one end of said mounting toward the other end of said mounting,
 - (c) a second conductor that engages and that extends from said other end of said mounting toward said one end of said mounting, 60
 - (d) a spring,
 - (e) one of said conductors having closely adjacent turns that constitute a contact for said electric fuse, and 65
 - (f) low melting point solder that engages and releasably holds said spring in engagement with said closely adjacent turns of said one conductor and thereby releasably holds said conductors in electrically-conducting relation, 70
 - (g) said spring coacting with said low melting point solder, as long as said low melting point solder retains its holding power, to maintain said electrically-conducting relation,
 - (h) said spring responding to softening of said low 75

melting point solder to move away from said closely adjacent turns of said one conductor and thereby interrupt said electrically-conducting relation to open the circuit,

- (i) said mounting, said conductors, said spring, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily introduced into said casing,
 - (j) said casing and said sub-assembly constituting a single operative structure,
 - (k) said mounting being elongated and engaging the interior of said casing at points spaced along the length of said interior to substantially prevent lateral relative movement between said mounting and said casing,
 - (l) said mounting supporting said spring and the major portion of the length of said one conductor and at least a portion of said second conductor and thereby substantially holding same against movement relative to each other and relative to said casing prior to the softening of said low-melting point solder.
- 15. An electric fuse that comprises:**
- (a) a casing and a mounting disposed within said casing,
 - (b) a resistance wire supported on and carried by said mounting,
 - (c) a fusible conductor supported on and carried by said mounting,
 - (d) a spring supported on and carried by said mounting, and
 - (e) a low melting point solder that engages and releasably holds said resistance wire and said fusible conductor in electrically-conducting relation but that can respond to heat to permit said spring to cause interruption of said electrically-conducting relation,
 - (f) said resistance wire having the length and the cross section thereof dimensioned to provide a predetermined thermal mass,
 - (g) said spring coacting with said low melting point solder, as long as said low melting point solder retains its holding power, to maintain said electrically-conducting relation,
 - (h) said spring responding to softening of said low melting point solder to interrupt said electrically-conducting relation and thereby open the circuit,
 - (i) said mounting, said spring, said resistance wire, said fusible conductor, and said low melting point solder constituting a sub-assembly that can be handled as a unit and that can be bodily telescoped into said casing,
 - (j) said casing and said sub-assembly constituting a single operative structure,
 - (k) said mounting being elongated and engaging the interior of said casing at points spaced along the length of said interior to substantially prevent lateral relative movement between said mounting and said casing,
 - (l) said mounting supporting said spring and the major portion of the length of said resistance wire and at least a portion of said fusible conductor and thereby substantially holding same against movement relative to each other and relative to said casing prior to the softening of said low melting point solder.

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